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A SENSITIVE TECHNOLOGY FOR A SENSITIVE CHALLENGE

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Abstract: This paper deals with technology and its applications for an ageing population. It aims at discussing the issues raised by such a relationship and highlights healthcare-related designs. It questions the notion of product acceptance and points out some challenges that need to be met by designers and engineers. The overall experience provided by owning and using a product must be designed in a holistic way, placing the human, his or her needs and feelings, as central guiding factors. These issues are further explained with the presentation of a design project made by Audrey Dodo and Teresa Georgallis, within the frame of a competition at the Royal College of Art in London: a self-monitoring health service, a toothbrush that assesses the user's health state through his or her mobile phone.

Keywords: design for all, universal design, ageing, technology, utility, usability, acceptability, empowerment, health care, emotional acceptability, sensitive design, Blackberry Aid

Introduction

"New technologies" are invading our ordinary lives. They *augment* our daily lives by their ever-increasing presence and can potentially find a place anywhere, certainly even where our imagination would less expect them. The most incredible scenarios can come to life: science fiction inspires the evolution of technologies and we are now used to what we could not even have imagined just a few years ago. Today's fiction is tomorrow's reality. We can see how fast technology is going and how it thus disrupts product life cycles. New forms are born and hasten the obsolescence of former forms.

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The ageing population has opened technology to other areas of research and oriented discussions towards the performance of our environment to respond to the functional and cognitive heterogeneity inherent in human beings. Diversity is the challenge. What are the issues it raises? How can technology and ageing coexist? How can technology respond to ageing?

Design issues in the context of an ageing population

Utility and usability

We experience the direct power that technology affords [1] to people; speaking about "superpowers" is not a euphemism. If a "simple" product is able to offer its users new ways of action on their environment, a product based on state-of-the-art technology is much more powerful, as it significantly increases a human being's natural capacities. "I can't be everywhere at once" is no longer receivable on its own. Ubiquity, teleportation are common gifts given by our everyday devices. What is important is not to wonder what technology can enable us to do, but rather, how we need to design technology so that it will benefit people.

The main concern behind the "what" question is the utility of the product. However obvious this may be, this criterion can be so easily avoided by seeking spectacular technological effects. Indeed, "new technologies" liberate designers from their creative thoughts (or any other people involved in the making of our environment), notably contributing to an upward spiral. Users' real expectations need to be kept in mind so as to abort unnecessary functionalities, which could potentially complicate the system. However, even useful, the best innovative product of all may turn out to be the one that we will never want to use.

When everything becomes technologically feasible, a product differs from the others by its usability (ease use), that is to say, its ability to respond to people's diverse cognitive and physical capabilities. From the norm ISO 9241-11, we can deduce that the quality of usability corresponds to the diversity of people who can use a product to achieve specified goals with

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effectiveness (task completion), efficiency (task completion with minimal time and effort) and satisfaction (user experience). Thus, if a product, because it is useful, empowers people, it means that it can be easily used. Usability needs to be placed at the centre of the making process. At a time when the worldwide population is ageing, there is no doubt that this criterion can no longer be ignored, and must be involved in the making of socially and economically reliable products.

Functional segregation and "situation of handicap"

The older population is precisely pushing forward the debate concerning the "functional segregation" [2] operated by our environment – a debate that was brought out by people with disabilities, leading Ronald Mace (an American architect and designer who contracted poliomyelitis at the age of nine) to coin the concept of Universal design [3] (also called Design for all or Inclusive design in Europe) in 1977. If our environment can empower people, it can also disable them: "(…) urbanisation is characterised by a design apartheid in which the design of the built environment actively disables disabled people (…)" [4]. This quote highlights the understanding of disablement as a process engaging the environment.

Indeed, environmental factors impact on the accomplishment of life habits (daily activity or social role). We can easily figure out the limits of the medical model of disability that corresponds to a linear conceptualisation based on a cause and effect relationship between impairment, disability and handicap (International Classification of Impairments, Disabilities, and Handicaps or I.C.I.D.H. by WHO, 1980). Here only the individual is held accountable for the difficulties he encounters (personal factors). This model does not call into question the ideologies that govern our societies (the worship of performance and the notion of norm) and leads people with disabilities to comply with the required standard (rehabilitation). However, there is no handicap per se. The negative or positive power of our environment can be understood thanks to the systemic model that considers the person within his/her environment and defines the handicap as a situation of failure in the accomplishment of a life habit, resulting from the

interaction between the individual and his /her environment (In France, Pierre Minaire and Claude Hamonet, were pioneers; their work led Patrick Fougeyrollas, in Quebec, to develop the Processus de production du handicap - P.P.H., 1998 [5]). This systemic conceptualisation rightly expresses and specifies the major role of the quality of use of our environment. The discussion generated by the P.P.H. led W.H.O. to revise the International Classification of Impairment, Disabilities and Handicaps (C.I.D.I.H.), with the adoption in 2001 of The International Classification of Functioning, Disability and Health (I.C.F.), which, for the first time, included a list of environmental factors.

Not only does our environment disable people with disabilities, it can also disable anybody. Indeed, the systemic conceptual model makes it possible to understand the universality of disability and its relativity: if handicap is a situation, it is not constant. Thus, everybody can face a situational handicap (Pierre Minaire, concept of "situational handicap" [6]), especially people who are more demanding with regard to their environment as pregnant women or people carrying heavy loads. Whether they are obstacles or facilitators, environmental factors can cause or prevent situations of handicap. Thus, our environment has a real impact - positive or negative - on personal factors. For example, by hindering the progress of an action, a product can negatively impact on the psychological health of the person (stigmatization, limited participation) and on his or her physical health (chronic disease, accident...). As the current social fabric evolves, there will be increased demands for a better usability. This evolution needs to be considered carefully so as to meet the challenges of ageing.

The concept of Universal design defined through seven general principles (equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use) that were established by R. Mace along with experts in 1993, sets guidelines in order to achieve, as far as possible, a universal usability. We can see Universal design as the process of transferring the expectations of performance from the individual towards the environment, which is then expected to suit people's needs. Indeed, R. Mace was quick to

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understand the significant role the environment plays in the disablement process, and conceptualized it into a creative approach, hence the universality of disability. He thus extended the concept of accessibility that was originally limited to the built environment and used to exclusively refer to "disabled people".

People involved in the making of our environment (designers, architects, engineers, decision-makers...) need to take into account the diverse range of capabilities that characterizes human nature in order to prevent possible situations of handicap by providing a good usability. Basically, it means paying attention to ergonomics through a holistic approach that considers all the interactions involved in using a product within a specific environment, in a variety of contexts.

Acceptability

If the question of utility is becoming critical with technological progress (useless functions), so is usability. Sophistication leads to complexification, the flow of innovations leaves no time to adapt, and electronic processes, which are not as easy to understand as mechanical processes, need translating into meaningful designs. Products that incorporate new technologies without adequately providing usability can leave their users far behind, especially people with disabilities or older people. Ease of use is crucial and the ability of a person to make use of a product depends on it. This is truly a basic design requirement and yet it is often overlooked.

However, if we keep the systemic model of disability in mind, we can see that utility and usability alone do not suffice to define what makes a product easy to use or what makes the user want to use it. The acceptability of a product is amiss when it confronts a person with a situation of handicap that is harmful to his/her psychological health (self-confidence) and physical health because his/her life habits cannot have been properly accomplished. But beyond this practical side, even if a person does not have any trouble using it, the product can send a stigmatizing image so that its user may not want to use it. As Jakob Nielsen said, "usability is a narrow concern compared to the larger issue of system acceptability" which is the

combination of the "practical acceptability" (utility, usability, cost...) and the "social acceptability" (norms and values) [7]. Designing non-stigmatizing products is a concern that relates to social acceptability. It is in the vein of the Universal design approach that transforms, as much as possible, specific needs for specialized products into mainstream needs, leading to the making of mass market products that are not labelled "disabled", "weak", "unable".

The importance of social acceptability has been enhanced by technological progress, which is profoundly changing the way we design our environment and the way we interact with it. Life today is utterly different from life in those days that preceded major innovations (fast means of transport, mobile phones, computers...) and every day our relationship with the world is changing. We need to face and adapt to these changes that empower us much more than what nature ever intended. This shows that social acceptability cannot be overlooked. As Donald Arthur Norman said, “we must design our technologies for the way people actually behave, not the way we would like them to behave” [8]. Design has a real role to play so that these changes may positively affect people's lives, and stressing, beyond their practical acceptability, their social acceptability.

Health care related technology

The importance of emotional acceptability

We can consider that the acceptance of a system by a person is eventually determined by the interaction between the actual acceptability (product features) and personal factors (user features: norm and values of his or her peer group, capabilities, tastes - related to education, culture, age - purchasing power…). The quality (pleasure) of this interaction conditions the user’s acceptance of a product. That is the perceived acceptability, which results from the experience of owning and using this product, and raises the question: is the experience enjoyable?

The impact of such an experience on a person’s psychological state is, in J. Nielsen’s conceptual acceptability model, the "subjectively pleasing" aspect

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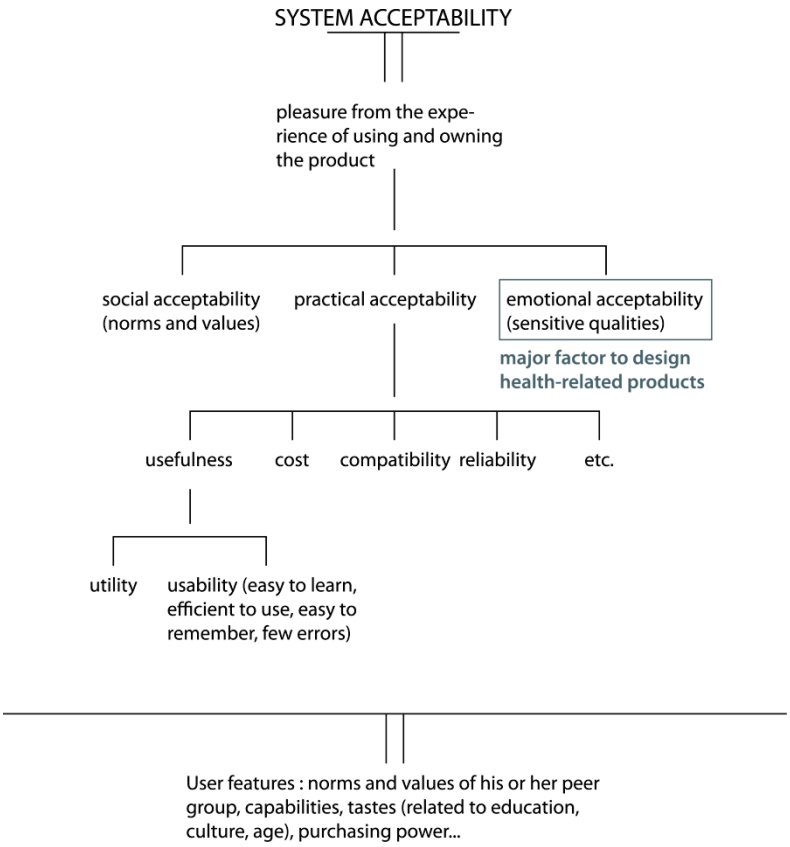
that is one dimension of usability. We argue that the pleasurable dimension should not be part of usability. Indeed, a product can be easy-to-use and socially acceptable while the overall experience that it provides is unpleasant and questions what we will call its emotional acceptability (sensitive qualities of the product). From our point of view, the overall acceptability of a system depends on the pleasurable aspect of the experience it provides, which in its turn depends on practical, social and emotional acceptability. Especially in health care designs, this third dimension that we call emotional acceptability is decisive for a product acceptance and can prevail over practical features.

Figure 1. Acceptability model.



Some "superpowers" can destabilize, especially when the technology that confers them is closely related to your body because of (1) its location - embedded technology - (2) its way of functioning –somehow dependent on the human body - (3) its formal or functional aspects - bionic technology -

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for example. The concept of acceptability cannot be restricted to these two social and practical dimensions. A product may well have positive representations and be given an undeniably useful purpose (health) but also be disturbing for the individual who has just gained an incredible power. It may be scary, for instance, to be able to prevent diseases or to control them. The potential of a product has to appeal to people's humanity. The distance created between the "natural" state and the "empowered" state must be open for acceptance by people so that they can assume new capabilities that exceed their human condition. Acceptance also relies on - and thus must be inclusive of - the qualities of the experience provided by owning and using a product. What does it feel like to use this device that enables you to be informed of your state of health? How is this information provided? Will such a product appeal to you?

Case study - A self-monitoring health service: issues at stake

In the context of an ageing population, technology is expected to mean better living for all. Good health relies on good quality of life, which depends on personal factors, and above all, on the environment (systemic model of disability). If products that incorporate "new technologies" can have a positive effect on people's lives, thanks to their utility and usability (as other products can do), they can more particularly have the power to directly sustain people's health. Health is an intimate and serious issue that embodies a real challenge for interaction design. The user-product relationship must be carefully designed. When a relative speaks to you about your health, he or she will naturally sound both concerned and considerate; he/she will behave in a pleasant way. Your doctor might sound less sentimental but will nonetheless take care of your wellbeing. What about a device that beeps frighteningly to remind you that you should take your pills? The design of a product (its aspect and its interactions with the user) must fit people's psychological schemes. Concerning health-related products, the way that the information is given does impact on the mental state of a person, who, in a poor health condition, can prove to be more fragile.

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This is the challenge that we undertook as part of an interdisciplinary competition called “Blackberry for body and life” [9] led by the Helen Hamlyn Centre of the Royal College of Art in London, which is specialized in Inclusive design, in partnership with Research In Motion, the designer and maker of Blackberry.

The brief proposed to RCA students gave them enough freedom to conceive prospective technology-based scenarios in an inclusive design approach. At that time, I was an intern researcher at the HHC and I took part in this one-month long project. With my team, made up of designers, one of whom is Teresa Georgallis, we decided to design a service that could help people to be aware of their general health state.

Throughout their lives people undergo changes and are capable of adjusting to their environment (up to a point). The ageing of the population and our fast- paced existence (stress, tiredness) leave no time to correctly look after our health and contribute to increasing diseases that could be prevented if we could find a way to easily inform ourselves. Indeed, the future scenario that we propose enables you to check your vital signs, thanks to a customized application. The idea is to encourage new health-related behaviours: being attentive to your body, communicating with yourself before (better) communicating with others, and adjusting your behaviour in accordance with your physiological signs. It is about supporting prevention by enabling people to evaluate their own health and decide if they should consult a doctor. Numbers of people do not even know that they actually have a disease, some do not have time to take care of their health, and others know that their family is liable to certain diseases, while more vulnerable populations, like older people, need to check their health state regularly.

Illness is a constitutive part of the human condition, everybody is concerned and needs to be sensitised on the issue. Thus, we wanted to design a service "for all" that would suit to a large range of people’s needs in terms of prevention (patients who require a regular follow-up care and people in general) and that would make them more attentive to their health.

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"Digital technology has changed the way we interact with everything from the games we play to the tools we use at work. Designers of digital technology products no longer regard their job as designing a physical object - beautiful or utilitarian - but as designing our interactions with it." [10]. Digital technology is a chance to enhance possibilities of interactions between the user and the product, and think of a closer and sensitive relationship.

Further to the service that we propose, our concern was the way the information is accessed and designed, and how it is integrated into a person's life. What could be the sensor and the product that indicates the state of health? What information should be provided? How should it be designed? How, when and where can the user access it? We needed to design an overall scenario that could incorporate all the qualities required to make this service human-friendly.

The sensor relates to the phase of monitoring and recording of the vital parameters, while the device-interface (whether it includes the sensor or not) relates to the phase of synthesis of the recorded data. Both phases need to be attentively designed. The first one must not be intrusive and the second one must not be scary. Keeping this in mind, we thought that objects already incorporated into our lives for other uses would be really appropriate, as they are not mentally related to a medical process. Thus, it would facilitate the formation of new behaviours regarding health. The objects that fitted these criteria and that we thought appropriate to these two phases are the toothbrush for the monitoring phase, and the mobile phone, for the phase of synthesis. Both are objects that most people commonly use everyday.

The toothbrush relates to hygiene and care. As a sensor, this intimate and personal object allows collecting information through saliva, the pressure of the hand on the handle, or bleeding gums. As we first brush our teeth in the morning, we are consequently able to analyse our blood sugar levels, as well as our blood pressure, on an empty stomach. Moreover, having the toothbrush as a sensor enables a comparative analysis of the monitored physiological signs at key moments of the day.

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The mobile phone is a device that is usually carried all the time by its user (as a garment is) and that is personal to him or her, which implies two advantages: it brings confidence to the user and the information remains fully accessible and potentially confidential.

Case study - A self-monitoring heath service: design choices

Let us imagine that while you are performing the simple act of brushing, the toothbrush picks up your vital signs, quietly monitors your wellbeing and sends the data to your mobile phone. This aid does not require any extra thought, and self-monitoring is naturally embedded into your daily life. Should you want to find out your general health state, you can access the data easily on your mobile phone.

Beyond this general scenario, the design of the toothbrush and of the interface follows the same human-friendly concerns. The toothbrush is stylish; its appearance does not give any idea about its actual extra medical function. It even becomes attractive and appealing, as cosmetic products are.

Figure 2. Prototype of the toothbrush (sensor)

The data provided by the toothbrush is translated into friendly animated figures: the interface communicates the information in a visual way that is pleasing and not intimidating for the user [11]. As previously mentioned, our main concern was to favour a sensitive interaction in the course of its use. The way the information is given mustn't be scary for the person, as medical design can be.

The vital signs that are monitored are listed in three categories that can be accessed from the home page: "Eat", "Breathe" and "Beat". "Eat"

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corresponds to the blood sugar levels and the body water, “Breathe” indicates the blood oxygen levels, while in “Beat”, you find pulse rate, blood pressure and temperature. These parameters altogether feature the main alert signs. The categories are represented by three concentric circles split into three equal parts that are singled out with colours, respectively green, blue and red.

Figure 3. Home page, normal health state

When you open the application, each part moves and gets distorted separately until they stop simultaneously and give a summary of your general health state. The static diameter of the pie chart (reference circle located in between the other two) represents the state of equilibrium, in accordance with your personal vital signs. The outer circle expresses the average of the highest values whereas the inner one represents the average of the lowest values. For example, if all the values corresponding to the vital parameters from the “Beat” category are higher than the expected balance, only the outline of the specific portion of the external circle will move outward. On the contrary, if some values are lower than the expected balance, the outline of the inner circle will move towards the centre. The average of the highest values is distinguished from the average of the lowest values by a darker colour; the reference colours are those of the circle that represents the balance. You can get further details concerning each parameter by accessing the category of interest.

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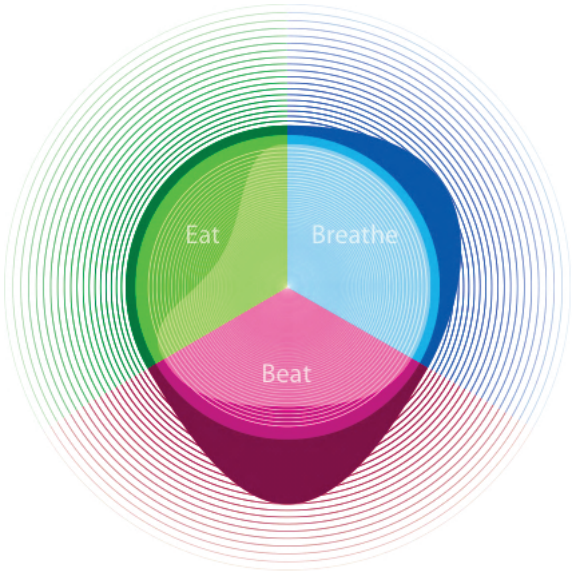
Figure 4. Home page, unbalanced health state.



Each vital sign is presented through animation expressing the values. No figures are given. Indeed, the given data allows the user to evaluate his/her health state but cannot be seen as a substitute for a medical consultation. That is an important point: this application just cannot replace a doctor's diagnostic. If the person desires it, the data can be directly transferred to his/her doctor, who can do an in-depth diagnostic. Even if we may envisage another version of this application that could feature numerical data with the doctor's consent, an interface that indicates the actual health state exclusively through figures would be emotionally stressful.

However, we wanted the design of the animations not to be reduced to an abstract codification of the vital signs, but keep the design sensitive. Indeed, we were inspired by real microscopic views and molecular representations that refer back to the parameters, in order to favour a more intimate communication with our body, opening on to a better understanding. These design choices support a humanization of technology. A person can figure out how his/her body functions as accurately as possible, without compromising the sensitivity of the interface.

In the "Eat" category, the sugar level is indicated by a circle (blood vessel) in which two other circles materialize different glucose levels. The reference point (normal level) corresponds to the intermediate circle. Glucose molecules are represented with an accumulation of white rounds discs

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expressing its chemical structure. When they move to reach the outline of the artery (biggest circle), the sugar level is high; it is normal when they move until the intermediate circle, while it is too low when they remain within the little circle.

Figure 5. Sugar level, "Eat" category

The body water is represented by the water molecules (designed according to their chemical representation, with two Hydrogen atoms linked to one Oxygen atom) that move on the screen and lose their blue colour (they "empty" their water) when they reach the virtual line symbolizing the current level. The upper part of the interface corresponds to the quantity of water needed by the person. The lower the dividing line on the screen, the more dehydrated the person.

Figure 6. Body water level, "Eat" category.

In the "Breathe" category, the blood oxygen is represented by a ring made of little discs releasing blue bubbles; this symbolizes a lung alveolus providing our organs with oxygen. The direction of the oxygen coming out of the alveolus indicates the level. For example, when the level is low, the blue discs concentrate in the lower part of the screen (lower part = low level; upper part = high level; centre part= normal level).

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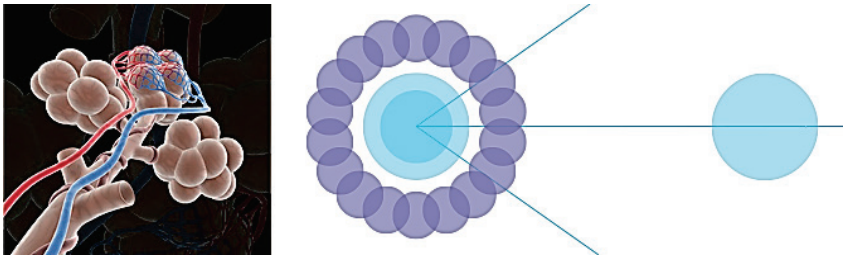
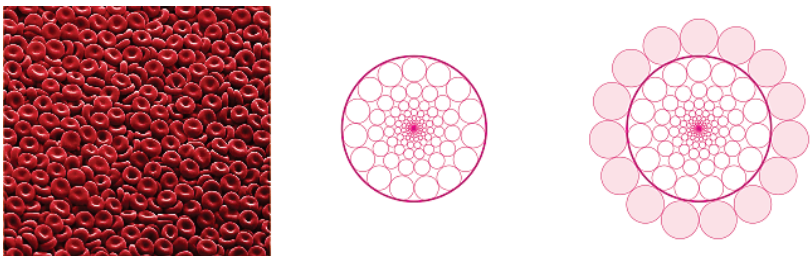
Figure 7. Blood oxygen, "Breathe" category



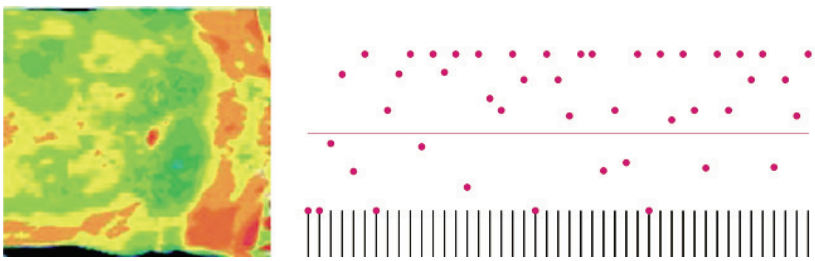
In the "Beat" category, the pulse rate is expressed by a circle (artery) that changes size according to the heart rate of a person. In this circle, which symbolizes the artery, there are little discs that correspond to the blood cells: when they go out of the circle, it expresses the pressure exerted on the inner artery wall. In this case, the person has high blood pressure.

Figure 8. Blood pressure, "Beat" category



The temperature is represented by red dots that are propelled from the bottom to the top of the screen. They move at an irregular speed until they stop and form a line. Depending on its position, relative to the reference line that symbolizes the normal temperature (in the middle of the interface), the person knows if he/she has a high temperature or not.

Figure 9. Temperature, "Beat" category.



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Conclusion

This paper aimed at highlighting the issues related to technological progress and the ageing population, especially in the health care domain. It does not claim to address all the design questions that may be raised, but to point out important challenges that, for us, must be undertaken.

Regarding ageing and diseases, technology has an important role to play and to this end, it needs to be embodied into holistic scenarios of use, which take into account the functional and cognitive heterogeneity inherent in the human being. However, a product can fully empower a person only when it allows him or her to take advantage of its actual performance, that is to say, when the perceived performance (user experience) is pleasant and does not compromise the actual one. However, especially in the field of health-related design, this consideration becomes even more important; a product actually endows its user with power when, beyond its practical and social acceptability, its design is sensitive and does take care of people's feelings (emotional acceptability). BlackberryAid, which corresponds to a one-month long research, has been presented as an example that supports this concern for a sensitive design in a context where the psychological dimension is crucial.

This paper focuses on the design of mainstream products for all, but the issues that have been brought up also concern specialized assistive products.

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