

**Found in translation: innovative methods of co-design in the development of digital systems for promoting healthy aging**

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# **Found in translation: innovative methods of co-design in the development of digital systems for promoting healthy aging**

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## **ABSTRACT**

This chapter describes the Design Research contribution to the NESTORE Horizon 2020 project, which adopted a participatory design research method, called ‘exhibition in a box’, developed by the authors which is predicated on ‘thinking through things’. Over 100 older people across four countries participated in the study, which sought to develop a virtual digital coach to support active ageing. We discuss themes that arose relating to the barriers and enablers to engagement with technology as identified by participants within the study. It critically reflects on the strengths and challenges of the co-design methodology. The methodological approach followed in NESTORE provides for users to be involved in the design of the solution throughout the project duration and permeates the work of all the work-packages.

The reason for non-acceptance of health technologies is complex and the context where the technologies will operate and how they relate to the end users’ lives are key factors to uptake and utilization. Researchers have suggested that the poor design of many devices and subsequent non-uptake may be directly attributed to the failure of technologists to engage end users and elicit understanding of their requirements. To date few studies have articulated how this might be achieved.

**KEYWORDS** - Design, Co-Design, Design for Health, Health Technology

## **1. INTRODUCTION**

The authors have a strong track record in the area of co-design. Chamberlain and Craig are co-directors of Lab4Living, an interdisciplinary research group at Sheffield Hallam University (SHU) based on a collaborative community of researchers in design, healthcare and creative practice. The focus of Lab4Living is to work in partnership with end users to develop products, services and interventions that promote dignity and enhance quality of life by applying design skills and methods to identify and formulate questions, build understanding and create solutions. Key to this work is working in collaboration with people who use products and services recognising their inherent strengths and knowledge based on their personal and professional experiences

Declining mortality rates mean higher life expectancies globally. In 2015 there were 901 million people aged 60 years and over worldwide. By 2050 it will have increased to 2.1 billion or 21.3% of the global population (DESA 2017). This ageing population and the resultant pressure on healthcare capacity and changing roles and expectations are driving demand for innovative solutions to support independence at home for people living with long term conditions and disability. Digital technologies are being seen as a way to respond to these challenges and as a consequence the way in which medical and healthcare is delivered is being transformed (EU 2018).

Much of the focus of technology to date has been on medical device development with a particular emphasis on products that measure to record data relating to physical functioning (e.g. blood pressure, heart rate, pulse-oxygen). However, more recently there has been an increased recognition of the link between social isolation, loneliness and reduced life expectancy (Bhatti et al. 2017, Holt-Lundstad et al. 2015) and this has led to a growing emphasis on policies to address the social dimension of health.

Alongside these changes, a paradigm shift has occurred within health that places greater emphasis on self-management and health promotion. Here responsibility is given to the individual to recognize and manage the symptoms of their condition (Lorig and Holman, 2004). Approaches that support a more pro-active approach and that do not rely on health and social care services are being promoted globally. Models of healthy and active ageing with a focus on the multi-stage life are replacing previous conceptualizations of ageing predicated on decline and withdrawal from society. Within this new paradigm technology can play a key role in offering integrated solutions to promote on-going engagement in meaningful activity and promote community connectedness.

Whilst technology can potentially have a significant impact on health and wellbeing, to date the uptake of digital health technologies has been problematic in a number of wide-scale studies (Steventon et al. 2015). Literature highlights that the reason for non-acceptance is complex. Authors have cited confidence, the stigmatizing aesthetics of products, meaningfulness of technology in the broader context of the persons' life, ease of use and integration into everyday routines as important factors (Bentley et al. 2014, Hanson et al. 2010).

## 1.1 Aims of the Research

Novel Empowering Solutions and Technologies for Older People to Retain Everyday Life Activities (NESTORE) is a Horizon 2020 funded project focusing on a technological innovation to enable individuals to engage in health promoting activities as they age. The innovation is conceptualized as a 'friend, a companion and coach' seeking to valorize the capabilities of the older person, to recognize and support them in maximizing their abilities and to experience mental, physical and cognitive wellbeing. NESTORE is intended to promote choice, to educate, to signpost to opportunities, to connect individuals to community facilities and resources and to promote on-going social connectedness throughout the life-course. The system is not a medical device. Rather, it seeks to promote wellbeing through enabling the person to identify and reflect on current lifestyle choices and to access opportunities to engage in meaningful health promoting activities. To develop a solution fit for purpose it is therefore necessary to build understanding of what end users identify as being meaningful and the qualities and characteristics the technology needs to possess. The role of the design set within the context of this project was to better understand the broader physical and social environments in which services and technologies will operate and how they relate to the contexts of the end-user. The aim then was that these insights would be communicated to the technologists in the development of the end product. The methodological approach followed in NESTORE provided for users to be involved in the design and development of the solution throughout the project duration.

The Consortium responsible for undertaking the research comprises of sixteen partners from eight European countries. Research expertise included: design, health (psychology, medicine, nutrition), engineering, business and technology. These partners span Higher Education Institutions and Industry. The overall study is divided into 4 distinct phases. Phase one of the research utilizes participatory research methods and is focused on developing cultural and behavioural insights related to technology, initially in the United Kingdom. Phase two extends and develops this participatory methodology to focus on the materiality, interaction and usability issues related to the NESTORE system. Co-design groups in the Netherlands, Italy and Spain extend these cultural insights and test the transferability of the methodology. Phase three of the study then supports the development of prototypes and product through an iterative co-design process. Phase four of the research comprises of a pilot study with over 60 participants across Italy, the Netherlands and Spain.

## 1.2 Methods of Engagement

There is widespread support for the fact that recipients or users of products and services should be involved in some way in their creation and there is a body of literature in support of the value of participatory and co-design. Arnstein's ladder of citizen participation (Arnstein 1969) describes levels of citizen engagement in planning processes that can usefully be applied to participatory and co-design. However too often participatory engagement doesn't extend beyond the level of tokenism as presented in Arnstein's ladder (Figure 1).

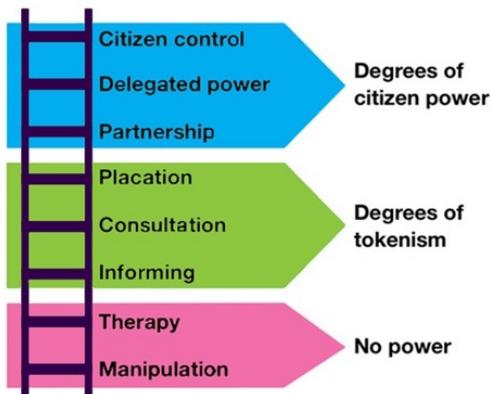


Fig. 1 Arnstein's ladder of citizen participation 1969

Participatory methods are centred on the principle that participant engagement can provide value throughout research planning and implementation, yielding findings that directly reflect on a community's needs and perceptions. Participants are given an active role, allowing them to shape the direction and methods of the research itself. Multiple benefits are associated with the use of participatory methods including developing collaborative and productive partnerships with participants, providing participants with a voice and harnessing participant engagement to stimulate positive change and the design of better products.

Within our study, co-design was defined as creativity of designers and people not trained in design working together in the design development process. From the outset of the research it was envisaged that as the project evolved multiple levels of engagement and participation would occur. For instance, in the earlier stages of the research, individuals would be actively involved in the co-design of the products whilst at other points participants would play more of a role in providing feedback and reflections on the products being developed. The overall study design followed the UK Design Council's Double Diamond with the initial phases of the research interrogating the requirements of the product by adopting a more exploratory approach, asking questions, conceptualizing possibilities rather than offering solutions (Figure 2).

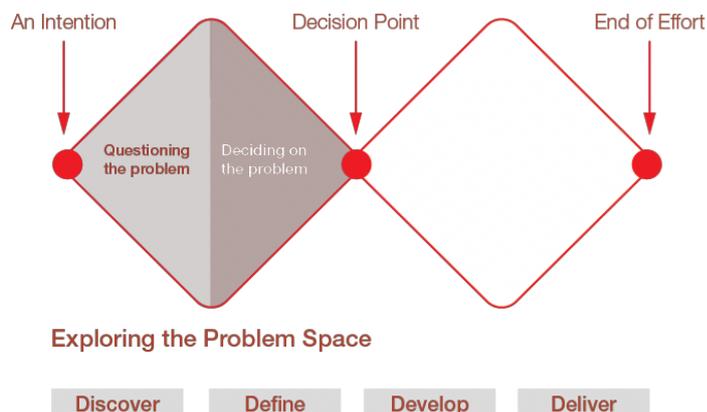


Fig. 2 Design Council (UK) Double Diamond

## 2. DESIGN OF THE RESEARCH

The research was structured into four phases to align with the Double Diamond model (Figure 3) The first of these phases to explore the problem space was undertaken in the United Kingdom. Community living older people were invited to engage in a co-design process to build understanding of user requirements of the technology, identify factors that promote and inhibit use and explore potential contexts where technologies would be used. An older expert group was recruited to help analyse the data collected.

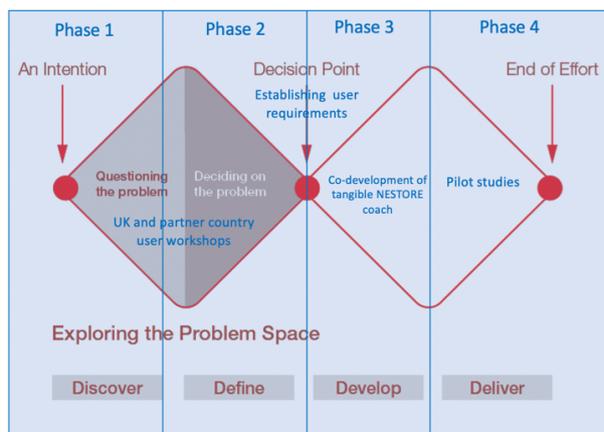


Fig. 3 NESTORE Co-design activity mapped onto Design Council's (UK) Double Diamond

Phase two of the research was then undertaken in the partner countries of Spain, Italy and the Netherlands. The same co-design methodology was used with groups of community living older people in these countries with the addition that themes from the first phase of the study were shared to build understanding of the potential for transferability. The aims of this phase were to build understanding of the similarities/differences in requirements of older people in these countries that would determine user requirements for the NESTORE system and in the context of the double diamond model arrive at the decision point. The expert older group from the UK and members of AGE Platform Europe were integral to this process.

Phase three, the development of the research, involved how the user requirements established through phase one and two could be translated into tangible solutions with the technologist. This again was conducted in collaboration with the older expert group through a series of co-design workshops. Phase four, the delivery phase of the process, would involve the pilot studies to test the NESTORE system in context with older users in the Netherlands, Italy and Spain.

## 3. METHODS

Co-design methods in NESTORE drew on an existing body of work developed by the authors (Chamberlain and Roddis 2003; Chamberlain and Yoxall 2012, Chamberlain and Craig 2013) which used objects and artefacts as methods to stimulate and scaffold thinking, offering valuable vehicles through which the complexities of lives can be understood. The concept of exhibition is embedded within the culture of art and design and has a long history as a form of gathering employed to prompt academic discourse. Exhibition as a research vehicle is often used by the authors to provide a theatre for conversation and a medium and method for data collection, creating a conduit through which societal assumptions can be made visible, explored and challenged (Chamberlain and Craig 2019).

Exhibition in a box (Chamberlain and Craig 2013) takes the form of nine objects defined through user workshops across multiple research projects. The objects have been carefully selected to code, represent and prompt further discussion on themes that have emerged through earlier research. The objects form the basis of an exhibition, contained in a box (Figure 4) à la Duchamp that can be transported to diverse environs including the home. Just as exhibition pieces invite individuals to express ideas and opinions and to articulate deeply held values and opinions, so the objects provide an opportunity for participants to express their emotional responses, to respond to and describe things of importance in the context of the research theme.



Fig. 4 Exhibition in a box

Whilst traditional qualitative research methods using structured and semi-structured interviews can preference the views of the researcher who can make assumptions about what the issues are, exhibition in a box offers participants the space to reflect, discuss, explore and define the questions that reflect their priorities. The objects offer scaffolds for communication because at one and the same time they are both concrete and abstract.

## 4. THE STUDY

### 4.1 Phase One

The aim of the study was to build understanding of user requirements of the NESTORE technology and the factors that promote and inhibit use. In addition to explore potential contexts of where the NESTORE technologies might be used.

Ethical approval for the study was granted from Sheffield Hallam University's Ethics Committee in October 2017. Between October 2017 - January 2018 a convenience sample of 82 older user representatives were recruited from organizations across the city of Sheffield, in the north of England, to participate in a series of NESTORE co-design workshops. Inclusion criteria for the study were that participants should be community living older people aged 50 and over; individuals able to give informed consent; people who had some degree of familiarity with the use of technology (reflecting future groups of people who may use NESTORE).

Workshops were facilitated across a number of different venues including community centres, people's homes, and the user-laboratory space within the University. It is important to consider the diverse environments that NESTORE might be used. Consequently, workshops were held in a variety of contexts, for instance where people might work, meet socially or in the home. The context of delivery of the workshop sometimes impacted on the conversations that were elicited and, participants could relate their experiences to objects and surroundings. Each workshop lasted on average between one and two hours and comprised of between four and eight participants, facilitated by a combination of two of the authors. The workshops began with a general introduction from the research team and an

invitation for participants to share (verbally) activities they engaged in and found meaningful, with a particular focus on hobbies or leisure. Exhibition in a box was then introduced and participants were invited, in turn, to select and use the object to explore their ideas further (this might relate to the object's form, its sensory quality or a more metaphorical use). This was shared with the broader group. Participants were then invited to share associations that came to mind when they heard the word technology. Again, the critical artefacts were used to explore and interrogate these themes further. With permission, each workshop was audio-recorded and then transcribed.

## 4.2. User Workshop Findings

A number of strengths in relation to the exhibition in a box method were identified. The objects transcended boundaries of culture, language and age and whilst the objects remained unchanging the associations they prompted and the stories they elicited were dynamic and ever changing. Across the various workshop/focus groups different objects elicited the same themes of conversation. Particularly powerful were the keys which very much related to security and the dice which participants used to talk about parity of access. Participants shared rich descriptions of their attitudes towards and experiences of technology and a depth of information was offered within the first few minutes of the workshop beginning. Older people expressed appreciation of the tangibility of the objects and their sensory qualities, acting as a physical prompt. The method also enabled individuals to achieve some distance when sharing more personal stories by 'speaking through the objects' or using the objects metaphorically. Rather than being dependent on fixed interview schedules whereby the researcher had pre-defined questions the method very much preferred the views of participants. This is integral to the co-design process. Individuals participating in the workshops expressed enjoyment of the experience and reflected on their learning and the new insights they had gained through the process. This positive experience led to an expressed interest in participating in other elements of the study.

The workshop was structured into two parts where the 'exhibition in a box' was used to prompt discussion on personal interests and attitudes to technology. The following topics and issues emerged.

### 4.2.1 Meaningful activities

#### Hobbies and activities

The range of hobbies and activities people described as being important was broad and included for example; listening to music, cooking, playing instruments, walking, gardening, drawing, art, creative writing, golf, cricket, football, and engaging in cultural pursuits such as reading, visiting museums and galleries. Older participants were more likely to talk about the importance of spirituality and faith and a number of individuals described the importance of attending church in relation to their emotional and spiritual wellbeing. Interestingly because a number of participants were still in employment, the value of work was described in some depth as an area which offered structure to the day, a role and a sense of identity. There was recognition, particularly amongst participants in the 50-60 year age bracket, of the need to keep physically well and to engage in health promoting activities. This was identified as a motivation to engage in a range of pursuits although it was also acknowledged that healthy lifestyle choices could be difficult.

#### Physical activity

Physical wellbeing was regarded as important and a number of participants engaged in a range of exercise including running and walking. However, exercise was not seen only in terms of physical wellbeing but also as offering an opportunity for relaxation and for the maintenance of mental wellbeing. Access to outside space and spending time outside was seen as key particularly as people grew older. The social dimension of exercise was a motivating factor – participants found purpose when being with friends or pets.

## Social dimension of activity

Socialising and engaging in activities with other people were a significant theme that ran throughout all workshops. Participants spoke of the importance and value of interacting with family, engaging in intergenerational activity and of being with others. Friendship and socialising were seen as key to maintaining good mental wellbeing. At times individuals spoke of the social dimension of the activity being the motivating factor and at other times keeping connected and spending time with friends became an end in itself.

## Creative activities

A significant theme that arose during the workshops was the value that participants placed on creative activities and in attending cultural events. Creativity was regarded as an outlet for self-expression, a way to reflect and to make sense of situations. Creativity was also seen as a form of problem solving, as a way to identify and to think about solutions. The idea of making something tangible and of engaging with physical materials in the creation of new things was linked closely to legacy and of the act of creating and making a mark that would live beyond the participants' lifetime. Across all workshops individuals identified creativity, art, writing and drawing as ways of keeping mentally and cognitively well and as a way to retain a sense of curiosity and new learning. For a number of individuals it offered a sense of balance and was key to emotional wellbeing.

## Factors that promote engagement

Some factors that promoted and maximised engagement were also identified in this phase of the study. Individuals were more likely to engage in health promoting activities if they were part of a routine, particularly if they were in full or part-time employment. Participants spoke of the importance of the social element of activities as a motivating factor, particularly if they could be undertaken with friends and family. Having a sense of challenge or a goal to work towards was also seen as being important particularly in terms of creating a sense of achievement.

## Barriers to engagement

Across all the workshops, participants also spoke of barriers to engagement. Lack of encouragement or reward was a theme that led some to disengage from activity, particularly when participants were seeking to learn something new. Lack of confidence and the challenge of taking the first step was also a theme that emerged across workshops. When people felt coerced or that they did not have a choice but to participate this acted as a barrier to engagement and continued engagement in the activity. However, by far the greatest barrier to engagement in meaningful activity was lack of time and financial resources. Within the demographic of this research a significant number of participants were of the so called 'sandwich generation' caring for children or even grandchildren and for elderly parents. Time was at a premium and the notion of engaging in any form of activity outside of work or caring roles was felt by a number of participants to be impossible.

### 4.2.2 Perceptions of technology

Perceptions of technology were broad and individuals described and identified this in a number of ways. The most common association was with digital technology: smartphone, computers, wires, cables, phones. A small number of people spoke about technology more generally including aeroplanes, cars, kettles and household objects and a couple of participants offered more philosophical definitions linked to time and place:

*So technology is essentially the stuff that has just been developed or is being developed and we're just trying to get to grips with it. So everything... watches were technology at one point, just as (telephone) landlines – we don't call landlines technology now, because they're just landlines.*

Digital technologies were seen as mechanisms through which to access information, and to offer vehicles and opportunities for new learning and to connect to interests. At the same time individuals framed technology as having potential detrimental affects on health and posing a threat to the present way of life.

With the exception of four or five individuals, everyone had access to a smartphone or tablet computer and this was the most common device described. Attitudes to and responses to technology across all the workshops were polarised. On the one hand, the strengths and potential of technology to be an enabler was recognised, particularly in helping individuals to overcome challenges such as dyslexia. Digital technology was also seen as a mechanism through which to access information quickly, to provide a vehicle through which it was possible to access opportunities, learn new things and to connect to interests (such as exhibitions and to book travel and accommodation). For some people advances were seen as a good thing, particularly when it had a clear function that enabled participation in meaningful activity. On the other hand the same technologies were seen as a threat to present way of life. Terms such as 'good' and 'evil', 'frustration', 'fear' were used. A number of participants described technology as being 'dull' and 'uninteresting' particularly in relation to digital technology.

#### Barriers to engagement

Barriers to engaging in technology included the speed of change leading to challenges in new learning at a point of cognitive decline, questions relating to privacy and trust in terms of who is able to access and use the data generated and the reliability of the technology and the information and readings created. Prohibitive costs and lack of technological infrastructures were also seen as challenges.

#### 4.2.3 Design Considerations

Design considerations which were identified as supporting engagement and adoption included the potential for personalization, portability, durability and considerations in relation to ergonomics. Features that promoted control and the building of self-efficacy were also valued. An aesthetic that was fit for purpose, as according to Dieter Rams 'good design is aesthetic' (Rosenfield 2012). A visual language that expresses reliability and durability, for example, was identified as an important aspect in the design of NESTORE.

Above all it was necessary to consider how technology relates to other elements of the person's life and how it fits with self-concept and value system. Specific design considerations identified by individuals participating in the study are described as follows: The ability to personalize the technology was by far the most desirable design consideration expressed in this element of the research. This was seen as a way to counter the uniformity of existing technology and to enable participants to create a sense of identity and ownership. If personalization and the ability to adapt and shape the technology reflected the owners personality then the opposite was true in relation to the operation of digital devices. Participants identified the need above all for consistency in design, in the symbols used on controls across products. These characteristics both align with and validate existing usability guidelines for IT systems (Rajanan (Marghescu) 2009).

Portability was another design consideration. Older people in our study enjoyed travel and pursuits in the locality and did not want to be tied to the home or to a particular room in the house. Within this, size and weight were both factors.

Participants valued design features to promote control and self-efficacy. Individuals were, for instance, clear that not being dependent on others to update the device or change batteries should be a consideration especially if the aim of the technology was to increase self-efficacy. Participants also appreciated the choice and option to have time to disconnect from technology and there was much discussion about feelings in relation to using systems that were completely automated. There were

mixed views in terms of whether devices should have multiple functions or whether a single piece of technology should have a single function.

One unexpected theme that emerged during this phase of the research was discussion the workshops relating to the potential negative impact technology may have on health. Concern was expressed as to whether a focus on measurement of health behaviours (pedometers, step counters) could result in the focus being on the behaviour rather than the activity itself. Technology was also seen as both being as addictive and as a gateway to websites that might provide dangerous to individuals vulnerable to addictive behaviours, feeding addictions such as online gambling and pornography. However, the greatest perceived threat regarding technology in relation to mental health was in the breakdown of relationships and the ensuing isolation.

#### 4.2.4 Data analysis phase one

Transcriptions of the user workshops were shared with a group of ten older people in the UK who formed an older expert group for NESTORE (Figure 5). During a one-day workshop these individuals were engaged in a process of identifying the main themes from the overall data collection and identifying the most important factors in relation to considerations and user requirements of NESTORE. These were; Privacy, Empowerment, Fits my life, Personalization, Cost, Freedom, Ergonomics, Reliability, Observation, Connectedness, Security, Infrastructure, Being social, Engaging, Keeping active.



Fig. 5 Older expert group UK

#### 4.3 Phase Two

A similar methodology was adopted in workshops with older people in each of the partner countries, Milan (Italy), Barcelona (Spain), Delft (the Netherlands). The objective of conducting user workshops in the Netherlands, Italy and Spain was to identify if the findings from the workshops in the UK aligned with communities in other countries. Nominated members of the country partner NESTORE team facilitated each workshop. All took part in earlier briefing meetings with the UK team prior to the workshop and workshops were delivered in the local language. The UK team was present and contributed to the workshop with translation support. A convenience sample of 30 older people across the three countries took part in this phase of the research (Figure 6).

Workshop participants engaged in the thinking through things method with exhibition in a box sharing their personal insights into what is meaningful in their lives and their opinions and

relationships with technology. The second part of the workshop focused on the priorities and characteristics identified from the user workshops conducted in the UK. Participants were collectively asked to reflect on each of these and whether they agreed or disagreed with their validity in the context of what NESTORE should consider in its development and application. In addition the participants were asked if there were any themes they felt were missing from the list.



Fig. 6 Co-design workshops (Delft, Milan, Barcelona)

### 4.3.1 Findings

Findings from phase one of the study were found to be congruent across countries with a few minor differences mainly concerning the politics of how NESTORE might be appropriated (distributed through current health systems and regulations) and a call for NESTORE to be underpinned by research. There were no significant cultural differences however it was noted that climate and environment should be carefully considered in how it might impact on lifestyles. Participants, and in particular the group from Italy, discussed a concern for the ethical dimension and sustainability of technology in terms of resource and rare minerals. The workshops were conducted during the winter period with extreme cold weather in the UK and the Netherlands in contrast with mild pleasant weather in Italy and Spain. This has significant bearing on the ability for people to engage in outdoor activities

### 4.4 Analysis of phase one and two

Following the workshops in Milan (Italy), Barcelona (Spain), Delft (the Netherlands) and in collaboration with the older expert group, the user requirements identified in phase one and shared in phase two were further refined and focused on three broad themes; TRUST, FITS MY LIFE and COST.

#### TRUST:

- Privacy/security/reliability of NESTORE
- The system's management of data is transparent. Users are aware of where data goes and how it is used. The user has control over their privacy settings (in a usable manner and who has access to the data)
- Health related data is accurate and can be viewed in real time by users of the system
- Users have the capacity to turn off analytics (on/off switch)
- The system will translate health data into contextualised user centred feedback appropriate to its audience.
- The system should be robust and withstand everyday use
- The system should not compromise or effect other health technologies of the user (e.g. pace maker)
- Charging requirements should not interfere with lifestyle
- Software updates should not alienate access

## FITS MY LIFE

- Responsiveness of the system to reflect the needs and preferences of the end user including considerations of ergonomics
- Interface should be clear, concise and elegant with the opportunities for manual customisation by the user reflecting their own preferences and style
- The visual interface (e.g. icons) should be easily recognisable, provide consistent look and feel
- Single sign in (log in once rather than multiple times)
- The system should provide a creative user-friendly solution for log in and resource access
- Users settings should be remembered throughout the platform
- When the user changes the interface settings the interface should be updated immediately and continuously
- Resources should be accessible and usable by all users of the system. Features should include interaction modes for touch and voice alongside high visibility settings appropriate to personal needs (e.g. high contrast for people with visual impairments etc) and language settings/options. Language should be clear and meet the needs of individuals with varied literacy skills.
- The system should be responsive and adapt itself to the environment and user needs
- The system should have the capacity to be used beyond the user's physical home environment

## COST

- Affordability
- NESTORE should be scalable (e.g. inclusive core features with option to purchase additional functionality)
- Costs should not be prohibitive to the specified user group.

## 5. TRANSFERABILITY OF USER REQUIREMENTS TO TECHNOLOGISTS

Phase one and two of the research concluded the *discover* and *define* stage phase of the double diamond model that established the user requirements for the NESTORE system, the *decision* point. Often this is the point in the design process where the co-design concludes and the development and delivery phase of the double diamond model is conducted by other partners stakeholders. The intersection of the double diamond becomes the transactional point of where an exchange of knowledge takes place. However, it is at this point where key insights can be lost in translation and consequently this research programme ensured collaborative engagement through further co-design activity continued between the design research team, the older expert group and the technologists. This was to ensure the user requirements identified in phase one and two, the exploratory phase of the double diamond, were interpreted thoughtfully and creatively. Consequently, a set of creative tools was developed by the design researchers to facilitate a further series of co-design workshops.

### 5.1 Digital probes

The aim of this workshop was to build understanding of design features of current digital interfaces participants find helpful/unhelpful. A digital probe methodology was used where participants were provided with a 'probes pack' created by the authors that included a disposable film camera, a tick/cross counter disc, and an instruction booklet (Figure 7). Each participant was invited to place counters with either a tick or a cross by particular technology interfaces they found particularly helpful or unhelpful and record with the camera. It was stressed that participants should make comment on the interface of technology rather than the activity associated with the technology. For example, watching television might be enjoyable but the interface not.

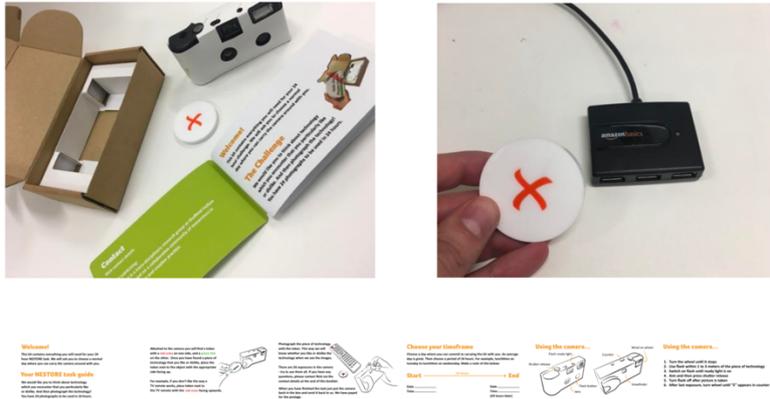


Fig. 7 Digital probe pack and instructions for use

Photographs were printed and the results were shared and discussed within the workshop (Figure 8)



Fig. 8 Analysis of digital probes

Multiple themes emerged through the workshop in relation to the design facets of existing technologies. Participants commented on the number of digital technologies they regularly interacted with and again questions were raised on the ethics of technology in relation to privacy and the sharing of data. In some instances comments were contradictory.

Within the expert by experience group, negative characteristics of existing technologies included:

- The need to have multiple controls to operate digital technologies (for example multiple controls to operate television, DVD player etc.)
- Interfaces with buttons requiring multiple hits to scroll through different functions. For example, setting digital timers
- The intrusiveness of many of the audio-qualities of technology ('indistinct bleeps and piercing sounds')
- Feeling tied to technology – an inability to get away from it
- Participants spoke of valuing particular types of digital technology but struggling with the interfaces (e.g. small numbers, symbols on buttons that are not uniform and which wear away over time)
- There were also questions raised by the group in relation to installation and the need to have clearer instructions in relation to how to use systems
- Poor cable management

- Restrictions in portability were raised by women who often do not have pockets in clothing.

Positive characteristics of existing technological interfaces included;

- Easy access to information (internet)
- Voice activated. e.g. Siri, Alexa
- Convenience of portability (iPhone)
- Gestural control (light switches)

There were mixed responses from the group with respect to multi-function products. Some people liked to have many functions in one device (e.g. smart phone) however others commented that they often use only a fraction of the functionality on many devices and stressed a desire to choose or customise would be preferable.

The group felt that one of the challenges is that often interfaces are designed without full consultation with end users and there was a sense that the technologists who are designing systems and products do not know enough about the end user. It was therefore decided to create a series of films to communicate to the technologists who the end user of NESTORE might be. This aligned well with the user personas developed by others in the consortium.

## 5.2 Personas

Over the course of four weeks the expert by experience group created a series of four films in partnership with the design researchers (Figure 9). The aim of the films was to bring life to existing personas and to support the technologists in understanding the audience NESTORE would reach.



Fig. 9 Screen shots of 'users' lives' videos

Whilst the technologists found the films of great interest, feedback was that it was difficult to relate the overall technology design requirements to such a diverse group within the NESTORE project team and that a system of more simplified personas was preferred. This led to the iterative development of a series of personas (Figure 10) developed in collaboration with the project partners and informed by the expert by experience group. This prompted critical discussion concerned with the target user for NESTORE and establishing 'inclusion' criteria based on socio-economic profile and health condition. It was generally felt that NESTORE should be inclusive as possible and provide facility for potential users at the lower end of the socio-economic scale. However, recognising the resource and timeframe of the project it was determined NESTORE might have to be developed in a staged approach providing varying formats and functionality to be able to target diverse social groups.

In addition it was felt NESTORE would not target users with chronic health conditions, where users should seek expert medical help, although it could provide additional healthy lifestyle support. However, NESTORE will include those with physiological decline as they age that lead to minor chronic conditions.

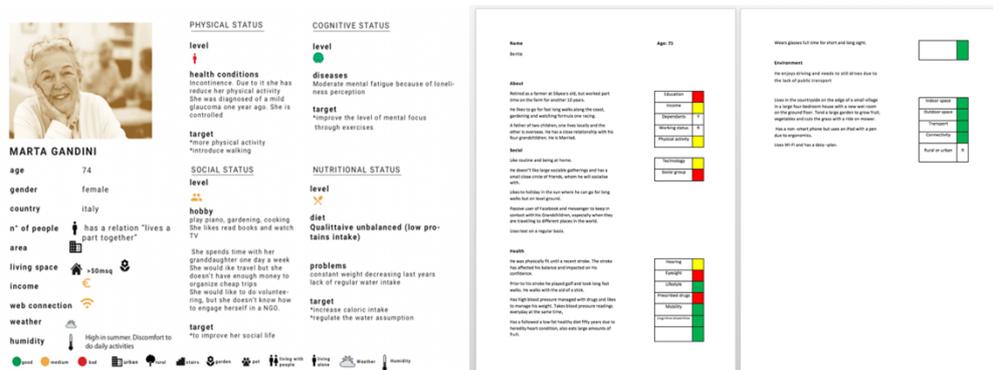


Fig. 10 Examples of personas (potential NESTORE users)

NESTORE is to support improved health and is conceptualised as a coach rather than a doctor. Whereas a doctor might instruct you to take action, a coach should be supportive to help progress the things deemed important from the user’s perspective. Consequently, if NESTORE is conceptualised as a coach it also might need a persona that would be considered in the design of the tangible coach

### 5.3 Pathways

User perspectives that have emerged through the workshops to date indicate the NESTORE system could potentially be complex both in the diverse content it needs to offer and the different ways people might wish to access this content. For the NESTORE team to collectively and conceptually understand how the system might operate to facilitate the diverse needs of users, it was decided to apply an analogue approach through the use of physical pathway cards to enable the expert by experience to map their pathways.

A set of pathway cards was co-designed with the older expert group to visually present scenarios of use based on a user’s profile, their needs/requirements and activities. For instance, NESTORE would need to understand who the user is, male or female, and maybe whether the system is being used by an individual or a couple. NESTORE needs to understand the intent of the user as to whether they wish or choose to improve their health and engage in familiar activities, or whether there is recognition that a behaviour change is needed and they will need a motivational and suggestive prompt. The range of activities to support healthy life may be offered and suggested through the NESTORE system but there may be a requirement for users to pro-actively inform the system of activities linked to their interests (a two-way approach). The systems intelligence may learn user preferences in time. The pathways need to be clear to users for them to understand options and how they will easily navigate their way to achieving their goal.

Based on the example scenarios the expert by experience group were tasked with creating pathways based on their own profile, motivation, activities and interests (Figure 11). The pathway cards helped the group systematically think through and visually map options and decision points. The expert by experience group worked in pairs in the spirit of co-design.



Fig. 11 Expert by experience group creating pathways through real life scenarios

The pathway cards (Figure 12) provided an important co-design tool and tangible interface to ensure NESTORE partners from different Work packages adopted a collective and coherent understanding of the complex variables presented by the NESTORE system.

Man	Woman	Single	In couple	Working	Not working	Part Time	I	Need	Want	Desire	Would like to	Don't want
To avoid	Help with	To maintain	To get	Being more active	My memory	My Stamina	Being more social	Losing weight	Putting on weight	Getting knee strength back		
I can	I am happy to	Swim	Run	Ride a bike	Go for a walk	Do some gardening	Go to the gym	Go Dancing	Go fishing	Play Golf	Go see a play	Go for a walk in the country
Physical activity	Nutrition activity	Cognitive activity	Social activity	Pub quiz	Play Cards	Cook a meal for a friend	Join a new class	We				
Pulse oximeter	Heart rate monitor	Blood pressure monitor	Body temperature	Food Cam								
Weight scales	Nutrition activity	Cognitive activity	Social activity	To find	To finance	Good habits		I can't	I would try	I am compelled to		



Fig. 12 NESTORE system Pathway cards

### 5.4 Co-designing the tangible coach

The NESTORE user requirements established in phase one and two of this co-design research programme were developed and translated through further co-design activity between the design research team, the older expert group and the technologists. A series of user scenarios developed by the older experts translated the user requirements into tangible systems and product concepts drawing on the data gathered from the digital probe activity set against the NESTORE user personas.



**Fig. 13** Co-design of NESTORE tangible coach

An iterative process of product design development incorporating interactive features were presented to the expert older group for feedback during as the development phase progressed. The design research team were equipped with the design and technical skills to realise tangible interpretation emerging for the co-design sessions (Figure 13). While the design research team focused on realising the user experience aspects of the design the technologists focused on the coding, visual recognition and voice activation features. What was critical was a common understanding between the design researchers and the technologists of the underpinning technological platforms that NESTORE would be based.



**Fig. 14** Prototyping of tangible coach

The tangible coach (Figure 14) would be one of the central physical interfaces of the NESTORE system that is currently being tested as part of the pilot studies in the final phase four and delivery phase of the research programme.

## 6. DISCUSSION AND CONCLUSION

This research study aimed to inform the design and development of NESTORE a digital platform and tangible interface which seeks to promote wellbeing through enabling the person to identify and reflect on current lifestyle choices and to access opportunities to engage in meaningful health promoting activities. In response to an ageing population and growing pressures on health services digital technologies are seen as a solution to these challenges. However, there is to date limited uptake of health technologies with literature suggesting lack of user engagement being a significant reason for this. Whilst the literature is clear in terms of the importance of involving end users from the beginning of the design process in collective imagining, few case studies exist of ways to accomplish this. Traditional qualitative research methods using structured and semi-structured interviews can preference the views of the researcher who can make assumptions about what the issues are. This can

be particularly challenging when seeking to imagine facets of products that have yet to be created. Within this study, exhibition in a box provided a tangible tool to offer participants a space to reflect, discuss, explore and begin to envision the qualities and characteristics NESTORE might need to possess. Finding ways to involve people authentically within research is important and exhibition in a box offers a useful method for engagement where researcher and participant enter a space on equal terms and individuals are literally able to think and talk through things.

To ensure commitment and buy-in from participants in co-design activities, it is important creative approaches are adopted to ensure it a positive experience for them. An important aspect of this research was the creative development of tools to support the co-design activity. Exhibition in a box, the pathway cards and the digital probe pack were central to the methodology and present transferable tools that could be applied in other co-design research contexts. Participants in this research programme shared rich descriptions of their experiences of and relationship with technology, and older people expressed appreciation of the tangibility of the objects and their sensory qualities, acting as a physical prompt. They also expressed enjoyment of the experience and reflected on their learning and the new insights they had gained through the process. This positive experience led to an expressed interest in participating in other elements of the study.

Co-design design activity can be applied to the Design Council's double diamond model at any stage of the discover, define, develop and deliver phases of the process. This research programme significantly embedded co-design that included participation from end users throughout all phases of the process. When involving multiple partners and diverse communities in research projects there are many stages of the process where knowledge and information can be lost in translation. Critical in this international research programme was the articulation and sharing of the research findings from the UK across multiple EU country partners and then interpreting their contributions. Translating the user requirements to the technologists was another critical point where contrasting disciplinary cultures could present opportunity for misunderstanding and misinterpretation. In this research study, the design research team, the older expert group and technologists provided a consistent team throughout the process while engaging older people across diverse international communities to minimise barriers to exchanging knowledge and ideas.

Designers bring a broad set of skill sets to co-design activity. Critical in this programme of research was the creative and technical understanding of the design research team who were able to facilitate the creative abstract conversations in the exploratory phase, tangibly interpret and realise conceptual ideas through the development phase and, importantly, present technically viable prototypes to the technologists. The co-design research led by the authors delivered through the NESTORE project presents co-design tools and a methodology that has been important in engaging end users that might increase the uptake and adoption of the system. The tools and methodology also provide a transferable model that can be applied in other research context to ensure end users have a voice and more likely to help shape the future health services and products that are fit for purpose.

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