DESIGN CONSIDERATIONS FOR HOMECARE PRODUCTS: TOWARDS THE DIGITAL HEALTHCARE TRANSITION

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Abstract

Digital Healthcare is one of the goals of the Digital Transition. It includes the digitalisation of healthcare and the implementation of a widespread capillary network in which the patient's home becomes the core of care (telemedicine, de-hospitalization). However, the challenge lies in making this transformation – and so the new domestic medical devices – patient-friendly, easily accessible, and acceptable. Shifting some medical and care practices to the patient's home requires redesigning medical devices to fulfil the broad needs of patients, family members and carers – as well as medical personnel, who monitor the patient remotely. This paper introduces some design considerations for the development of homecare products (telemedical devices to be used independently by users in their home environment). It opens by laying out the context from which these considerations were drawn (an educational experience: a full-semester workshop within the master's degree in Product Design at the University Iuav of Venice, Italy) and then presents five design principles: simplicity of use, aesthetics and likeability, discretion, camouflaging, recreational (which are listed as fundamental and integrative principles of health product design) along with, where needed, references to a selection of student projects. The purpose of this paper is to emphasise that while designing healthcare devices the same attention paid to the technical function and its accuracy should also be paid to these five design principles because translating them into formal and functional aspects of the product will contribute to the final acceptance and adoption of the system by the user, hence to its success and effectiveness. Ultimately, promoting the digital health transition, the spread of telemedicine, and de-hospitalization. Finally, the article encourages the scientific community to identify new design principles in a field that needs design intervention more than ever before.

Keywords: homecare; product design; design-driven innovation.

1 INTRODUCTION

Healthcare has become a crucial part of contemporary debates on worldwide changes and crises. The central role of hospitals in today's healthcare organization is revealing its ineffectiveness in providing a resilient service: modelling itself on the changing needs of citizens (demographic, economic, social, and epidemiological ones). A situation that the Covid-19 pandemic has drastically highlighted.

On the one hand, the arduous desire to direct health care to the territory through de-hospitalisation policies has encouraged us to imagine new healthcare places: a widespread capillary network in which home becomes the core of care. On the other hand, shifting some medical and care practices to the patient's home requires redesigning medical devices to fulfil the broad needs of patients, family members and carers – as well as medical personnel, who monitor the patient remotely.

In this ever-changing scenario it is added the revolution in digital technology pushing towards digitalised medicine (and telemedicine) that is transforming our lives and improving patients' self-management. According to researchers at King's College, the (still current) challenge is how to make most of these technical transformations and, consequently, the new domestic medical devices, patient-friendly (El-Miedany, 2017).

Discussing healthcare at home means reflecting on the homecare practices and instruments. The term homecare hardly finds a universal definition. According to the Organisation for Economic Cooperation and Development (OECD), it refers to services enabling people to stay living in their home environment (focused only on long-term care) (WHO, 2012), but the World Health Organization (WHO) defines it as an array of health and social support services provided to clients in their own residence. Such coordinated services may prevent, delay, or be a substitute for temporary or long-term institutional care (Thomé, Dykes & Hallberg, 2003; Knight & Tjassing, 1994). In this work, homecare is regarded as the totality of personal care services in the home, from therapy to rehabilitation, with a spotlight on self-health management.

At the same time, a home-use medical device (HUMD) is defined, by the Home Health Care Committee of the Center for Devices and Radiological Health of Food and Drugs Administration (FDA), as a device intended for use in a non-clinical or transitory environment [that] is managed partly or wholly by the user, requires adequate labeling for the user, and may require training for the user by a healthcare professional in order to be used safely and effectively (FDA, n.d.).

Commonly, the main recipients of homecare and telemedicine services are complex, long-term and fragile patients. A type of user that still struggles to use digitalised and connected systems to manage their health and wellbeing independently at home. To facilitate these activities, and consequently the transition to digital, it is hence crucial to adjust the products, i.e. the medical devices entering people's homes.

This paper introduces some design considerations for the development of homecare products to be used independently by users in the home environment. It opens by laying out the context from which these principles were drawn (an educational experience) and then presents five design principles (divided into fundamental and integrative ones) with references to a selection of student projects.

2 CONTEXT

Given the topicality and importance of this issue, it is crucial to bring these social complex scenarios, modifications and challenges into design education. In addition to being a comprehensive and ambitious educational experience for young designers, it is also one of the channels to foster the digital transition: educating and raising design students' awareness about critical sense and evaluation of current patients' needs in this “transitional” era. Therefore, several full-semester workshops within the master’s degree in Product Design at the Università Iuav di Venezia have been conducted on this topic in the last years (Medical Design, Design for Multimorbidity, Design for Health and Wellbeing, Design for eHealth and Telemedicine, etc.). The students' results are an example of how the considerations and principles we highlight in this paper can be applied. In some cases, it is because of them (if not precisely through them) that the principles have become entrenched.

3 DESIGN CONSIDERATIONS

To design a medical product in line with users’ capabilities, there are some aspects to take into account: (i) the task, (ii) the person providing or receiving care, (iii) the technology being used and, (iv) the environment and the social system enclosing the task (National Research Council, 2010). It is common knowledge the occurrence of some general and essential principles, known as the seven Principles of Universal Design (equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance error, low physical effort, size and space for approach and use (Story, 2001)) guides designers in developing successful solutions in different project fields and kinds of objects.

However, several principles come into play precisely in the design of medical products for everyday and domestic use. Some are tangibles, and others are less or no tangibles, like emotional ones. In the following paragraphs, we highlight some tangible and no tangible factors which should be kept into consideration while designing homecare products.

3.1 Fundamentals

The principles listed below (especially the first two: simplicity of use, aesthetics and likeability), which deserve additional pages of analysis, are actually universal design principles to focus on every product design. What follows is their specific adaptation for homecare products design.

3.1.1 Simplicity of use

It is one of the fundamental principles of design. It may seem trivial, but it is always good to remark on it. Carefully designing a homecare device means making it compliant with patients' special needs, that most of the time they may be elderly. Therefore, the device must be intelligible to all, that is, also including those who by age are entering the cognitive, sensory, motor decline – which in turn results in improving the overall product's usability and making it compliant with other (less-demanding) age groups (Buffagni, 2022). Usability is defined as the extent to which a system, product or service can be used by specific users to achieve specific goals effectively, efficiently and satisfactorily in a given context (ISO, 2018). A concept that does not limit itself to the sole principle of 'ease of use' and 'being user-friendly'. In design, it has a composite value: it deeply relates to the outcome of [human] interacting with a system, product, or service (ISO, 2018). In design practice, it can translate into: minimizing the steps of use, as well as the number of devices the patient is required to manipulate; minimizing the risk of errors; limiting the need to memorize the sequence of use; and promoting a natural mapping between the commands to be manipulated and the action produced (Norman, 1988); considering the slowing down in processing information and cognitive fogging (it applies not only to the elderly, but also to patients on pharmacological therapy); choosing multimodal feedback (visual, auditory, haptic) and feedback of varying intensity and frequency, especially for alarm signals; considering the reduced motor dexterity and, thus, avoiding interfaces requiring fine motor skills (i.e., to develop big and spaced-out icons and keys, avoid combination of clicking buttons to generate commands, minimize the command sequences, and where possible, enable voice control, are wise choices); bearing in mind visual decay, i.e., providing the software with the option for variable text and icons size, avoiding colors with low wavelengths (violet, blu, green). Ultimately, all these considerations are linked to the concept of reduction. However, oversimplification can also be counterproductive. If the device is overly self-directed, unengaging, the user may become frustrated. Engagement is important, even more so the sense of involvement and, consequently, the idea of control. Being aware of these few factors while designing homecare products may prevent disaffection and avoidance of technology by the patient (Buffagni, 2022).

3.1.2 Aesthetics and Likeability

Needless to specify how aesthetics play a central role in the design of everyday objects, even more in the contemporary materialistic trend where people tend to express themselves through the material assets they own. Aesthetics, therefore, influences users' experience of use, understood, according to the ISO 9241-210:2010 standard, as the perceptions and reactions of a user that result from the use or expectation of use of a product, system or service. There is also a significant emotional component in the design and use of everyday objects (Norman, 2004), not only concerning the external appearance of the product (visceral level) but also pleasure, the effectiveness of use (behavioural level), rationalization and practicality (reflexive level) (Pistolesi, 2020). Moreover, aesthetics and time of use of a product are closely related factors. If you use a product continuously, then the aesthetic and emotional value attributed to it will be increased. When referring to chronic users – the main protagonists of homecare, suffering from one or more diseases for which there is no solution, who manage their condition autonomously through portable or wearable medical devices –, it is clear that the aesthetic factor and value play a key role in the success of the therapy.

3.1.3 Discretion

This principle is strongly recommended in the design of healthcare devices, especially if they are wearable or portable, and are to be used even outside the home. A principle that is strongly connected to the previous, and as we will see, to the next. A device that is bulky, does not hide in clothing, is too technical, or is even a blatant reference to the disease in its design, may generate discomfort in the patient with the ultimate risk that he or she will refuse to use it. Figure 1 shows ISO, a discreet device for Isoprene control in Diabetic patients (Isoprene is a chemical compound overproduced during the course of a hypoglycemic attack and detectable in the exhaled breath) designed as an accessory of style, even before prophylaxis. This is not a fad, it is an essential approach in medical design, especially if remote, where the actual success of the therapy depends entirely on the patient's good disposition to use the device regularly. Making it discreet, as well as efficient, is precisely the health product designer's task. The patient would not use a stigmatizing product, compromising the first condition of its effectiveness: the will to use it (or wear it). Hence, making it useless to its aim.

Fig. 1. ISO, non-invasive kit for Isoprene control for patients affected by Diabetes designed by Danilo Battistelli, Ciro De Candia, Giovanni Cortellessa, Federica Signorin.

3.2 Integratives

The following two principles integrate the fundamental ones. These are not to be considered mandatory principles in the design of home medical devices (depending on the task to be performed by the product). They are, however, strongly recommended, as their application will significantly participate in the final acceptance of the product by the user, i.e., its success.

3.2.1 Camouflaging

Camouflaging medical devices may be a viable strategy to make them more user accepted. Two approaches are considered in this context: one related to body image and the other to the domestic environment. In fact, in both cases, it is possible to move in the direction of disguise.

1. *Body image.* What we choose and accept to wear is a means to express our body, it defines our identity, and more specifically our body image (an expression first adopted by Freudian neuropsychiatrist Paul Schilder, in 1935): the intimate perception we have of our appearance that influences our attitudes in complex ways (Mair, 2018). That said, wearable healthcare devices inevitably affect our body image, and therefore it must be kept in mind while designing this kind of product. The designer should pursue a design that, besides the underlying healing function, a person always ‘wants’ to wear it: making them fashionable, stylish or desirable accessories that match with clothing, it will prolong the user’s emotional involvement, facilitating the technology acceptance, hence the continuation of care, while promoting the longevity of the product (Emotional Durability (Haines-Gadd et al., 2018)). To bring up an example, figure 2 depicts IUVA, a set of three pairs of fashionable gloves that conceals smart materials and technologies in its weave to treat and monitor people affected by hand’s Systemic Sclerosis and Pulmonary Hypertension in comorbidity (the figure shows one pair: the “second skin” to treat Raynaud's Syndrome).

Fig. 2. IUVA, physiotherapy and monitoring system for people affected by hand’s SScl and IAP designed by Martina Bresciani, Francesco Carraretto, Alessandro Santoro, Mario Sibau.

2. *Home setting.* Not only over the body but also in the domestic environment camouflaging medical devices may be a wise choice to preserve patient adherence to therapy. Figure 3 shows PHIL, an integrated system of three devices for monitoring and home treatment of patients diagnosed with arterial hypertension and first-class obesity. This project translates the principle of camouflage into a design that does not stigmatize the patient, integrating the system into the home environment like a

piece of furniture. The wall-mounted device provides a clear view of disease progression. It acts as a dock station, a reminder and warning for the patient, as well as a data collector, blending in with the environment and “masking” the measuring devices it contains. In a different way, but following the same principle, Hemileft (see Fig. 4) also fits perfectly into the home environment, providing a kind solution to post-stroke occupational therapy. The product allows users to train their left-hand ability to naturally take objects, activating not only the muscular system but also the cognitive processes related to it. The kit composed of three objects will be embedded in the domestic landscape (like a sort of sculpture): it is in fact a series of non-invasive devices, which can be disguised as part of the home furnishings while being always present and ready to use. The “Domotics” modality allows the user to transform his home environment by associating the device with different elements of the house, which will be made interactive (such as light, radio or TV): the user can interact with his own home holding onto specific parts of the three objects. If it is true that the device influences the home environment, so, too, should the home environment inspire the design of the device (Frausin, 2022). And then, medical solutions could blend into patients' homes with benefits both in terms of perceived intimacy of space and de-stigmatisation. A design approach that is not only human-centred but even "(home) context-and-material-centred" (Ludden & Vallgårda, 2019).

Fig. 3. PHIL device for disease trends monitoring and visualisation designed by Marco Antoniazzi, Chiara Comuzzi, Francesca Ferrucci, Tao Yang.

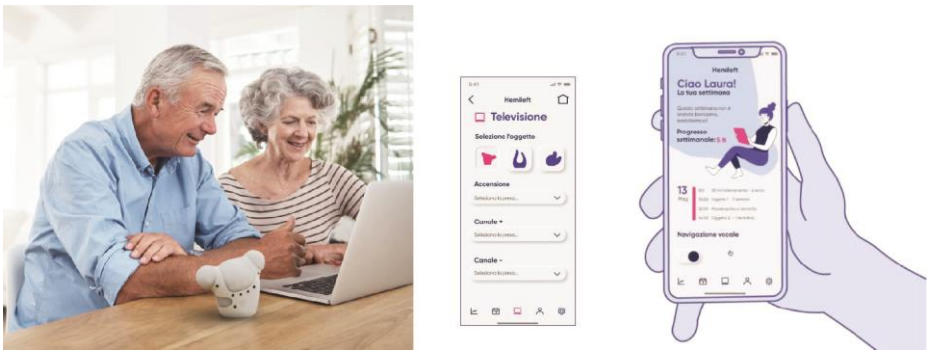

Fig. 4. HEMILEFT, a device for post-stroke rehabilitation designed to improve hand movement in patients affected by left hemiplegia, designed by Giulia Cassiani, Cecilia Garuti, Arianna Monaci, Caterina Vagnozzi.

3.2.2 Recreational

Alleviating therapy through gaming is a successful strategy for some patients, especially chronically ill ones, who perform specific medical treatments regularly (Sardi & Fernández-Alemán, 2017). Among these patients are, for example, children and adolescents. ORBIT (see Fig. 5) is designed for teenagers who suffer from Cystic Fibrosis and type 1 Diabetes and must receive respiratory therapy on a daily basis. In fact, teenagers

must do physical and respiratory activities as a key part of their therapy, but they often underestimate and avoid it. The kit is made of a device that brings together different functions, one of a spirometer and of a pep mask, and e-patches, which monitor parameters during training. Its smartphone application processes physical and respiratory parameters, but it also aims to connect teenagers to a gaming platform. They are divided into teams and they challenge each other, in order to have the possibility to build relationships and lighten the therapeutic load.

Similarly, ATOLL (see Fig. 6) is a system consisting of an app and a smart board with integrated impedance balance whose purpose is to monitor and promote the light activity of the lower limbs during the dialysis session for patients with chronic renal insufficiency and secondary arterial hypertension. It is designed to entertain the patient through games, offering a valid alternative to classic activities such as watching television, movies, reading, and listening to music, allowing them to occupy time in a healthy and effective way. In the final analysis, LUDO (see Fig. 7), a video projector equipped with motion sensors that monitor speed, errors, coordination, reaction times and completeness or omission of movements. The user can choose among different macro areas of skills to improve: problem-solving, coordination and organizational, and sequential skills. The single or multiplayer game mode involves interaction through both visual and sound stimulations. In addition, when placed on its charging base, Ludo blends into the environment like a piece of furniture (camouflaging). In conclusion, designing homecare devices that are both effective and recreational can stimulate a good disposition in the patient to use them regularly. Hence, participating in the success and acceptance of the product.

Fig. 5. ORBIT, a toolkit designed for teenagers who suffer from Cystic Fibrosis and type 1 Diabetes designed by Carmelo Leonardi, Valentina Paciaroni, Linda Raffaeli, Claudia Vagnoni.

Fig. 6. ATOLL, a smart board to monitor and promote a light activity of the lower limbs during the dialysis session designed by Sara Ceccato, Marta Finotti, Emanuele Gatti

Fig. 7. LUDO, a game console that aims to train, develop and stimulate cognitive-motor skills designed by Alexandrina Bargan, Ludovica Bellussi, Alexandru Mihu.

4 CONCLUSIONS

In the era of digital transition, in which the use of home medical devices is expected to become increasingly widespread, reviewing the design of these devices cannot be left behind. To foster the transition, and make home medical devices consistent with it, we emphasize that while designing this kind of product, the same attention paid to the technical function should be paid to the simplicity of use, aesthetic and likeability, discretion, camouflaging and recreational aspects (which, in this paper, are listed as fundamental and integrative principles of health product design), because translating them into formal and functional aspects of the product will contribute to the final acceptance and adoption of the system by the user, hence its success and effectiveness.

Besides providing design considerations for healthcare products, this article seeks to encourage the scientific community to identify new design principles in a field that needs design intervention more than ever before. An identification that is, most of the time, the result of an appropriate user involvement. As a matter of fact, it is good practice (if not mandatory) to involve final users in the design process. Their involvement, not only professionals in medical fields but also patients, (although involving the use of non-negligible resources) is the approach that brings the most benefits in terms of achievable results (Shah, Robinson & AlShawi, 2009; Romero, Borga & Frausin, 2022). Even though this added value is recognised, recent studies (Woudstra et al., 2021; Yang, Mahmud & Wang, 2021) show that there is often a tendency to underestimate the importance of the patient in projects, limiting the involvement to professional users (doctors, nurses, engineers, etc.). Can this limitation be attributed to the limited involvement of the designer and design methodologies in decision-making and design processes in the medical device sector? Becoming familiar with complex issues, such as homecare, during university education can be a first step towards affirming designers' role in future healthcare.

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