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Giuseppe Di Bucchianico
Pete F. Kercher *Editors*

Advances in Design for Inclusion

Proceedings of the AHFE 2017
International Conference on Design
for Inclusion, July 17–21, 2017,
The Westin Bonaventure Hotel,
Los Angeles, California, USA

Advances in Intelligent Systems and Computing

Volume 587

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Advances in Human Factors and Ergonomics 2017

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*8th International Conference on Applied Human Factors and Ergonomics
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*Proceedings of the AHFE 2017 International Conference on Design for
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Preface

This book has two underlying messages, the emerging importance of the social issue of inclusion and human diversity in contemporary society, and the increasing awareness that there is no such thing as a ‘standard human being.’ The first question is considered to have a primarily political repercussion. US President Obama spent his mandate championing inequality and social disparity as a necessary milestone toward economic revival, among other things, while a vital role in the strategies adopted by the European Union’s Horizon2020 framework program is played by the ones that focus on strengthening equality, participation, and accessibility for all to goods, services, and what Dahrendorf called ‘life chances.’ What this means is that the issue of social inclusion of diversity and for equality is firmly on political agendas all over the world, not least because of increasing awareness that new visions, new strategies, new tools, and new approaches are needed, if we are to tackle the challenges arising from recent phenomena of economic and cultural globalization, demographic change; economic migration from poorer countries and an ageing population in wealthier countries, a phenomenon that is destined to upset the entire planet’s micro- and macro-economic and social structures in years to come.

The second issue tackled in this book is more technical in nature, since the paradigm changes from ‘designing for standards’ and ‘inclusive products and service design’ to the enlightened awareness that there are no such concepts to fit the standard human being, and this has immediate, direct repercussions on the specialized dimension of designing. The realization is at last taking hold not only that those individuals are physically, psychologically, and culturally ‘diverse,’ but they also have widely diversified skills, abilities, aspirations, and desires that make each one of us unique and not at all replicable. Since the diversity of individuals is the rule, not the exception, it makes sense to consider it as a resource, not as a limiting factor or a restriction on design, while equality between individuals, communities, and peoples should be treated as fundamental strategic inputs to the sustainable development of contemporary society, where everybody should have the same opportunities to experience places, products, and services. Numerous design approaches have been adopted to facilitate social and cultural inclusion in recent decades: Design for Disability, Universal Design, Inclusive Design, and

Design for All. All of these philosophies, approaches, and methodologies aim to build value on all aspects of human diversity, from psychophysical to cultural issues, and to offer equal opportunity to everyone in order to experience places, products, services, and systems. With this in mind, this book sets out to forge a climate conducive to discussion and comparison between these approaches, without any prejudice in favor or against any one of them, but attempting to identify the elements they hold in common and to build each one's heritage of originality, because we are convinced that the true resource of Design for Inclusion may well be found in this very diversity of opinions.

In particular, this book describes the state of the art of recent research conducted in a variety of fields that share the focus on Design for Inclusion and was presented in the second international conference on Design for Inclusion (AHFE 2017, Los Angeles, California). On this occasion, the numerous research papers presented were collected together into seven different thematic areas, corresponding to different sections of this book:

- Design Driven Social Innovation: Methodology and Training;
- Advances in Design for Ageing Population;
- Inclusive Products and Service Design;
- Smart Tech, Web and Media for All;
- Design for Inclusion in the Living Environment;
- Inclusive and Universal Design in Clothing, Footwear and Accessories;
- Design for Users With Disabilities.

Each section contains research paper that has been reviewed by members of the International Editorial Board. Our sincere thanks and appreciation to the board members as listed below:

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July 2017

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Smart Tech, Web and Media for All

Design and Smart Technologies for Physical Activity as Key Factors in Promoting Quality of Life and Social Inclusion

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Abstract. Technological innovations offer many opportunities for design in the context of wearable computers and smart objects and their interaction with user and with ubiquitous computing systems. These technologies can be used to make new products and services designed to collect, increase and share information, knowledge, and emotion, through platforms, which support higher social awareness. If applied to the field of wellness, they can interact among each other, with the network and with the person, to drive and assist people, including socially vulnerable groups, towards an active and dynamic life, and they can become a means for monitoring the state of the user's wellbeing and health. The aim of the research was to use the strategies of Human Centred Design to identify innovative scenarios and solutions able to involve people in an increasingly active and healthy life, as a commitment towards oneself and as a social responsibility.

Keywords: Design · Human-centred design · Design for inclusion · Smart technologies

1 Introduction

New projections on European population have recently shown how quickly the number of elderly people is growing.

The first question posed by an increasingly ageing population depends on their greater need for assistance and cure as well as on the impact of costs to society.

In order to contain costs for their assistance, as well as to reduce the burden posed on family members due to the reduced capacity of the elderly to take care of themselves, society must aim to preserve the health of its population and to promote ways of life capable of sustaining self sufficiency over time, favoring a process of ageing which encourages one to remain active and healthy as long as possible [1].

General physical activity, practiced consistently, and the engaging in sports while one is still young are important objectives aimed at preventing illness and social malaise. Such things require an attitude of awareness and a growing responsibility towards his own health on the part of each citizen.

In this scientific context, we asked ourselves the following research questions:

- How can design contribute to addressing and helping people towards an ever more active and healthy life (through physical activity and sport, prevention, early diagnosis), as a commitment towards oneself and as a social responsibility? [2, 3]
- Can smart technologies and ubiquitous computing be used through an activity of ‘sensing’ and ‘actuating’ - that means: can means collecting data and information on people and communities, and reply to these data with intervention strategies - in order to make people smart and active, create new dynamics, build personal and social awareness, concerning individual, community and context, which can lead people to change their lifestyles?

2 Methodological Approach

Our research started from the assumption that design and digital technologies, if applied in connection with products and services for physical activity, can be key factors for promoting quality of life and social inclusion.

The general aim of the research was to use the strategies and innovation methods of Human Centred Design [4] and of Design Orienting Scenarios [5, 6] to identify plausible near future scenarios and possible innovative solutions able to involve people in an increasingly active and healthy life (through wellness, prevention and smart healthcare service), as a commitment towards oneself and as a social responsibility, through collective use of smart technologies and smart interaction by stakeholders.

The process has been divided into three main steps: (i) collecting data and information in different contexts; (ii) co-designing through a workshop series; designing the final Design Orienting Scenarios (DOS).

The first phase investigated: (i) the motivations that spur people to engage in physical exercise; (ii) the strategies that can be implemented to nudge the user toward an active way of life; (iii) the role of physical activity as a preventive factor in health care and as a factor in social cohesion and sharing of emotions, experiences, information and data, which can increase social skills; (iv) current trends in demographic change; (v) new user profiles; users’ needs and expectations; and (vi) the smart technologies applied to date in this sector.

The second step has provided a conceptual map of the aspects related to user experience, during the physical activity, and to the possibility that the application of smart technologies could offer to meet users’ expectations and the micro-socio-cultural trends. These events have seen involved athletic users, experienced engineers and designers in this field, graduate students in design and computer scientists.

The third phase addressed design of a scenario for innovation; in particular, design of a services-products system for the wellness sector, capable of encouraging and assisting people, including the more vulnerable categories, to engage in an active and sports-minded life in a perspective of prevention for health.

The aim of the design research was not only to define a new services-products system, but also to exploit the project itself for further investigation. Following the guidelines

laid down by [7], the design research was conducted using the tools of design itself and above all the most original and specific characteristic of design: the project.

2.1 Physical Activity and Wellness: The Investigative Phase

The concept of wellness as a philosophy of life that spurs us to adopt behaviours we might define as ‘virtuous’ from the point of view of motor activities, nutrition and maintenance of our emotional balance centres attention on the individual by suggesting regular physical activity and a healthy diet.

The importance of promoting health by spreading a culture of a ‘healthier and fitter life’, attainable through prevention and a correct lifestyle – which includes ongoing practice of physical activities – is by now evident [8].

In order to understand people’s lifestyles and the attention they devote to their health and wellness and to physical activity, and to investigate the motivational and emotional aspects of the user experience as concerns the practice of a physical activity, a questionnaire was made available online at the national level.

The questionnaire used a ‘quick and dirty’ qualitative method applied to a selected sample of 100 users divided equally into age and gender groups.

The first important result that emerged from analysis of the data gathered via the questionnaire was that while 46% of the subjects interviewed stated that they attributed great importance to physical activity and another 46% that they attributed it ‘sufficient’ importance, only 24% stated that they practiced regular physical activity three times per week and 19% that they practiced physical activity only occasionally or never due to ‘laziness’ or lack of time. This means that despite widespread appreciation of the health benefits of regular exercise, this knowledge does not guarantee a practical reflection in people’s lifestyles or that users perceive the benefits as attainable or relevant to their lives.

Furthermore, European-level comparative data drawn from the Eurobarometer report analysing sports and physical activity show that Italy is in next-to-last place in Europe in terms of the percentage of the population that regularly practice a physical activity with a mere 3%, followed only by Bulgaria (2%), as opposed to 16% in Ireland, in first place. Generally speaking, the results show that people in the northern European countries are the most active in terms practicing regular physical activity [9].

Maintenance of psycho-physical wellbeing and health is considered the most important factor motivating people to practice physical activity on a regular basis. This is followed closely by such motivations as the opportunity to meet others and to cultivate friendships, the need for ‘escape’ (for example, from the stress of the workplace), the opportunity to establish social relationships with others, the desire to improve one’s appearance and finally – at a certain distance – the desire to discover and confirm one’s physical capabilities.

One factor that is repeatedly associated with the practice of physical activity is contact with nature and the natural elements – water, wind, plant life – and the emotional impact generated by this contact.

Engaging in physical activity with friends or in a group is also considered a motivational factor since it ‘can keep exercise fun’ and help cope with the uncomfortable

side of physical exertion, as are the satisfaction deriving from having exceeded one's limits, of succeeding in something one feared one could not, the gratification deriving from attaining objectives and good results and, last but not least, winning, even when the activity is non-competitive. Enjoyment, stimulation and escape, psycho-physical wellbeing and a sensation of relaxation all aspects linked to the pleasure derived from the user experience (UX) [10].

Disappointment with physical activity, on the other hand, is most often associated with coming face to face with our limits and physical problems, with the fear of not succeeding and finding confirmation of failure and with the idea of ageing, and only infrequently with the actual fatigue deriving from the activity.

The results of the questionnaire show that the physical activities most often practiced are cardio exercises (jogging, spinning, soccer, dance, etc.). Most of the subjects interviewed stated that they practice physical activity both indoors and outdoors, without distinction, probably according to the season, and in the majority of cases in the company of others.

Finally, investigation of the opinions of the subjects concerning the elements they consider important for improving the physical training experience and prevention for attaining future health benefits revealed the following:

- among aspects linked to the culture of sharing, those considered most important were sharing information and knowledge in order to increase social capabilities and sharing of the experience itself and of emotions;
- with reference to the context, the factors on which to concentrate for improving the UX were identified as the quality and the naturalness of the experience and the ease of reaching the site for practicing physical activity;
- as concerns the emotional sphere, it is important to concentrate on 'play' and the sensorial aspects of the experience;
- as concerns augmenting people's motivations to embrace a healthy, dynamic lifestyle, important factors could be education in a culture of physical exercise and prevention and training from a young age in such a culture of psycho-physical wellbeing.

Aspects linked to empathy, sharing and the emotional sphere were found to be important: man is in fact 'designed' to be empathic in his relations with others and to share affection with other individuals. Sharing allows people to feel they are part of a group and interconnected; social interactions include the social emotions that permit accomplishing things such as establishing friendships.

When a group of people meets, interactivity increases through sharing of ideas, tools, creations and such processes as cooperation and collaboration.

Sports and physical activity are important in terms of social cohesion and inclusion, 'tools' for sharing emotions, information and data that can increase the psycho-physical wellbeing of individuals and favour more coherent social integration.

Physical exercise is a part of human nature and impacts at least four significant dimensions of human life: health, education, quality of life, sociality. Also of note among

the motivations that lead people to practice a physical activity are a need to enjoy themselves and to relax, a need to communicate with others and a desire for contact with nature.

Important social supports for promoting physical activity are the family and social relationships. Practicing a physical activity requires an outlay in terms of time, which can impact the time usually devoted to family, work and friends. For this reason it is important to include these subjects in its promotion; otherwise, conflicts that can undermine individuals' compliance with the physical exercise program may arise. This explains the success of group events/activities that include family members and friends.

The ideal context is that in which physical activity is practiced in an organised group setting; for example, simple walking or biking excursions or other forms of collective physical exercise. This aspect is no small matter: it has been demonstrated that engaging in physical activity in a group setting is a factor that can reinforce motivation. Most people who practice physical activity prefer not to train alone, and promotion of an active lifestyle must necessarily take this fact into consideration.

Physical activity is without a doubt an important key factor for improving quality of life and for social inclusion, and there are no limits on age range or social category.

A study by the Zukunfts Institut points up an interesting contemporary user type denominated 'forever youngsters' [11].

The 'forever youngsters' (FYs), sometimes called 'grey rebels', embark on new lifestyles as pensioners, prompted by curiosity to discover new aspects of life and new horizons and to realise new dreams. One of the principal values of this category of people is to remain physically and mentally agile. The FYs want to remain dynamic and pay great attention to their health in the sense of harmony among body, mind and spirit. Sports, healthy eating and discipline are the basics for achieving such balance.

To conclude, thanks to the increase in life expectancy and developments in medicine that increasingly minimise the classic disorders affecting seniors, this category is becoming increasingly numerous and relevant. The FYs, in particular, represent a valid target for experimenting new tools and smart health devices that can improve quality of life.

3 Results

3.1 The Design Orienting Scenario for a System-Product for Wellbeing and Health

Technological innovations offer many opportunities for design in the context of personal/collective wearable computers and smart objects and their potential for interaction with user and with ubiquitous and pervasive computing systems. These technologies can be used to make new products, services and interactions designed to collect, increase and share information, knowledge, emotion, experience, through platforms which support higher social awareness. If applied then to the field of wellness, they can interact among each other, with the network and with the person, to drive, help and assist people, including socially vulnerable groups, towards an active, dynamic and athletic life, and they can become a means for monitoring the state of the user's wellbeing and

health, with an eye to prevention and early diagnosis, and an important tool for studying and understanding the activity of the body on a large scale [12–18].

Following careful acquisition, review and integration of the data and basing our work on current technological macro-trends and the design opportunities that arise therefrom, our research led to definition of a DOS and several possible trajectories for innovation.

With the DOS, we succeeded in communicating our idea of how the smart technologies and the ubicomputing that is widespread in cities could be used, employing ‘sensing’ and ‘actuating’ activities – that is, gathering data and information about people, individually and collectively, and responding to these data with suitable intervention strategies – to make people ‘smart’ and active, to create new dynamics and to build personal and social awareness at the individual, collective and contextual levels, all of which can lead people to alter their lifestyles.

3.2 The Digital Wellness Hub

The system centres on a system of products and services implying the involvement of various players, from producer companies to service providers and from public entities to research centres. It is expected that the project will impact various sectors: on the one hand, for creation of intelligent garments and smart accessories for monitoring individuals’ physical activity and health as well as the contexts in which they live; on the other, for design of a platform capable of gathering and processing incoming data, in real time, on the vital parameters and the activities of the single users and of people in general and information and data on their habitats; finally, for development of new models for services provision (involving a network of gyms and a smart health centres) and implementation of wellness and rehabilitation equipment capable of acting as physical interfaces between the users and the network.

The system-product may extend to the public administration, since it can provide feedback on the state of cities and citizens.

The project vision as developed should be able to provide responses to several fundamental queries:

- **What if** man were to become a moving sensor for monitoring himself and his habitat (the city, the home, the workplace)?
- **What if** we were to endow physical training equipment with artificial intelligence?
- **What if** we were to create a set of services and products capable of processing data gathered by wearable devices and smart garments: physical parameters and information concerning the lifestyles of the wearers, their health, their homes and their cities, and information about the environment?

The design orienting scenario as developed is the following.

- (i) **Man**, by using wearable devices and smart garments, becomes a sensor for monitoring himself and his habitat: as he moves around, as he engages in physical exercise, works, spends time at home or sleeps, he can gather information about his psycho-physical state and about the context in which he lives.

- (ii) His **wearable computers** (smartphones, smartwatches, wristbands, activity trackers, smart glasses, wearable webcams, intelligent garments and fabrics equipped with accelerometers, sensors and actuators) are data-gathering tools that can collect near-infinite amounts of information; via dedicated apps constituting the man-machine-network interface, these instruments can communicate with the connected online platform to send the data they have gathered and to receive feedback (Fig. 1).

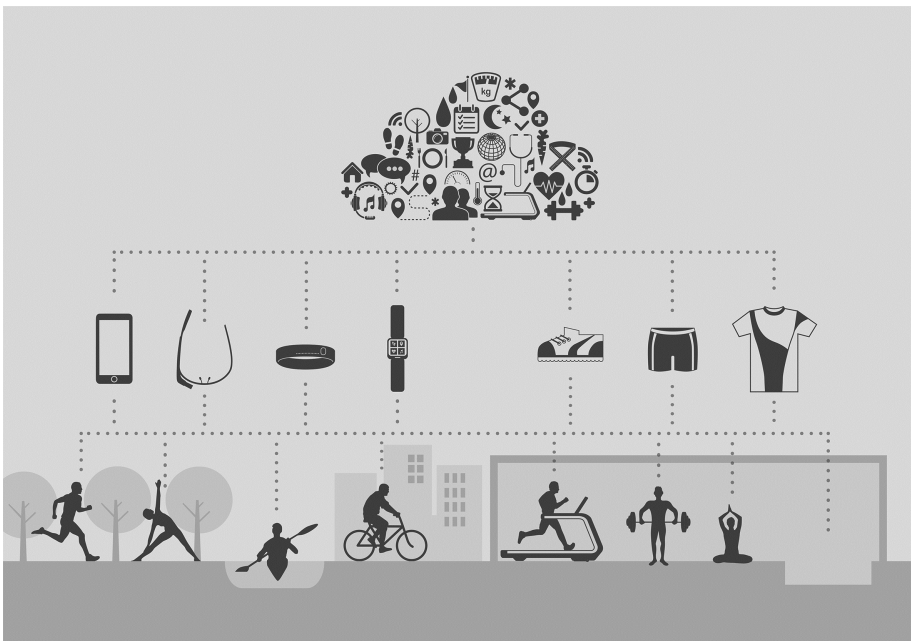


Fig. 1. The Digital Wellness Hub: design orienting scenario of a product-service system for people’s wellbeing and health. Through wearables devices and smart garments the users send data about themselves and about their context of life to a digital hub.

- (iii) The **Digital Wellness Hub** is the online platform which, thanks to cloud computing, manages the data incoming from the wearable devices of its networked users; the data thus gathered and processed are sent to the digital personal trainer and to the individuals’ physicians, a first step toward development of a smart health system. Additionally, the project concept stresses that uploading one’s data to a wellness-oriented cloud computing platform instead of managing the data privately, on a PC or smartphone, means that larger sets of ‘big data’ can be processed in order to understand the lifestyles and quality of life of the public in general as well as the quality of the contexts in which people live (the city, the home, the workplace).

The Digital Wellness Hub thus carries on a sensing and actuating activity targeting the health of the community at large and its living context/conditions, providing

feedback not only to individuals but to the healthcare system, public administrative bodies and, should it be the case, to companies as well, with the aim of creating new dynamics and adopting policies that can correct lifestyles and improve quality of life.

The overall goal is to succeed in building both personal and social awareness of the individual, the community and the living context that can lead to changing people’s lifestyles. Increasing the quantity of available data and sharing information, knowledge, emotions and experiences via a digital platform that supports an increase in social awareness permits aiding and assisting people, including the more vulnerable categories of the population, to attain a more active, dynamic and sports-minded lifestyle and at the same time permits monitoring users’ wellbeing and health with an eye to prevention and early diagnosis. This is a fundamental difference between making personal use of individual wearable devices and being part of a smart system, of a circuit of wellness providers (Fig. 2).

- (iv) The **gym** becomes a wellness provider, the point of connection between the individual and the Digital Wellness Hub; a physical site, one of many in the territory, where the service is tangibly provided and verified. Thus, in our view, the gym will no longer be a simple physical activity provider but will become a provider of solutions for health and active ageing.

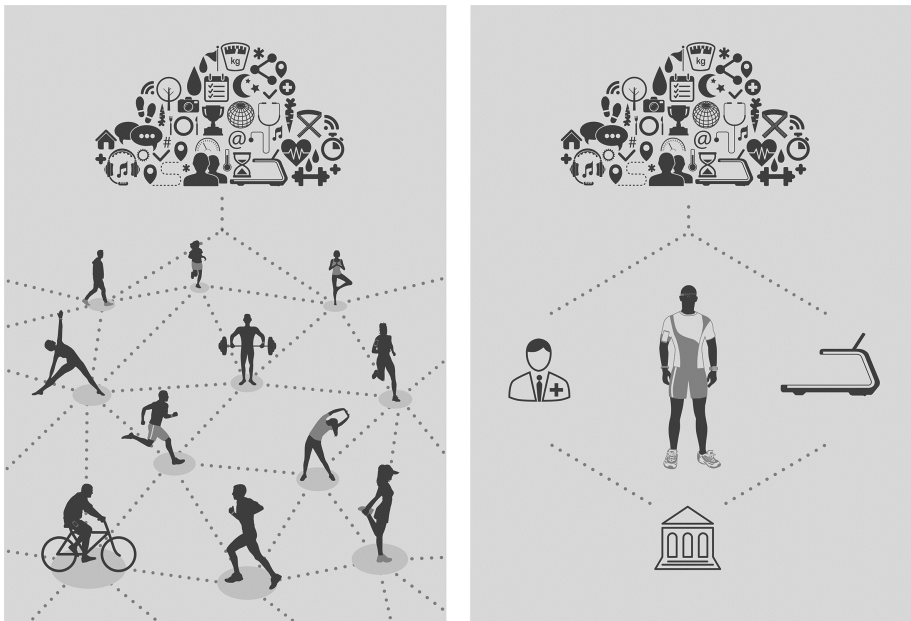


Fig. 2. The Digital Wellness Hub collects and processes the data of all users connected to the system (*on the left*). The hub sends feedback to the user, to the digital trainer, to the health system and to public administrations (*on the right*).

3.3 The Digital Wellness Hub Results

The main project strategies for stimulating people to subscribe to the service and for encouraging them to increase their engagement in physical activity are the following:

- Move physical activity and the Digital Wellness Hub system out of the gyms. If people practice physical activity in the open air, while remaining within the ‘cloud computing for wellness’ system, it will be possible to bring those who practice sports or regularly practice a physical activity closer to more sedentary subjects, in such a way as to stimulate the latter to also engage in a physical activity. The aim of creating Wellness Capsules placed throughout the city is to bring the culture of physical exercise and wellness closer to the public, by providing dedicated spaces in our cities where people can try out the training experience (Fig. 3).

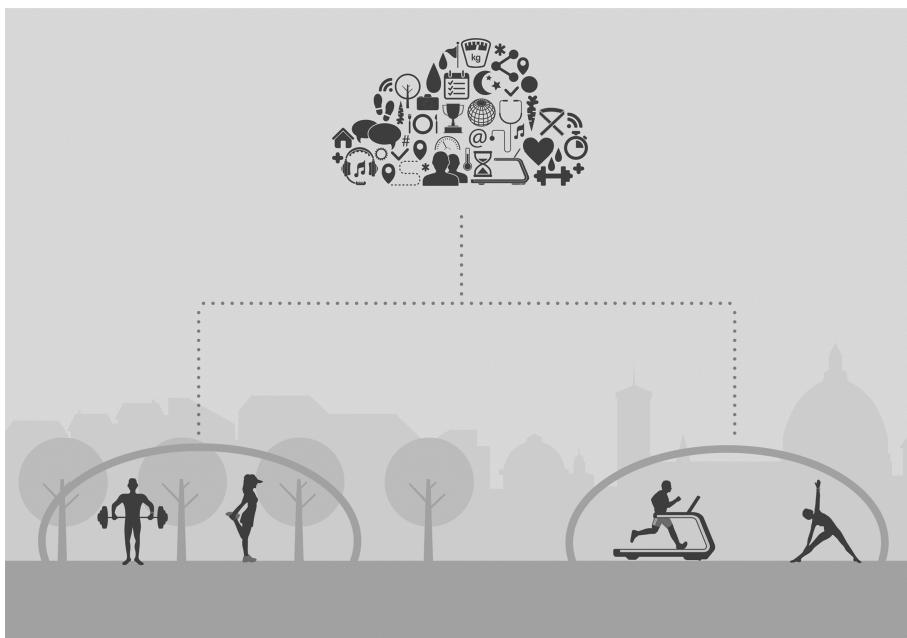


Fig. 3. The Wellness Capsules are widespread in strategic locations in the city, in parks, close to the workplaces, to meet users.

- Bolster motivation through provision of a service that also touches on ‘sensitive’ aspects such as basic prevention (via monitoring of heart rate, physical activity carried out, calorie intake and calories burned, the ratio between hours of work and hours of free-time activity, blood pressure, breathing, blood glucose and other parameters), ‘personalised’ assistance for physical exercise targeting cognitive evaluation of each subject and cognitive restructuring of his/her approach to movement, personal hygiene, and the quality of his/her living context (from the home to the city) and

lifestyle (hours spent in traffic or at the computer, quality of sleep, stress, emotive aspects of living).

- Support the factors that affect satisfaction of certain fundamental human needs, and in detail:
 - (i) *the need for a rapport with nature*: by encouraging people to get outdoors;
 - (ii) *the need to belong to a group*: by developing aspects such as the component of ‘play’ or ‘the game’ and sharing of emotions, competitive spirit and fatigue, in part through the social networks; and by spreading a culture of wellbeing as a social responsibility of every individual;
 - (iii) *the need for ‘beauty’*: the search for aesthetic gratification through achievement of a pleasing appearance and physical form but also in the design of the devices used, the intelligent garments, the clothing and accessories for physical activity and the man/machine/network and service interfaces.

Within the project, design plays a primary role, a responsible role as problem-finder at the critical and ethical levels. In this context, design is not only an important key value for making the system-product more attractive, functional, ergonomic, comfortable and as natural as possible and for improving the user experience, but it is also a fundamental tool for identifying users’ real needs and expectations as well as for understanding what technology is actually capable of generating in terms of responses and for reorienting it towards sustainability.

4 Discussion and Conclusion

The idea sparked by our research into the possible contribution of design to wellbeing and health and to active ageing, through application of smart technologies, was to involve a group of players in a process of design and development of a system-product capable of stimulating and encouraging people to adopt an active, dynamic, healthy lifestyle.

The system-product we envision comprises intelligent equipment for both indoor and outdoor physical activity, capable of stimulating and interacting with the user and of receiving and sending data about the user and the community from and to the Digital Wellness Hub, the online platform which, thanks to cloud computing, manages the data incoming from the intelligent wearable garments and accessories of the individuals making up its network.

This man/machine/network interaction permits aiding the user in his/her sports activity, of including and so involving even people with minor disabilities and seniors, of measuring biological signs indicative of both physical and emotional states, of remotely monitoring individuals and identifying any anomalies pertinent to their health status, declining performance, and/or other indicators that can aid in prevention or in rapid diagnosis of emergent health problems and illnesses.

The system-product takes into account possible areas for its experimentation, such as wellness providers (gyms and sports clubs) and healthcare facilities, and anticipates development of services that embrace the concept of sharing in such a manner as to

channel user information into an open-source system, the aim of which is to increase people's psychic and physical self-knowledge and self-awareness.

The innovation embodied by the research lies in the idea that wearable computers (including e-textiles and smart garments) and smart objects can be used not only to provide information and data about the activities and the lifestyles of individuals but, thanks to interaction with ubiquitous, pervasive ubicomputing systems, can also send information about people's living contexts to the Digital Wellness Hub and thus become, in a certain sense, 'collective wearables'; that is, devices capable of gathering data about the entire community and of responding with intervention strategies. Such strategies will aim at making people 'smart' and active, at creating new dynamics, and at building personal and social awareness of the individual, the community and the living context that can lead to changing people's lifestyles.

Additionally, the system-product impacts a large set of products and services: smart textiles, garments and accessories; smart objects, ubiquitous and pervasive sensing and actuating systems; systems for monitoring the vital signs and activities of individuals and man at large in real time; services for encouraging people to remain/become active, for building information sharing and an awareness that can lead to adoption of an active, sports-minded lifestyle and facilitate prevention and basic diagnostics.

We thus feel that this research could provide solutions and proposals for encouraging people to adopt an active, healthy lifestyle, and also could additionally offer a broad spectrum of possible areas for innovation and development of an original vision of wellness to European manufacturing – and in particular, to the Italian system, one of the world's most advanced as regards textiles, fashion and accessories as well as in the sector of equipment for sports and rehabilitation [19–21].

In parallel with the above, the research investigates the role of design as a driver of innovation and competitiveness and attempts to draw a picture of the current evolution in the field and of the significance of the project and its methodologies.

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