Design Strategies for the Ageing Society
– Focused on healthcare products –

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Abstract: As the population is ageing, a number of healthcare products and related services are introduced for supporting the elderly group. Many disciplines such as medicine and management offer strategies and countermeasures to meet the ageing changes. This paper introduces the possible key strategies for designers to create new products and services. The propositions were explored and tested to design portable healthcare products for the elderly at the final synthesis studio class of the academic year 2008/2009 in Politecnico di Milano. The new blood glucose monitor, wearable ECG (Electro Cardio-Graphy) recording system and automated external defibrillator show the designerly contribution for the ageing society.

Key words: Design strategy, Ageing, Healthcare

1. Introduction
The population is ageing world-widely and afflicted with chronic diseases. Healthcare has reached an important turning point [15]. In fact, the assistance and healthcare for such an old society means higher costs for national health systems. France, United Kingdom, Holland, Austria, Italy and other countries granted national programs in order to face this emerging problem. Telemedicine and home-care have been suggested as a solution to face chronic pathologies and support disabled people. This allows the reduction of the overall costs while maintaining high quality of care and providing an easy access to care for citizens from any place at any time. This situation also shifts the focus of healthcare from treatment to prevention and early diagnosis through wellness programs. The first issue to be faced and solved is technology. However, the other key factor is how to use and show the technology. In this sense, designers on the front line to form the future need design strategies for the ageing society. Design to change healthcare experiences and improve daily living is more in demand than ever.

In the didactics by the Faculty of Design in Politecnico di Milano, this topic was dealt with a class of students carrying out their final projects for the bachelor’s degree. Under the theme of ‘Design and Health’, a group of students was asked to design especially portable products for the elderly. The three sample projects in this paper, a wearable ECG (Electro Cardio-Graphy) recording system, a blood glucose monitor and an automated external defibrillator, were chosen to highlight design innovation with emerging technologies. These products show the needs and idiosyncrasies of whom have popular health conditions following ageing. Moreover, the process, from research and ideation to product and technical design, is connected with design strategies for the ageing society.
2. The goal and process

2.1 The goal of the project

According to the publication of United Nations in 2005, 20% of today’s population is aged 60 years or over, and by 2050 this portion of the population will be up to 32 percent. Today, just 11 developed countries have a median age above 40 years. By 2050, there will be 90 countries in that group. Ageing population, which is becoming a pervasive reality in developed countries, is also inevitable in the developing world and will occur faster in developing countries [19]. The largest percentage of the healthcare cost is originated from rapid explosion of the elderly population. Thus, cheaper and better healthcare products for the old are needed. Studies also show that due to fast developing smart and wearable biosensor technology, the focus of the future healthcare will be more in prevention than cure [8].

The range of medical instruments and aids is very wide. However, the products and services are often evaluated as inadequate or inaccessible both for experts (clinicians) and not skilled users (patients and their families). What is more, they can be a stigma or harm users if human factors are not considered carefully. In that case, consequently the products are not accepted by users despite of their functional advantages. Therefore, designing healthcare products needs consideration not only for technological performance but also for users and the use context.

2.2 The process

The group of ‘Portable products for the elderly’ was intended to understand the ageing users at various levels from individuals to the society, find out the desirabilities, and execute design innovation radically. To understand explicit and latent needs, emphasis had been given to ethnographic approaches [11]. Each student met the related user groups like old women with diabetes, and doctors and medics who have used defibrillators. The group also visited ‘Fondazione Castellini’, a nursing home in Milano, and interviewed doctors, therapists and residents. To define what to change and how to intervene, students also investigated the trend of existed products and related research, and tried to find the market insight. They were encouraged to find unsolved needs, and show designerly innovation to improve experiences with the newest technologies.

Before deciding product concepts, students had a discussion for future products with ‘what if’ questions all together [1]. To test various possibilities and find the right direction, quick prototyping helped idea seeds evolved. To express concepts on body boundaries, various ideas were introduced. In addition, cognitive and physical ergonomic data on the elderly guided the design to be customized for the actual users.

3. Understanding of ageing

3.1 Active ageing and the elderly

An old person has to live independently with chronic conditions. Besides chronic diseases, the old have age-related disabilities including vision and hearing loss. About 88% of people older than 65 have at least one chronic health condition, and in many cases the condition impairs function and well-being. Services and supporting systems to extend healthy life expectancy and quality of life for all people as they age are under discussion from various angles such as Active ageing, the WHO’s policy framework.
Active ageing is the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age. Active ageing applies to both individuals and population groups. It allows people to realize their potential for physical, social, and mental well-being throughout the life course and to participate in society according to their needs, desires and capacities, while providing them with adequate protection, security and care when they require assistance. Maintaining autonomy and independence as one grows older is a key goal for individuals. Moreover, ageing takes place within the context of others – friends, work associates, neighbors and family members. This is why interdependence as well as intergenerational solidarity are important tenets of active ageing. Personal responsibility (self-care), age-friendly environments and intergenerational connection need to be encouraged and balanced. Individuals and families need to plan and prepare for older age, and make personal efforts to adopt positive personal health practices at all stages of life. At the same time supportive environments are required to ‘make the healthy choices the easy choices’ [13].

3.2 Technology for supporting the elderly

The focus of healthcare has shifted from treatment to prevention and health promotion. The necessity to increase the potential impact of home-care solutions is a complex and multi-facet problem where coexists different technological issues among biosignals monitoring, data communications and preliminary automated signal analysis able to cover such an important share of population.

The need to accomplish the challenges motivated the research and development in the field of Wearable Health Systems (WHSs). WHSs are integrated systems on body-worn platforms like wrist-worn devices or biomedical clothes, offering pervasive solutions for continuous health status monitoring through non-invasive biomedical, biochemical and physical measurements [9]. WHSs provide an ideal platform for remote health status monitoring for primary and secondary prevention, early diagnosis and disease management, but also support for elderly people in need. WHSs enable, in particular, unobtrusive multi-parametric monitoring including body-kinematics, vital signs, biochemical as well as emotional and sensorial parameters by taking into account a given social and environmental context. Under these perspectives, WHSs are expected to have a significant impact on the efficacy, quality of care, and citizens’ quality of life [4].

WHSs integrate a plurality and complexity of disciplines and challenges. Each of them is necessary even in its apparent simplicity: sensors, actuators, materials, wireless communication, power supply and management, control unit, data processing, user interface, new algorithms for biosignal analysis, connectors, sensors washability and stability over time and external conditions, sensors positioning on the human body according to the movements and activities to be monitored, human anthropometry, elasticity of clothes and adherence to the skin, and other minor characteristics to be faced.

Regarding technology, the current state of the art has achieved a good level of maturity to be ported into industrialization and the market. But another key factor which is still immature is ergonomics or human factor in terms of usability, comfort and acceptance of the device by the end users. In connection with these issues, one of the main objectives of ongoing research in WHS is to fulfill the aforementioned requirements for enhanced user-
friendliness, affordability and monitoring capabilities in several clinical applications [4]. Hence, design can change the experience or wearability, and evolve the supporting technologies for the elderly to the next level.

4. Results

4.1 Blood glucose meter

Diabetes is a group of diseases that lead to high blood glucose levels due to defects in either insulin secretion or insulin action. Type 1 diabetes has universally called as childhood-onset diabetes, juvenile diabetes, and insulin-dependent diabetes mellitus (IDDM). Type 2 diabetes also has been called as adult-onset diabetes, obesity-related diabetes, and non-insulin-dependent diabetes mellitus (NIDDM) [17]. The prevalence of diabetes increases with ageing. The numbers of old persons with diabetes are expected to increase as the elderly population is rising rapidly. It is a chronic disease without a cure, and medical emphasis is on managing and avoiding diabetes-related problems. There is an exceptionally important role for patient education, dietetic support, sensible exercise and self monitoring of blood glucose. To check the value of blood glucose, a small drop of blood obtained by pricking the skin with a lancet is placed on a test strip, which the meter reads and uses to calculate the blood glucose level. Many research programs are in progress for non-invasive methods but at present non-invasive glucose meters are not available in the market [16].

Most of popular glucose meters are not customized for the elderly users. A glucose meter for an old person with visual impairment and dull senses cannot be same with a glucose meter for a teenager. Many old people are often dubious about new technologies and inflexible to changes. The group of the elderly may be one of the most vulnerable and sensitive users. For this reason, the aim of a new glucose meter was to respond to not only the physical needs but also the emotional and psychological needs of the elderly with diabetes.

To help the target users to be free from the current limits in daily living, the designer investigated the available technologies and decided to make use of ‘occlusion spectroscopy’. The technology which has been developed by OrSense in Israel and approved by FDA measures blood glucose non-invasively and optically [18]. While mild pressure occludes the blood flow of a finger, the level of glucose is measured by the light which is transmitted through the finger. This enables continuous and painless measurement of blood glucose. The conversations from the interviews which the designer with several old people had guided the new design to focus on simplicity and ease to understand and use.

Considering the electronic components and the area of measurement, the first concept was started from a form of a watch linked to a ring, the most popular belongings to an old person. Throughout repeated revisions for internal elements, the new glucose meter named Glucoeasy was set to a simple watch having a very small transparent pipe. The pipe, which is rolled up inside the glucose meter when it is not used, is stretched out to a ring for measuring blood glucose. The adjustable watch-strap has an USB port to transfer data to computers and to recharge the battery.
The design of Glucoeasy was intended to be as ordinary as possible. As the role of well-controlled blood glucose is important for the prognosis of diabetes, a good design to encourage and enable an old person to manage his glucose level actively and continuously can be another name of treatment. Bigger text size or stickers of nice patterns to be attached on a glucose meter can improve the user experience incrementally. However, when a new technology are ready for radical change, the role to realize desirable ways and connect the needs and the right solution can be designers’.

4.2 Portable ECG (Electro Cardio-Graphy)
As individuals age, noncommunicable diseases (NCDs) like cardiovascular diseases become the leading causes of morbidity, disability and mortality in all regions of the world, and are costly to individuals, families and the public purse. But many NCDs are preventable or can be postponed. Failing to prevent the growth of NCDs appropriately will result in enormous human and social costs that will absorb a disproportionate amount of resources [14].

The ECG is the most common signal and technology used in cardiovascular monitoring. The portable versions of ECG monitors are definitely very useful when continuous monitoring is needed for chronic heart pathologies. However, the industrial look of the device repels users from the device and it disturbs the patients to behave normally which is the most important condition of ECG monitoring. Traditional ‘cyborg looking’ arrangement of portable ECG monitors including main ECG recorder, electrodes, wires and strap could potentially discourage patients who are undergoing ECG monitoring.

A detailed market research showed that there are no product that satisfies both compatibility and comfort. Most products lay between ‘good compatibility’ with ‘bad comfort level’ or ‘bad compatibility’ with ‘good comfort level’. The problems of current products are recapitulated in the following points;

1) Users need to write down time and what they were doing when they go through symptoms. However, the elderly may forget this instruction, and this step is quiet annoying when they want to concentrate on something else.
2) The device is very uncomfortable. The electrodes may come off easily and it gets in the way when the user is trying to change his clothes or when he is sleeping.
3) The appearance of the device is so industrial that the users unconsciously avoid what they are wearing.
4) It is not a very pleasant experience to be hooked up with lots of electrical wires.

In order to solve the problems stated above, rather than using traditional 12-lead configuration which requires 10 electrodes, the ‘Reduced lead set technology’ is used. Technical advancements now enable all 12 views of the heart on a continuous basis to be obtained by just 5 electrodes [7]. In addition, one of the most promising user friendly solutions is the smart clothing system. Accompanying the new lead configuration, several different arrangements of the wearable devices were studied. As the device is normally rented from the hospital and returned within couple of days, it is also important that the device can be washed out after one use. Furthermore, the device also should be fitted to men as well as women. Both male and female patients with underwear need to be comfortable while they are being monitored.

The concept of the new portable ECG was to mimic sport wears as much as possible so it does not seem like a medical device but a normal wear. It consists of removable battery and main processor, disposable electrodes and embedded smart textile that transfer data from electrodes to the processor. The thickest hardware, processor and battery are placed on the front side so that when the patient is sleeping with the device on, it will disturb the patient least. The garment portion which wraps around the patient’s body is made up of soft and stretch material. Accordingly, the electrodes automatically find their position and it is very comfortable to patients. There are no dangling parts outside because all the wires are hidden in the garment. The battery and processor can be removed for recharging and the analysis of the gathered data. The disposable electrodes will be replaced with new ones for another patient. With all parts removed, the garment can simply be washed with a washing machine. During all this process from a patient wearing the device to the device being washed, literally there is nothing the patient has to do. The patient simply has to keep it on his/her body for designated length of time.

![Figure 2. The new portable ECG designed by Younkwang Cho (2009)](image)

The new portable ECG concept suggests that healthcare for an old patient should not just be an attempt to extend his life. An attempt to extend life is meaningful only when the user really agrees to the process or he is not disturbed by it. If the procedure makes the person depressed or lose desire to live because of unfriendly look & feel of medical examination, it can be a big challenge to designers to transform the experience positively.

4.3 AED (Automatic External Defibrillator)

When cardiac arrest happens, defibrillation is the only way to solve the sudden accident which is the leading
cause of mortality in the world. In 2005, 17.5 million people died from cardiovascular diseases (CVDs), representing 30\% of all global deaths [20]. WHO predicts that before 2020, nearly 40\% of all deaths will be related to cardiac diseases. The ageing population and consequent increase in the number of cardiac arrests support the high growth rate of the market. In addition, timing is critical to patients’ survival. At every minute after cardiac arrest, the chance of survival decreases by 7\%-10\%. Public awareness of sudden cardiac arrest and the need for immediate treatment have resulted in increased demand for defibrillators. To reduce the time between cardiac arrest and defibrillation, some initiatives such as PAD (Public Access Defibrillation) were introduced to keep defibrillators in public areas [6].

An Automated External Defibrillator (AED) consists of a central unit and a set of two electrodes. The central unit provides a source of power and control. The device is designed to deliver electric shock to a patient, in an effort to stop irregular heart rhythms. The two electrodes are placed directly on the thorax in fixed positions to make the shock passing through ventricles. Including a medical scissor to cut clothes and a razor to cut hair against electric impedance, the whole components are contained inside a small case [2].

Mostly, AEDs are operated by trained persons but the trend to purchase AEDs to be used at home makes concerns that users without appropriate training may operate them. Considering this, the new AED of this project was designed targeting lay rescuers in public areas like universities, companies, shopping centres, etc. To provide the certain usability for any case of emergency, the structure needs to clearly explain the steps to follow. The designer tried to make distinct connections between each action and relevant parts. In the new AED, when an operator opens the package, the person can find the necessaries according to the order and go forward as he sees below;

1) Laying the patient in supine position
2) Taking away clothes
3) Performing CPR (CardioPulmonary Resuscitation)
4) Removing hairs on the chest if needed
5) Attaching the electrodes on the chest following the color and guide map. When the electrodes are taken away, the last 3 steps are shown.
6) Scanning the patient’s ECG with the green button
7) The result is provided on the display as one of 3 possible types: a) If the scanning was failed, the user has to attach the electrodes again; b) If the scanning was done successfully and the cardiac rhythm is not evaluated as fibrillation, 8) is not required; c) If the scanning was done successfully and evaluated as fibrillation, the operator should go on to 8).
8) Applying shock with the red button.

A number of defibrillators have been introduced in the market. This new AED is differentiated from other products because it clearly explains what to do next and helps users to concentrate on operating even when the surroundings are very noisy or skilled aids are not available. Defibrillators and AEDs in public areas are the best example to show how ageing changes the society and system. An old person can be a major target which AED is applied to but in fact, he is not the user. However, the product asks designers to consider not only users but also
related people, and not only a product but also the related system and environment.

Figure 3. The new AED designed by Lucia Turco (2009)

5. Design strategies for the elderly and the society

Strategy is a matter of choice rather than truth [1]. When designers make healthcare products for the elderly, there would be many possible directions and solutions. However, considering a number of issues around an old person and the surroundings, some strategies can take precedence over others. The design strategies below were the particular propositions which were suggested to be explored and tested for new products. Each strategy can be transformed to 'what if’ hypothesis.

5.1 Design should enhance quality of experience as well as quality of healthcare.

Care receivers and care providers have their own different needs for one product at the same time. For patients as users, safety and comfortability may come first. On the other hand, for clinicians as users, accuracy would be more important. However, a healthcare product is more than an usual product. The moment to use the product is included to the user's long healthcare journey. To provide healing experiences beyond consumption can be the ultimate goal of a healthcare product. Therefore, designers need to meet the different needs and find the optimum solution, and create better quality for experience as well as healthcare.

5.2 Design should have an active role to harness technology for radical innovation.

New technology can provide completely different opportunities which were not available before. If the level of blood glucose can be measured without blood, people do not have to use popular invasive glucometer in public areas any more. As medical technology evolves, how to use technology is a critical issue. Before technologies meet basic needs, users are satisfied with better technology and more features. But once technologies are sufficient, people prefer convenience and aesthetics to functions and performance, and technology becomes subservient to healthcare stories [10]. Good design creates products and experiences that not only satisfy a function or solve a problem but are also compelling and delightful [3]. When designers redefine a product and its usability in more human ways, the gap between people's needs and technological advance can be filled with design innovation.

5.3 Design should enable active well-being.

People are re-defining their wellbeing, not so much in material ways but more in terms of health and wellness,
connectedness, personal growth and personal control [5]. If a healthcare product helps to manage an old person’s chronic conditions, it would be nice. But if the product can enable his capability and promote the active attitude, it would be great. Ageing actively and elegantly is a common interest. If designers investigate users' conditions at all stages and figure out the desirabilities beyond problem solving, a new design can encourage old people to improve their own capacity for self-care.

5.4 Design should connect care and support networks.
A healthcare product does not stand alone. The data from a blood glucose meter is transmitted to the server and shared with clinicians. A defibrillator is managed on the internet and shown where it is on Google Maps. Social media and network are becoming a standard part of healthcare process [11]. For the elderly, designers can help the people and network around an old person to make more collaboration. This would improve access and quality of healthcare and make care and support sure.

5.5 Design should empower the partnership of care receivers and providers.
At the last decade, there was a big emphasis on patient safety. Healthcare organization published the guidelines for patient safety with designers. WHO's Patients for Patient Safety works to improve healthcare safety in all the settings throughout the world by involving consumers and patients as partners. Moreover, web 2.0 enabled patients, They are not passive recipients anymore. They have been empowered and now demand more partnership and openness. The elderly also have big interests at health thereby wanting to be involved in his healthcare process. The healthcare products can activate the partnership and let down the bar.

5.6 Design should maximize usability for safety.
When a healthcare product is planned, the first condition would be harmlessness, and when it is evaluated, the first criteria would be safety. Design should provide the maximum usability to prevent possible human errors [12]. Moreover, when the users are the old group having well-known limitations, more concern is a matter of course.

6. Conclusions
The goal of this paper is to propose design strategies for the elderly and the ageing society, and show the application to the real development process of major healthcare products. A blood glucose meter, the typical healthcare product for a chronic disease, can be totally innovated with new technology and provide improved quality of interactivity and lifestyle. A portable ECG garment also can provide same comforts to different genders. Clinicians can have more accurate data from ambulatory monitoring and patients can be free from uncomfortable and unfamiliar experiences. An Automatic External Defibrillator with an intuitive form and interface can help emergency to be expected in public spaces more fastly and efficiently. The stated propositions as design strategies suggest designerly contribution to help the elderly, and finally the ageing society.

7. References


