Process of design and usability evaluation of a telepsychology web and virtual reality system for the elderly: Butler

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Abstract

Butler is a multi-application system based on Internet technology and virtual reality, designed to meet the needs of elderly users. Its objectives are to assist elderly populations in accessing technology and new forms of communication, replicating, as far as possible the way of linear interaction that this population group had traditionally to interact with information in order to facilitate the first contacts with technology. Butler is equipped with e-mail, videoconferencing, blogging, access to the Internet through a well-known web search engine, image and sound gallery, new contacts searcher, and two virtual reality environments. In this paper we describe Butler’s most relevant features taking into account the usability design process and the usability evaluation of the system, which, after pilot testing, have proven to be highly acceptable and satisfactory to users. We also present the results of evaluations pertaining to the iconography used in the program, the navigation and users’ help design process, and the first functional prototype, all of which were designed and redesigned with the aid of web heuristics and guidelines for the web design for elderly users. Results suggest important features to be taken into account when designing and developing this sort of application for the elderly.

Keywords: Usability; Virtual reality; Social network; Elderly; Digital divide; Social networking service

1. Introduction

The Internet provides numerous services in society, which have, in just 20 years, changed the way we work and the way we understand leisure time. At the same time we have witnessed an extraordinary exponential growth in use, since, according to Internet World Stats (2011), in December 2000 there were 360 million Internet users all around the world, and in August 2010, there were 1966 million.

With such a fast evolution, the technological gap between two generations has become more pronounced, divided between the digital natives, that is, the population group that was born already in the age of the Internet, computers and videogames and that masters “digital language” and the digital immigrants, that is, the population group that was born before the age of the technology revolution and that had to learn to interact with technology at a older age (Prensky, 2001). This differentiation lead us to think over the way to tackle all these changes and what happens with those who have not even managed yet to become immigrants, and are simply non-users being “unplugged”, that is to say, isolated from the digital information flow. We are speaking of a new social barrier, the so called digital divide.
Wresh (1996) was one of the first authors to approach this subject, raising the need to include all population groups in the access to the information through the Information and Communication Technologies (ICTs).

The aim of the present work is to shorten the distance between technology and the non-users, or between technology and those who, despite being digital immigrants, have experienced difficulties in the use of ICTs.

It is important to notice that the digital divide shows also a generation gap between older users and younger users, where older users had a significant lower level of access, knowledge and use of the Internet (Karahasanovic et al., 2009).

Brandtzæg et al. (2011) in an empirical investigation of 12,666 people in Europe between the ages of 16 and 74 years, found that the Internet usage in Norway, Spain, Sweden, Austria and the UK is characterized by the following five user types: (1) Non-Users (42% of the sample), (2) Sporadic Users (18% of the sample), (3) Instrumental Users (18% of the sample), (4) Entertainment Users (10% of the sample) and (5) Advanced Users (12% of the sample).

However, the “digital demography” of the Internet does not match the population pyramid, since, at the industrialized world the population grows older, the presence of elderly users on the net remains small.

According to several reports (United Nations, 2009; Eurostat 129/2006) in 2009, one out of nine people was older than 60 (737 million), and it is estimated that in 2050, this will reach 2 billion (one out of five people). In contrast, however, 50% of social network users in Europe are between 15 and 24 years old, whereas the users older than 54 account for just 13% of the population (Flash Eurobarometer 241, 2008).

It is estimated that only 4% of elderly use computers and the Internet in Europe (European Comission, 2010). However, technology is increasingly present in everyday life, and the elderly usually face usability problems related to the unsuitable design of central features, such as the graphic user interface design, input devices choice, etc. (Czaja, 2005).

In general, ICT applications have adopted standards which are appropriate primarily for young and middle-aged people, that is, the native and digital immigrants. But, what happens to those who are unplugged? The effort they have to make in order to incorporate these new media in their lives is so high that many just choose not to try. And this is one of the new realities the ICTs give rise to: the unplugged become isolated.

Several studies show that, under controlled-use conditions, elderly users have a greater number of usability problems than young people, and that improving the usability of a program improves all users’ efficiency, whether young or old (Chadwick-Dias et al., 2002). According to Chadwick-Dias et al. (2004), there is a clear correlation between one’s experience with computers and one’s success rate. Elderly users find it more difficult to manage ICTs, and, when they do, their success rate is lower due to their lack of experience. For example, the use of a widely-used gadget such as a mouse can be quite difficult for these users (Dickinson et al., 2005; Hawthorn, 2005). The same applies to websites, which elderly people, in contrast to other categories of users, have a harder time using them (Chadwick-Dias et al., 2002, 2004; Nielsen, 2002; Fidgeon, 2006; Bernard et al., 2001).

The given cause for these difficulties varies depending on the author; Nielsen (2002) remarks that these difficulties are due to bad design and to users’ remote conceptual model, as well as due to the particular ways in which these technologies work. Similarly Dong et al. (2002) suggest that interface usability problems might be a result of a combination of issues: small font size (sensory problem), confusing menus (cognitive problem), small keys with small gaps between them (sensory and motor problem), etc. On the other hand, Dickinson et al. (2005) posit that it is the lack of training that poses a problem, suggesting training courses and strategies for making effective use of friends’ and family’s computer expertise. All authors agree with the need to take special actions for this group of population by either improving accessibility, design, or training, or through social support to integrate these users.

At the European Union, a high percentage of citizens (near 40%) believe that people who do not use Internet are avoiding frustrations inevitably raised when facing complex technologies (Flash Eurobarometer 241, 2008). However, it is obvious how beneficial it would be if the elderly could positively engage technology.

According to the “eInclusion revisited: The local Dimension of the Information society” report, “the ICTs have the ability to build social capital and make intervention politics more effective, however, the groups that suffer wider social exclusion usually tend to have a limited access to the ICTs’” (Eurobarometer, 2005).

From a social point of view, it is obvious why technology use is increasing in importance. The expectations Europeans will have regarding social conditions in 20 years time reflect the importance the technological progress plays in achieving a good quality of life (Flash Eurobarometer 241, 2008).

The problem becomes further accentuated because within the same service (e-mail, for instance), every page has its own rules. Requiring all websites to apply universal guidelines in order to improve their design is, apart from being unfeasible, not enough, as the problem goes beyond simple accessibility, too-small font size, the design of big icons, or the use of test links. In order to truly make the websites user-friendly, as Nielsen (2002) points out, it is necessary to develop systems that adapt to the mental model of users who lack any kind of experience with computers, or whose experience was largely negative; these are systems revised to consider usability as a goal in itself.

The benefits on the other side of the breach are countless, but in order to be able to enjoy them it is necessary for the unplugged users to be able to use ICTs in...
an autonomous and satisfactory way. For users to be able to focus on their intended task, the technology must be so intuitive that it becomes invisible.

Fortunately, recent approaches to adapt new technologies to the needs of the elderly, and to contribute to the improvement of their wellbeing are increasingly remarkable. One example is the work carried out by the project ACTION, a video conference system which connected the elderly’s homes to those of their families and caregivers through a call center. The objective of this project was to contribute to end the social isolation of the elderly people; 88% of users stated that the use of the program decreased significantly their feeling of isolation and loneliness (Savolainen et al., 2008). Another example is the project CIRCA (Computer Interactive Reminiscence Conversation Aid), which allows the elderly to review the multimedia material, and aims to find ways of promoting communication between elderly with dementia using multimedia material (images, videos and music) by means of a touch screen. The system was positively evaluated by both, people with dementia and carers. The system helped to maintain a conversation to people who usually find impossible to carry out a conversation (Gowans et al., 2004; Alm et al., 2005). We should stress the fact that those systems were designed to be used together with a support figure (a relative, caregiver, etc).

Another system is PACOSY (The Patient Communication System), which aimed to develop “better ways” to give information to patients and their families about their medical condition. The study was conducted with patients with “low or no computer literacy” using several types of touch systems. Most patients reported that “they liked this kind of computer” and, in general found the touch interface easy to use (Holzinger, 2003).

There are also studies as the one conducted by Sayago and Blat (2010), who carried out an ethnographic study of how the elderly actually used e-mail over the course of three years. According to this study, Senior Mail, Simple Mail, and Cybrarian are the three most relevant e-mail systems addressed to the elderly, being all of them desk applications (for example, Simple Mail is a Microsoft Outlook Express simplified redesign). These authors highlight the cognitive load involved in executing digital tasks (e.g., remembering the number of steps for a task, relating icons with features, keeping attachments, and remembering where to go, etc) as the most significant accessibility barrier for the elderly users. In summary, it is necessary to study alternative ways of interaction in order to simplify the tasks for those elderly users who want to enter the world of ICT.

As Internet is the most popular of the ICTs and the elderly population is the most affected age group by this digital breach, this work has focused on the development of a system mainly based on web technology that includes the most popular services on the Internet. It is integrated into a single platform, and adapts its characteristics to the needs of this population. The result is a system whose main objective is to allow the unplugged and low-tech skills users to use, in an autonomous way, with no training and no support figure, such common services such as using e-mail, videoconferencing, blogging, visualizing digital images, listening to audio files, widening their social network by meeting new users with similar interests, and surfing on the Internet. The system has been given the name “Butler”, reflecting the idea that the new technology is at the user’s service, helping and supporting them throughout the process. The options that Butler offers can be done also in a traditional way (writing a letter, making a phone call, going through a paper photo album, looking for information at the library, etc). In fact, we believe that maintaining these traditional ways of communication and management of information is completely compatible with the use of ICTs. The problem occurs when the technology is so complex that it stops from being a feasible option for this type of users. Therefore, the idea is not to replace or force to change the way that elderly behave but to offer them one more possibility and have the freedom to choose.

Another objective of the system is to provide support and help from a psychological point of view; in order to do that, the system has an automated diagnosis system that personalizes the menu according to the user’s mood state, offering the more positive options. It also has a Virtual Reality system (VR) provided with mood induction procedures, where the users can carry out psychological tasks for positive mood training. The psychological aims of Butler are not the objective of this paper. They are widely described in a former work (Botella et al., 2011).

The objective of this work is to describe both the design process and the usability evaluation of the Butler system.

2. Design and evaluation of the butler system

2.1. Initial specifications of the butler system

Butler was conceived as an application based on web technology and Virtual Reality (VR), whose main objectives are the improvement of users’ emotional state, the empowerment of the social support network through the use of new technologies, and the provision of activities that help to improve the emotional state and quality of life of the elderly population (Botella et al., 2011).

The team was made up by a research group with expertise in Clinical Psychology, a Usability expert and a team of engineers and graphic designers in the development of Web applications and Virtual Reality (VR). In this way, all the relevant areas for the application (clinical content, system usability and technical development) were approached by experts in each of the subjects.

The group of psychologists developed the content for the psychological functions, selecting the evaluation tools, the contents of the psychological exercises of the VR area, the reinforcement texts, etc, and also making recommendations for the graphic design (colors, texture, look, and
voice of the avatar) in order to build a pleasant emotional induction environment.

The usability expert adapted the psychological specifications proposed for the design and navigation while working closely with the engineers and modelers team.

The team of psychologists defined the required elements of the system. The specifications document provided by this team contained the following elements.

An avatar, represented by an elderly butler, introduces the system through audio and text instructions. The objective of the use of the avatar is to catch the attention of the user in order to facilitate them follow the instructions given by the avatar (Hongpaisanwiwat and Lewis, 2003; Ortiz et al. (2007) emphasized that the use of an avatar can facilitate the understanding of instructions for the elderly. This avatar will follow the user alongside their tasks, providing them with the necessary instructions at every step, and occasionally offering some friendly, positive reinforcement. For example, "you are doing really great" or "I see you can already type letters on the Internet, let's go on a bit further". The avatar gives the help instructions by means of audio and text. Every application works independently from the rest, clearing the screen from any distracting element, including the wallpaper, and offering a minimal number of decisions with information elements (buttons, text, etc) in a larger than usual size.

The Butler system contains the following applications:

**SOCIAL TOOLS**: Videoconferencing, e-mail and The Book of Life and Friends.

- Videoconferencing: by entering the videoconferencing area, the user can see the pictures from the friends that are connected. Those who are available are placed in the upper part of the agenda and have a green frame around their picture. Those who are busy appear with a red frame, and those who are disconnected, appear with a gray frame. When the user touches the picture of one of the available friends, the call is made simulating the sound of a phone (calling or busy). The videoconference does not start until the user accepts it.

- E-mail with the possibility of attaching images. The users make an action in each screen. First, they choose the address, then they write the text of the message, then they choose and image (if they want), then they preview the email, and finally they push “send”.

- The Book of Life: a blog-type application that works as an online diary where the users can share their memories with the users they choose, through text, photographs, and music. They can also choose which pages remain private, that is, accessible only to the author, and which ones are to be shared with the rest of the users. The aim of this tool is to improve communication and increase the number of relationships, promoting the sharing of their life memories with other users.

- Friends: a section where they can widen their contacts by searching for people by affinity (city of residence, place they were born, hobbies and interests, etc). The system offers suggestions of possible contacts with similar database profiles.

**PLAYFUL TOOLS**: My memories and Internet.

- My memories: an online music and images library where the user can save his/her pictures and audio files or the elements received by e-mail in order to enjoy them privately or share them through the E-mail or the Book of Life.

- Internet: As the main objective is to integrate the users in the use of the Internet, one of the applications provides access to a well-known and free search engine (Google). In this option the user essentially exits Butler, as the program has no control over the design of the external webpages. In the future, a higher frame will need to be implemented where the avatar and a home page return button stay to allow the user to easily exit the webpage and return to the home program by simply clicking on a button.

**PSYCHOLOGICAL TOOLS**: Happy Nature and Relaxing Nature.

- Walking through Nature: there are two virtual environments based in a natural scenario, Happy Nature and Relaxing Nature. The environments were designed to promote positive emotions. Studies conducted with elderly users obtained preliminary promising results (Botella et al., 2009; Etchemendy et al., 2010).

Each environment starts with a welcome narrative, inviting the users to walk through the environment and enjoy the elements that it offers. Both environments have the following elements:

- A walk along a path which allows users to stop and observe nature.
- Crossroads that allow the users choose the place he/she wants to go (tree, bridge or lake).
- A big and leafy tree where users can do slow breathing practice (Relaxing Nature) or memory training, listening to instructions inviting them to remember positive events (Happy Nature).
- A bridge over a stream where meditation is performed, consisting on instructions inviting to mindfully focus attention in all the elements of the environment (light, colors, the grass, the water, the music, etc).
- A lake where users may observe the rising sun at dawn. The lake is a place where the users can rest; because of that there are no instructions or tasks to perform.

2.2. Hardware

At a hardware level, Butler was designed to be used in any type of computer. Nevertheless, given the scarce knowledge of the new technologies the potential users have, we recommend for those who never had used a computer before the
use of the following configuration: Touch screen (Holzinger, 2003), a PC, 1 Webcam and network connection. Besides, for those who had never used a typewriter, we recommend to try “BigKeys” keyboard, with ABC key order (not QWERTY) with $1 \times 1 \text{cm}^2$ each key.

2.3. Sample

The sample in this studio is made up of 10 participants, 8 male and 2 female, whose age range spans from 60 to 72 years old. All of them could be considered non-users given that none of them had used a computer before and they did not have a cell phone or other devices. Their relationship with ICT was limited to the use of basic appliances (TV, DVD or stereo). They all live at a retirement home in Valencia, Spain. The users were chosen by the psychologist at the center.

2.4. Inclusion criteria

The following inclusion criteria were used:

– People over 60;
– with no cognitive deterioration;
– with a proper audition level to be able to carry out an interview;
– with a proper vision level to be able to see the Graphics material shown at the sessions; and
– who were computer illiterate.

2.5. Stages of the study

This study is divided into four clearly defined stages. Each stage was executed consecutively and their results were implemented at a real time programming level, so that the evaluated system at each stage reflected the recommended changes in the previous ones.

– Stage I: Iconography

As a first step in designing the system graphics, iconography was analyzed through the group inquiry method (Nielsen, 1993) of interviewing real users to obtain feedback on the icons’ esthetics and comprehensibility. Specifically, interviews assessed how much users liked the initial design and whether they understood what each button was for. In order to do so, a qualitative analysis of the performance of the proposed tasks was carried out.

Stage II: Navigation

The first prototype design crafted by the team of engineers (low fidelity mockups) was very difficult to navigate, given that users were forced to take multiple decisions in each screen. Because of that, we decided to conduct the navigation analysis by means of a “cognitive walk through” research method, widely used in early development stages (Polson et al., 1992; Mahatody et al., 2010; Ligons et al., 2011). In this method, the usability expert adopts the role of the user and builds the task scenarios while moving through the software from this perspective.

Stage III: Help

The analysis of the needed help and its elaboration is based on the specific and possible action list, elaborated through the cognitive path carried out during the navigation analysis.

Stage IV: Evaluation through heuristics

In this last stage of the present study the method applied was the heuristic evaluation research method (Nielsen, 1990, 1994b; Nielsen and Mack, 1994), where the usability expert assessed the software using recognized usability principles.

2.6. Procedure

First a text report outlining the system’s desired functions was created (described at Section 2.1 Description of the Butler System), and four evaluation stages were planned.

2.6.1. Stage I: Iconography evaluation

There were two meetings with the sample of ten users at a retirement home selected by the center’s psychologist, with the objective of testing:

(a) The metaphors used in the iconography.
(b) Iconography’s cause-effect relation.

In the first meeting with the users, after defining which of the initial specifications were best suitable in order to keep the psychosocial objectives of the program, high fidelity mock-ups were designed.

A meeting at the center was arranged with ten users and the center’s psychologist. They were informed that they would be watching some images of a computer system oriented towards older users. Their task consisted of answering the following questions: (1) What is each icon’s use? and (2) What will happen when each is selected? Next, they were shown the initial iconography of the Butler System as replicated in Fig. 1.

From left to right the icons are displayed “Walking through Nature”, “Mail”, “Videoconference”, “Book of Life”, “Internet”, and “Photo Album”.

The first evaluation of these non-functional prototypes exposed some needs that had not been taken into account in the initial specifications. Given the scarce computer experience that the potential final users have, the iconography should reference easily recognizable actions, that is, metaphors whose content is relevant to and quickly understood by elderly users. The metaphors for “Videoconference” (webcam), “Internet” (globe) and “Photo Album” (see Fig. 1) were not understood.

Another element that was not fully appreciated was the need to clearly represent an icon’s function as a “click on”
button, in order to understand what elements on the screen are actionable. Therefore it became necessary to put every icon with a text label that clearly defined its function.

The evaluation of the iconography was the first to reveal nascent usability problems. Results showed that the icons chosen to represent the system’s features were inappropriate. Given the scarce experience of the sample with ICTs, 100% of the users were unable to identify the graphic correspondence of the videoconference, image and sound gallery, and Internet (see Fig. 1). Icons’ metaphors did not depict items close to their experience (analogical) so the icons were not recognized. This problem was increased by the absence of text labels next to each button, which would have explicitly identified each function. Additionally, users in this category are unfamiliar with the most basic forms of interaction with computer technology, and so the initial iconography (see Fig. 1) was not understood to be buttons which could be clicked to progress through the program.

On the basis of these premises, an iconography redesign was carried out, with more than one proposal for some of the different icons, assigning each a text label expressing its function and framing it to make clearer its identification as a button (see Fig. 2—Iconography 2 Butler).

This second version of the iconography was tested again by the same users, and with the same tasks. The graphic interface was remarkably modified following the first evaluation. A clear example is the change at the initial menu, as seen in Fig. 3. There, the first prototype of the initial menu (on the left side of the figure) showed the iconography around the avatar (initially of a bigger size) without text labels identifying each function. Also, icons were not embedded within an area framed by a button, and some of the metaphors were based on digital referents (e.g., Videoconference was represented by a webcam, Internet by a globe, and My Memories by a web album).

As it can be seen in the comparison of the images showed at Fig. 3, iconography increased in size, reducing the presence of the Butler avatar. Each icon was redesigned, adding a circular frame to represent the figure of a button (therefore encouraging the pressing action). A text label was also added to explain this pressing action, and the metaphors for the Videoconference and My Memories functions were changed to more meaningful analogical referents (e.g., Webcam was replaced by a telephone and My Memories by a picture frame next to a gramophone).

We decided not to create a symbol for the Internet icon, as there was no recognizable representation available that was based on users’ experience. This icon was instead represented by the shape of a button with a corresponding text label.

### 2.6.2. Navigation design

2.6.2.1. Web navigation. As it has been remarked, Butler was organized with several web technology-based tools and one virtual reality tool, all designed for users who are...
mainly unskilled in computer technology. As the final users are not familiar with the hypertext base of the Internet navigation, some authors point out that it is probable they may feel frustrated and may fear getting lost in cyberspace, as it is possible that the actual navigational structure frequently causes confusion in the navigation (Rosello, 1997; Fukuda and Bubb, 2003). From all potential navigation styles, linear navigation is most familiar to these users; the information is shown sequentially, as in books, which prevents non-experts from getting lost among multiple options.

The initial graphics interface proposal for the web applications (mockups) did not reach the desired simplicity, as some of its services emulated the traditional services structure used by more advanced users. Fig. 4—Initial design of the graphic e-mail interface, demonstrates how the mail application was initially integrating multiple decisions in the same screen, offering, for example, the options to select mail from the message list, reply, new, or delete mail, and using two scroll bars to display the information of two different frames.

This design presented difficulties, as the users did not understand such basic concepts as the difference between previewing a message and typing a new one. Also, the use of two frames and two scroll bars in the same page confused them. These results informed out new design for the user graphic interface.

In keeping with this, all web applications were redesigned with a hierarchical linear navigation, like a tutorial. With this structure, the number of options the user sees in every screen is simplified so they meet no more than two or three options.

For example, at the start menus, users simply decide which application to use. If they choose mail, next they just have to choose either typing or reading a letter. Once they select Typing Letter, they choose in the first screen to whom they want to send the letter, and, in the second screen, they type it, continue, or quit. In the third screen they choose whether to attach a picture, etc. When finishing a linear sequence (for example, sending a letter), the system then returns to the start menu, resetting the linear navigation.

The different system processes were divided into sequential steps, making it a completely linear navigation. This way, it emulated the structure of a tutorial for every function. The number of screens of the system notably increased. For example, because of the modifications to the e-mail, its number of screens increased from 1 to 10 (see Fig. 5).

With respect to the general structure of the navigation, the technical team continued throughout to map cognitive paths and to detail the interaction elements and their possibilities.

2.6.2.2. Navigation in the VR environments. The Butler virtual environments have a clear psychological objective: positive mood induction. This induction is carried out in various virtual locations: the tree (D), the bridge (B) and the lake (E), as it can be seen in Fig. 6, Butler virtual...
environment sketch. Users begin at point A, where they receive the instructions and are welcomed. When reaching point C (Crossroad), they find a sign where they must choose among venturing to B, D, or E.

The nature of the application involves both traveling around the virtual world as well as orienting oneself towards reaching each of those clearly significant places. Furthermore, from a psychological standpoint, it was advisable to allow users control over the camera view so that they could, for example, turn their heads while walking. The main objective of the environments is for the users to get to the bridge (B), tree (D), and the lake (E), and follow the instructions of the psychological tasks present in those environments. Elderly are not usual consumers of videogames and 3D environments, therefore, those less familiar with ICT can feel disoriented and not able to get to any of those places.

Because of this, the virtual environment was designed with partly-guided and semi-automatic navigation emulating the tutorial-type linearity implemented in the web applications. In other words, the system does not react to the users’ interaction, but to their lack of interaction.

As a result of this design, the system moves automatically around the paths. In each place, a psychological technique is practiced and the experts decided the best order to perform the tasks in order to improve psychological wellbeing (in this case, the order was tree, bridge, and lake). Less skillful users will automatically be led to the crossroads, and once there, the system will ask them what they want to do. The users can then

Fig. 5. Pop-up windows Videoconference module.

Fig. 6. Butler virtual environment sketch.
choose where to go, but if they do not reply within 2 min, the system will automatically lead them to the most significant place, that is, the place with the most psychologically relevant task (previously programmed according to experts’ criteria). In this way the system detects the lack of interaction and enters in “autopilot” mode assuring that the less ICT skilled users can be able to practice the psychological content. Whenever this task finishes, the system will ask them again what they want to do. Again, the user can take the control and choose what to do; but if the user does not reply, the system will choose the next most relevant place. This semi-automatic mode continues until all three virtual environments have been visited. Once all psychological tasks have been carried out, if there is no response the system tells the user their walk is over and returns them to the web menu. However, more advanced users can choose to stop, to change to camera view whenever they wish, and to choose the destination they prefer once they are placed at the crossroads or at the significant places.

In this way, less skilled users move around the Butler virtual environments assisted by the “automatic pilot”, which guides them through the environment and psychological tasks, whereas more skilled users can gain control simply by touching the screen.

2.6.3. Stage III: Design of the help

The elderly lack of knowledge regarding new technologies extends to a lack of understanding basic technological terms such as e-mail, Internet, videoconference, or webpage, a situation affirmed through the initial interviews done during Stage I of the present work. The initial design also provided audible help given by the Butler avatar (See Fig. 4). Although this was actually useful, it was not fully effective, as the users had to make a great effort to understand and remember the instructions at the same time they were given. This feedback led us to redesign the help and to support the basic instructions with visual text. Given that users' experience levels are heterogeneous, the help section was designed to accommodate two levels: Elementary and Advanced Levels. The avatar always presents a text with advanced help with a minimum of instructions accompanied by an audio with more elaborated instructions and positive reinforcement. In this way the Basic instructions to perform the task are always present in the written help. Initially all users receive elementary help, that is, they do not only receive instructions oriented to the task but also explanations that ease the understanding of the task they are carrying out. For example, the first time they enter the e-mail application, Butler sends them a letter:

Hello,

This is your first letter on the Internet. Did you see how easy it is? I would like to tell you a secret. At the Butler world you do not need stamps to send a letter. You just have to know the address where you want to send it to. Ask your acquaintances about their e-mail addresses. Did you know that if you send today a letter to someone, they can read it right away? Even if they live in another city or country!!!

If you want someone to write to you, you can give them your e-mail address. It is your “user name”, at butler dot com (@butler.com) (written as it sounds to facilitate the verbal communication among users)

Remember you can enter and check your mail box whenever you wish to.

Best regards,

Butler

As the user progresses through the system, the help recedes to some instructions oriented to the running task (for example, “click on the green button to continue typing the letter”) and positive reinforcement (for example, “You are doing great! I see you have already mastered the Book of Life. Keep going, there is very little left to finish.”).

Within every application the spoken text provided by the avatar was supplemented with instructions in written text with the idea of optimizing recognition rather than memory. To accomplish this, the user’s graphic interface was modified in all web screens to include a large-font (24 px) text bubble at the top of each screen wherein help instructions would appear as needed, as seen in Fig. 7—Modifications graphic interface due to users’ help.

2.6.4. Stage IV: Evaluation through heuristics

The results of previous stages allowed for the development of the Butler alpha prototype. Once it was completed, the last evaluation stage was carried out through two well-known recommendation lists for the web design. The use of heuristic evaluations allowed for the detection of a great number of design flaws at an early stage of the development (Nielsen, 1992). The main objective of the heuristic evaluations of websites dedicated to the elderly (Becker, 2004; Hart, 2004) was to uncover whether the design recommendations for this type of population were able to be put into useful practice. Starting from the recommendation list for the design of webpages for the elderly, we adopted a methodology that allowed us to assess to what extent these recommendations accomplished their goals. There are several review methodologies with heuristics for the web addressed to this type of population were able to be put into useful practice. Starting from the recommendation list for the design of webpages for the elderly, we adopted a methodology that allowed us to assess to what extent these recommendations accomplished their goals. There are several review methodologies with heuristics for the web addressed to this type of population, some made in a more detailed way than others (Kurniawan and Zaphiris, 2005). Other studies (Becker, 2004; Hart, 2004) support the use of a more concise model, such as the one presented by the National Institute for Aging NIA (2002).

When designing Butler the twenty-five principles suggested by the NIA (2002) were taken into account together with the ten heuristics suggested by Nielsen (1994a, 2005).

Out of the 25 National Institute for Aging (NIA) principles for making websites more senior-friendly (2002), the Butler alpha prototype successfully accomplished 80% (20 principles).

Those not accomplished at the evaluation stage were the following:

- Double spacing
- Consistent design throughout the site. At the checking stage, the Videoconference module was not consistent
with the rest of the website. This was due to some programming difficulties as the module depended on an external program (Netmeeting) that included some pop-up windows (see Fig. 5).

- Site map.
- Glossary of technical vocabulary.
- Contact information.

Keeping with the NIA’s recommendations (2002), the text size was enlarged, as was the interlineal gap, both when reading and typing mail (46 px). Additionally, both the Book of Life (46 px), and the “Making Friends” tool were modified to optimize their tolerance of mistyping. However, the applications were not consistently double spaced, as it increased the need for a scroll bar, hid relevant elements of the graphic interface, and saturated the design, thus sacrificing the desired minimalism.

The second heuristics list used was the one by Nielsen (2005). The 10 heuristics were reviewed and further broken up into 69 sub-heuristics.

At this stage of the evaluation the system did not fulfill five of the sub-heuristics (7.25%), four of them being critical. It was also recommended that eight further sub-heuristics be revised as they related to the visibility of system status, the use of recognition rather than recall, help users recognize, diagnose, and recover from errors thanks to a proper design.

In the e-mail application, the differentiation between read and unread mail was improved, placing the text in boldface and improving the “unread mail” icon by making it bigger and changing its color to green, a color associated throughout the system with positive action. In every application the action buttons were enlarged and the actionable area was expanded beyond the button to include each corresponding text label. The redesign incorporated various critiques and suggestions made at the initial evaluation using heuristic models (Nielsen, 2005). As a result, the main menu was reorganized to double as a site map.

On the other side, the Videoconference application was redesigned as an integrated web application, eliminating the need for an external program, so as to optimize the consistency of the design by eliminating pop-up windows. All technical terminology was replaced with terms suitable to the users’ experience and was integrated into the contextual help on every page.

In the virtual surroundings, the text-background contrast was optimized at the crossroads options and at the different orientation signs.

3. Lessons learned

The design and evaluation process of this system has taught us some lessons.

From a general point of view it is obvious that the central goal of usability is to adapt technology to the users’ needs. However, when dealing with elderly users, design guidelines and recommendations, although very useful, are still not enough. Simplifying the graphic interface of the user, enlarging the size of the icons and the typography, just to give some examples, are basic features of design. However, this is not enough to make a system understandable to someone who has never used a computer and does not understand what the metaphors representing e-mail or videoconference are, or, for that matter, what the applications themselves do. For these users, issues of usability go beyond making a system easy to use. They must learn how to use the system while simultaneously learning what the system can do.

Therefore it can be stated that the early evaluation of the prototype, including its initial iconography and graphic interface, was crucial, as the information it provided reoriented the entire philosophy of the application. Our attention was drawn to the need to simplifying the
of users' abilities. Clearly, designing applications for this screen. The application could thus be modified to meet a range of users, advanced users could disable the "virtual automatic pilot", giving the user more control over the application just by touching the screen. The design of the interaction in virtual surroundings completely changed after the first interview with the users. The objective of these Virtual Reality environments is for the users to reach particular places where they would then engage in training exercises designed to induce positive emotions. Therefore, the design of the interaction should guarantee that every user, irrespective of their technological skills, should reach relevant areas in the environments, that is, those areas where some tasks with psychological content are carried out. From that point, in order to prevent confusion among users it was decided that some of the environments would be partly-guided, where the user would travel the system through predefined routes (paths in the nature). At the same time, the application would also work in a partly-automatic way, moving the user by default through the predefined paths and, if the user does not respond, acting as a "virtual automatic pilot" by choosing a destination for them. However, more advanced users could disable the "virtual automatic pilot", regaining control over the application just by touching the screen. The application could thus be modified to meet a range of users' abilities. Clearly, designing applications for this category of users involves testing and carrying out a critical evaluation of all established standards, iconography, text labels, navigation, help, and even the use of peripherals (such as the mouse or a qwerty keyboard).

It is usually the usability expert's task to maintain contact with the users while informing the developing team of the features to be taken into account. However, in this process, and specifically at the beginning of the development, it was highly beneficial to also connect users and psychologists, modelers and developers. This strategy greatly improved the latter's sensitivity to the needs of the user population. It facilitated communication among the team members, provoking synergies that have allowed the development of ideas from a truly multidisciplinary point of view.

Obviously, one of the main lessons learned, perhaps redundant but still important, was the need for design and usability evaluation processes in every feature involving this category of users with new technologies.

4. Conclusion

This article describes the process of design and evaluation of a system oriented to elderly users from the initial conception to its first developed version. On the one hand, the process has showed that the mental model of this category of users is very different to the mental model of the user population. The usability expert's task is to maintain contact with the users while informing the developing team of the features to be taken into account. However, in this process, and specifically at the beginning of the development, it was highly beneficial to also connect users and psychologists, modelers and developers. This strategy greatly improved the latter's sensitivity to the needs of the user population. It facilitated communication among the team members, provoking synergies that have allowed the development of ideas from a truly multidisciplinary point of view.

On the one hand, the process has showed that the mental model of this category of users is very different to the way ICTs generally operate, a conclusion supported by Nielsen (2002) as well. Sayago and Blat (2010) propose that the biggest barrier is actually in the large mental load these tasks generate (remembering what to do at every stage, identifying the icons, understanding terminology, etc). These results coincide with those collected in our study, so the conclusion reached is that there is a need to simplify the number of options in every screen, adding visual and audible aids, bringing the terminology closer to the users' experience, etc.

A great number of systems oriented to the elderly simplify their use by creating a mono-application system, that is, its scope of use is limited to just one application (Savolainen et al., 2008; Gowans et al., 2004; Alm et al., 2005), by developing desk applications that reduce the possibilities in order to avoid such a substantial mental load (Simple Mail, Senior Mail and Cybrarian).

Our results indicate that the mental model of the elderly users can be successfully represented in web and virtual reality applications, but it requires additional effort in designing and evaluating these applications.

Each of these stages in the design and implementation of techniques have contributed with relevant data that have helped us to better understand the needs of this category of users, and reorient the design towards meeting these needs. At every stage we have been able to deepen the level of detail, to create new features, and to observe the limitations of every stage of the design and its current form; it is not yet possible to know whether the use of different techniques and processes would have led to a different result.

One of the clearer conclusions of this piece of work is that recommendations for usability techniques do not on their own contribute with enough information to develop a system such as ours. Recommendation guidelines, although greatly useful, represent a starting point for the design and development of this type of application, and should be properly interpreted so as to not accidentally create further usability problems. For example, overuse of double spacing may saturate the graphic interface or may force the use of the scroll bar, so that the benefit of easier-read text is nullified by the challenge of using a difficult navigation tool. The early evaluations provided by users have also proved highly beneficial but also inadequate by themselves when foretelling the users' behavior. Seniors have based their entire learning experience on linear systems of information bearing analogical support (mainly books) where the users' involvement does not alter its content. However, the hypertextual model of the Internet requires the user to make multiple choices while seeking information, choices which will subsequently vary its content. This way, the medium (the Internet) becomes the source of the problem for older users, as the gap between information-gathering between traditional text and the Internet is too big. It is necessary to provide them...
with a starting point that is coherent with their previous experience (linear), which will direct them to the most usual services, optimizing their learning time by focusing attention on real objectives in the use of the technology (for example, communicating with their loved ones using the e-mail), instead of wasting hours trying to understand how to do it. In this way, the user can achieve some knowledge that can be applied in other standards whenever this newly learnt process is steady.

We would like to stress that Butler is right now being used with real users and we are beginning to collect some results. For example, the first results obtained in a pilot study revealed a high degree of satisfaction and acceptance of the Butler system by users whose ages ranged from 66 to 74. The results demonstrated that after using the Butler system, users had high levels of satisfaction, low levels of difficulty of use and a significant increase in their mood state and levels of happiness, as well as reduced levels of sadness and anxiety (Botella et al., 2009; Etchemendy et al., 2010).

Another recent Butler study involving real users revealed that the perceived difficulty level during all sessions ranged from “very easy” to “normal”, and 100% of the users would recommend Butler to other people. Users considered that from 87.5 to 100% of the things they learned during the sessions would be useful for other aspects in their life (Etchemendy et al., 2011).

This work has some limitations that we would like to highlight. First, the sample may have a country’s own cultural bias that could have influence the election of analogical metaphors (for example the icon of the phone for videoconferencing). The same cultural bias can come from the development team. It could be interesting to replicate the evaluation of metaphors in other cultures. Second, we would also like to notice that the usability evaluation was performed by the same expert, given that at that moment there was only one person in the staff with that expertise, although we would have had other points of view in order to improve the system.

In future work we will continue polishing the Butler application, as well as testing it under controlled studies within different user environments. We could, for example, offer it for use at retirement communities or at individuals’ homes. This work has also brought us closer to the idea of creating a practical guide of the different features to be considered when developing applications for the elderly population. It could supplement ones already in existence while hopefully helping designers and programmers to avoid the same mistakes we made during the early stages of the development.

A video demonstration of the Butler system is available at: http://www.labpsitec.uji.es/esp/multimedia/videosMYD.

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