Chapter 5
AGILE Interface for 'No-Learning nor Experience required' Interaction

Santiago Martinez, Antonio L. Carrillo-León, Ken Scott-Brown, and Juan Falgueras-Cano

Abstract The wide variety of technological devices is a barrier to satisfactory usage and learning over all. Different types of interface element distribution and dissimilarities of their functionalities, even in the same category of products under the same brand, can steepen the learning curve to effective device operation. Interface design can be understood as a mechanism for the adequacy of the technological environment to substantially improve performance, satisfaction and life of the user with special requirements. Based on an inclusive paradigm, we aim to improve the usability, accessibility and satisfiability of the interface for a specific group of users, such as *novice elderly*, to benefit all types of users in their daily lives. The requirements derived from a holistic analysis of user, goals and context lead to the introduction of the AGILE Interface (Assisted Guided Interaction with no Learning nor Experience required). This interface is the pillar of a new interaction style designed to assist and guide users with specific needs owing to age and non-Information and Technology experience. In the context of present-day technology interactions, the ultimate goal of this work is to move beyond out of date user stereotypes to tailor appropriate interface design adapted to realistic and specific user demands.

5.1 Introduction

5.1.1 What is AGILE

AGILE (Assisted Guided Interaction with no Learning nor Experience required) is an assistive interaction style for optimal performance of a digital transaction without requiring previous learning of how to use the interface, and designed for users with no technological experience. AGILE is the acronym of Assistive Guided Interaction with no Learning nor Experience required. The name is similar to the AGILE Software Engineering methodology [10]. They have in common the iterative design typical of any user-centred interface design. Beyond that feature, there is no inspiration or relationship between the two terms. The benefits of the AGILE type of interaction is reflected in its interface, designed to improve the performance, satisfaction and life of users with distinctive requirements, with special mention to the novice elderly. The interaction style is designed to assist and guide inexperienced user throughout the interaction process of a regular digital transaction. Its ultimate goal is to tailor appropriate interface design adapted to realistic and diverse user demands.

A clear classification and representation of the target user is necessary to effectively design for their needs. First, we will visit a concept presents on user classifications related with interface design. Second, we will look the traditional interaction styles over to select what relevant features could be useful to be incorporated to the new interaction style. At the end of this section we will describe in depth our intended target users, elderly users with no technological experience, described as novice elderly users.

5.1.2 The misleading concept of the 'average user'

Our starting point in this chapter is to discuss whether the stereotype of an average user is convenient to fairly represent the heterogeneous spectrum of users in general, and any special type of user in particular. In the case of users with no Information and Communication Technology (ICT) experience, it does not seem to be the case.

5.1.2.1 Research Question: Is the average able-bodied user a useful and fair concept for interface design?

It is common to find that system interface requests are generally constructed on the assimilated concept of an average user (Norman alludes to it as "the representative user" [42]). This representation is meant to illustrate a prototype of the intended user of the application interface. As a result of that, the design cycle of technology interaction has been predominantly evaluated from the perspective of a homogeneous user stereotype. However, continuous introduction of new technologies alter and extend prevalent scenarios of use, increasing the number of target users and, more importantly, diversifying those prevailing user types. This means that, at present, traditional user profiles do not entirely reflect a spectrum of users constantly growing in variability, requiring a fairer analysis of user needs and their context where technology use occurs. Whilst it is true that the incorporation of Accessibility [1, 61, 34] and Usability [16, 44, 17] principles of design have increased heterogeneity in design for users in mainstream technology, in comparison, there is still a reduced number of effective applications developed for specific target users, such as elderly, children, disabled, or any with special needs [29, 31]. Quoting Langdon and Thimbleby [27]:

> *Much of the accepted research [on usability work], is likely to be inadequate for informing user interface design in the future, and certainly inadequate for informing inclusive design of user interfaces.*

On the other hand, fields such as Universal Design [12] and Inclusive Design [52] deservedly attempt to equilibrate the User Interface (UI) research scene, increasing the quality and number of designs for those special types of users, laying aside the traditional marginal approach of supposed user uniformity.

Different categories of software, hardware and context of use may easily derive in different average user representation for each one, because of what average user definition means in one context may differ in other. For instance, an average user of an old typewriter with an analog and mechanical interface does not exactly fit into the same parameters as an average user on a daily shopping trip to the supermarket, using a Self-Service Checkout with a touch interface. The experience of the user in the first scenario, may or may not translate to the context of the second, but both users could be the same. In addition, rapid changes in device technology make it difficult to say if the traditional computer model based on the average user is applicable for other devices, or other types of users, or different contexts of use. Besides, device technology evolution also requires developments in the accessibility, ubiquity and interaction techniques of such devices, and always considering a realistic target set of users. This leads the authors to have doubts about average user concept utility in UI design. These issues clearly suggest that a relationship between the cognitive and physical human aptitudes, in conjunction with new types of devices and their scenarios of use have to be devised.

5.1.3 A fairer approach: Understanding users and their limitations

The variety in type and number of the range of different disabilities makes it difficult to use the term average disabled user. In this work, we pursue the Inclusive Design [52]paradigm, which implies that it is the diversification not the homogeneity that should lead research decisions in the context of specific types of users to therefore apply the results to the widest number of users with or without the same characteristics. Awareness of user needs in unison with capabilities and limitations are necessary for a correct interface design. However, the reasons for such importance are rarely described. Intrinsic advantages are: more usable systems, more appropriate interfaces, less trial and error in use and design, and reduced user training [48]. The study of the user limitations with their context of use has to be done considering the technology interaction as a cognitive process, involving multitude of different actions such as perception, attention, recognition, reasoning, thinking, use of memory, etc. It is important to know their mechanisms and intrinsic limits of operation to properly adapt design methodologies. Thus, the Cognitive Psychology discipline is becoming more important in the identification of problems users have when they use technology, based on their profile and context. Along the same line of thought, the mentioned discipline's approach, Inclusive Design, tackles problems found when 'less-able' users face technology. It pursues two goals: to reduce the exclusion on target users and the frustration able-bodied users find using the same products. This work applies the intersection of both disciplines, Cognitive Psychology and Inclusive Design, to contribute with guidance and methods that lead the design of optimal interactive products.

5.1.4 Our target user group: novice elderly users

HCI user models have not traditionally considered the user with specific requirements in the same classification where able-bodied users were commonly described [55]. Whether these users are described, they belong to differentiated and separated set. While it is true that they do not share the same characteristics of able-bodied users (i.e., they would not probably present the same tendency of knowledge progression, as it will be described in Fig. 1), usage may coincide in terms of goals. From an Inclusive Design perspective, we accept that all users have needs. The issue is to find those needs that can be covered and solved by the design of an effective interface. We argue that a true usability and accessibility approach for a specific subset of users is thus transferable to all users. The improvement can be appreciated by target users but also for those outside the scope originally considered (i.e., able-bodied with no experience nor time to learn, cognitive mild impairments, etc). Quoting Newell [37], *Designing interfaces that benefit users with special needs can benefit all users.*

In this work our target users are the novice elderly users, those users above 55-years old and with not enough ICT experience to undertake a digital transaction with a sufficient threshold of knowledge and confidence. These users have further special requirements due to deteriorated cognitive processes created by age, which are essential to be considered in the UI design. The following list shows the senses and cognitive skills typically affected by the involutional process of aging [15, 58, 59] and examples of their associated limitations:

- Vision, i.e., low vision, blindness
- Sound, i.e., hearing impairment, deafness
- Touch, i.e., haptic disruption, paraplegia
- Reading, i.e., illiteracy, dyslexia
- Attention, i.e., attention deficit disorder
- Emotion, i.e., anxiety, depression, autism

AGILE is focused on enhancing the interaction on vision, touch and sound channels. Age introduces sense deficits affecting not only the sensory data, but also the cognitive processes associated with them. For instance, response time and cognition processes are gradually and negatively affected with the age progression. Attentional focus and shifts are difficult to maintain, operate and equally to learn. Previously learned skills, together with long term memory and reason are still well exercised. However, capabilities likely to be involved in unfamiliar or first time tasks, are more impaired with increasing age: instantaneous reasoning, working memory and executive control (adapted from [27]).

In the following sections we will thoroughly introduce a new guided interaction style for users with no ICT experience, and with no learning required for its first use, with novice elderly as target users. In Section 2, we will describe the literature relating to elderly users, focused on inclusive methodologies. In Section 3 we will describe the AGILE fundamentals, selecting relevant information to conform new experimental variables. In Section 4 the new interaction paradigm, AGILE, will be presented. We will describe the evaluation of the AGILE interface in Section 5. Finally, in Section 6, we will discuss the overall conclusions in the context of interface design, user models and future work.

5.2 Literature Review

5.2.1 The undeserved double exclusion

Many technological designs are created by people between 20 and 50 years old, who lack practical knowledge about the challenges experienced by younger and older user groups, as well as knowledge of the interaction style most suitable for them [7]. Thus, historically, designers have ignored users who do not fit the intended target, such as those who have physical disabilities or are functionally illiterate [37]. In response to that marginal approach, differences created by age have been reported by studies on interaction styles for user groups with different age [65, 25]. Furthermore, styles of interaction widely accepted and seen as revolutionary paradigms for interface design, such as WIMP (windows, icons, menus, pointer) (WIMP GUIs were popularized by the Macintosh in 1984 [64]), were putting aside the consideration of possible exclusion. For instance, blind users *had to see the items* to effectively interact with them (i.e., for interactions such as item selection, drag and drop, etc) [37].

Taking into account the fact that young people have a natural tendency to use technologies and can easily adopt new ones, most marketing investments are driven to engage those users with high expectations of using new devices and services related. However, elderly users do not usually have easy access to and usage of technology. It was well stated by Pieper in 2002, on his concept of the *Digital Divide* about the divergence between those users who can access the technology and those people, potential users, who do not or cannot [46, 14]. For instance, in 2008, there were more people over sixty years old than fewer than sixteen in the U.K. [25]. Demographics of aging anticipate research near future direction, showing a 7% of population older than 65 years old in 2008, with expectations to be doubled in the next 30 years.

5.2.2 Validity of Inclusion

Research on universal technology access has been mainly focused on user groups with special needs (SN users). Usually, these special needs are represented by different factors such as speech, motor, hearing, and vision impairments; cognitive limitations; emotional and learning disabilities; as well as aging and environmental factors [41]. Fields that addressed computer access for the disabled started in the early 1970s, where methods for keystroke reduction were of interest to rehabilitation engineers. There have been many designs for older or disabled people, which led to mainstream products. For instance, in 1985, anticipating the direction of Inclusion Design, a predictive interface to reduce typing effort was demonstrated to be beneficial for people with no obvious disability other than problems with spelling [62]; talking calculators designed for blind were useful for eyes-busy tasks and low luminance conditions; less 'wordy' or 'verbose' interfaces with mostly visual content designed for people with language dysfunction were valuable for multilingual environments [37]; the first cassette tape recorder was designed specifically for blind people, and because of the poor sound quality, there were no expectations for it to be a universal product as it eventually became [38]; the large button telephone produced by British Telecom, was an example of a commercially successful product with both visually-impaired and mainstream customers; etc (see [49] for an extended list).

5.2.3 Inclusive, Task and Cognitive Models examples

Inclusive models are the newest across the user models existing in the literature. Generally speaking, they consider the user as a wide set of features categorized in several levels, such as cognitive, perceptual and physical. Their goals pursue adaptation for user with special requirements and inclusivity projection for the wider spectrum of users. For instance, Jacko and Vitense made reference to specific cognitive, perceptual and physical abilities to draw a capability classification. They were interested in age related degeneration of the retina and constructed a user profile based on the information of loss of central vision. Importantly they stated some guidelines in order to overcome and bring an adaptation to the new state of user vision. Those guidelines involved font size, colour background and input and output speech [23]. Newell and Gregor broke the traditional UI design and gave priority to cognitive and physical needs of non standard user to later accommodate mainstream design in that process, understanding non-standard user as that one with requirements beyond the user profile erroneously considered average (adapted from [40]). Langdon et al. analyzed processes of cognition from the information processing models perspective. Their empirical studies pointed the high levels of adaptation that a user model will have to gather, and for that the user had to be necessarily studied based in a holistic awareness of their capabilities [28]. Hanson revisited the digital divide situation, describing the interconnectivity between older adults, network services and technology on computers and mobile platforms [13]. Another interesting approach is the Universal Access Reference Model (UARM) focuses on the accessibility of the interaction between users and systems. It is aimed to discover the common knowledge and abilities shared between users and systems reducing their handicaps. It used the Common Accessibility Profile (CAP) to describe user profile disabilities [9].

Tasks models are valuable for synthesizing the transactions into stages that can be built and analyzed. For instance, ConcurTaskTrees (CTT) [36] is a notation for model specification. It has a hierarchical structure of tasks, graphical syntax, concurrent notation and is task-centred. However, it is a notation mainly focused on the analyst's work, which will use it to design a solution based on tasks. Unfortunately, the user is not taking part on that solution building. The specification and interaction type result of that process is plain, without distinguishing between user types or their requirements. So, a novel user will have been alienated at the same level as an expert user. This can bring some problems into the overall performance and experience not on the model, otherwise in the satisfaction and effectiveness of the interaction built.

Regarding cognitive models, the work of GOMS (Goals, Operators, Methods, Selection) [5] has had great influence in this work. From there is taken the concept that the main goal is to guide and drive user, step by step, in a progressive fashion over a hierarchical predefined goal structure. To accomplish these goals in a satisfactory way, tasks and actions have to be conducted in the same way they were described. Consecution mechanisms should be simple and coherent in all moments and using the user interface. In fact, parallel works are being carried out by authors to develop specification tools that extend and improve the NGOMSL notation [25].

Other main standard with influences in this work has been ISO 9241-171, including some guidelines used in the AGILE interactions style, such as suitability for the widest range of use, provide text label display option for icons or provide user-preference profiles [22].

5.2.4 Why the mainstream misfits novice elderly user needs

UI Design has traditionally used two key factors to shape the able-bodied user: experience and learning. These factors are commonly assumed in a sufficient level to not consider explanations of how to use the interface, which can consume time and disturb the experienced user in prospective use of the interface. Nowadays, some applications include tutorials and demonstrations (which visualization can be voluntary or obliged) to show how to use the interface. The number of such applications is still reduced, particularly in the case of non-experienced users or those with special requirements, such as elderly.

To build a successful interaction style, it is important to understand the relationship between user, their experience and learning about technology. For this, we need to study why traditional models do not reflect these special users. Under normal conditions of cognition and no physical limitations, we analyze how experience of the same or analogue technology affects the knowledge a user acquires. Figure 1 shows this influence in a graph where the x-axis represents the accumulated experience of use, while the y-axis sets up the learning about the application domain and functionality of the system. It can be observed how the knowledge-progression about the system starts from a maximum and decreases as the use of the system grows (Fig. 1, region A). This situation remains until a specific point is achieved (Fig. 1, point 1), after which the knowledge progression is digressive. This point represents the moment where the user has reached sufficient knowledge about the application, and subsequent use of the same system will provide little knowledge compared with previous sessions (Fig. 1, region B). This fashion will end up at the point where no more sessions will provide any new knowledge about the system (Fig. 1, point 2).

The previously discussed average user (previously seen in section 1, second paragraph) would be hypothetically placed in the centre of the curve (region B), representing the set of users with an average experience of the system. The region B described delimits other two different sets of users outside the central region of the distribution (region A and region C). Unfortunately, novice elderly users or any other user with special needs do not fit into the latter regions (B or C). The dynamic diversity of elderly users makes the traditional user-centred paradigm incomplete, based on homogeneous groups of user testing [45]. The key point is how to lead a user in the correct use of an interface, increasing motivation through a didactical approach to demonstrate its use from the very first and ensuing times (region A).

This idea of knowledge associated with previous experience and expected future uses of the same interface, explains the lack of success on the one-time user interface, or any of those where the user is unfamiliar with them. Their design is many times based on the assumption of the future sessions with the same interface that will provide the sufficient knowledge to improve the interaction. This trial and error exploration process, apart from non-optimal, fails when we talk about users with no experience or users unfamiliar with the interface faced. This is why there is a clear misfit between the models applied to average users and those applied to elderly or special needs users. The result is that misfit users perceive the inadequacy of interaction, and many times feel fear of technology use or see themselves as incompetent users.

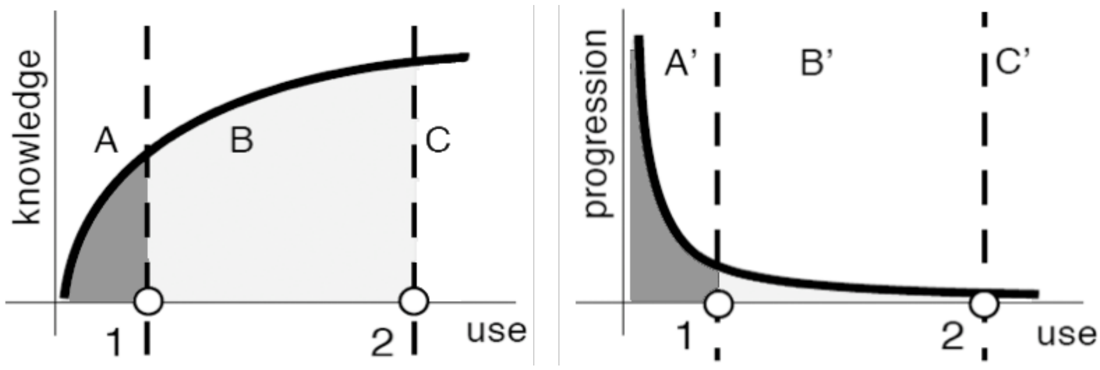

Fig. 5.1 Knowledge progression of the able-bodied user of a system: x-axis denotes accumulated experience of use; y-axis learning about application domain and functionality of the system. The region A (left-hand side on both graphs) represents where the knowledge is rising with the use and the highest progression tendency. The region B (middle on both graphs) represents where the knowledge rate is reduced, resulting in a digressive progression. The region C (right-hand side on both graphs), where the progression tends to disappear and the knowledge remain constant. Point 1 is where the knowledge reaches the peak. Point 2, where the knowledge progression ends

5.3 AGILE Fundamentals

5.3.1 The importance of the environment

In this work, we are focused on users with specific limitations occasioned by age, which result in their subsequent needs, presented too when they interact with technology on their daily lives. These interactions occur in specific scenarios, and they matter at least as much as the technology itself. The environment has to be accounted as another key element in the equation of design. Citing J. A. Whiteside [65]:

> *[…] There is nothing absolute about user characteristics; they are only meaningful within a context. Removing individuals from the context destroys the meaning of the characteristics used to classify them.*

To illustrate the consequence of the mismatch between the user's needs and abilities regard the environment, we introduce here the definition of "handicap" (The International Classification of Functioning, Disability and Health (ICF), 1983), which expressed disadvantage for a given individual due to impairment or disability, but from the perspective of the interaction with and adaptation to the person's surroundings [30]. For instance, a person could have impairment and a disability but at the same time avoid the handicap: a wheelchair user could avoid the handicap issue whether the environment propitiates inclusion for such impediment, for instance, through the use of dropped kerbs to allow easy access from sidewalk to street (adapted from [42]). Thus, a strong correlation is found between the extent of how the environment accommodates to user's needs and the resulting avoidance of a handicap.

In addition, it is important to work towards how the environment fits the users' needs in a given situation to compensate so user's deficits in relation with such environment. There is a translation of responsibility from the user with specific needs to the environment and its designers, acknowledging the necessity of adaptation. We do not refer to limitations or capacities in isolation; it is a holistic approach to focus on how the environment can help to achieve user requests, including the dependency between their condition and the environment. Thus, it is the environment, not the person, which is seen as the *disabler*, noting the importance of the interaction between the individual and the environment [47].

5.3.2 User Participation

One problem a user usually confronts on everyday interactions is that their success is depending of how well (or bad) designed is the interface they have to face. To more finely describe this situation, we use some qualifiers created by the World Health Organisation's International Classification of Impairment, Disability and Handicap, ICIDH [66], and are the following:

- *Capacity*, describes an individual's ability to execute a task or action, without personal assistance or use of assistive devices;
- *Performance*, describes what an individual does in their current environment in a life situation, including personal assistance or use of assistive devices;
- *Environmental Factors* establishes the distinction between environmental 'barriers' and 'facilitators', as well as the extent to which an environmental factor acts in one way or another [24].

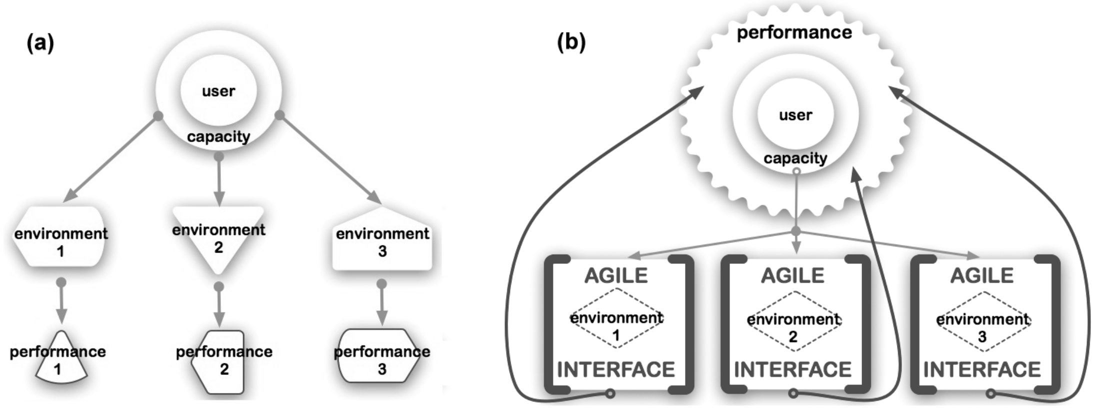

Fig. 5.2 (a) The graph shows the traditional approach of User Interface design ignoring enviromental factors that result into different performance for the same user's capacity. (b) The other graph shows the new AGILE interface approach, which encapsulates the environmental factor to offer a unified and augmented performance for the same user and their capacity

Thereby, we could say there could be different performance for same capacity, depending on the adaptation of each environment the user develops in. In the Fig. 2, we can observe a common situation on interface use. In the figure on the left (Fig. 2.a), the user performance is depending on each interface design, which is not homogeneous and together with other environmental factors involved may provoke the same transaction be successful in one case and fails in another. In contrast, AGILE methodology pursues the goal of augmenting user performance across a guided and self-explained interface, using consistency and permanency on the interface style and designed elements across the different types of interfaces in consonance with the environment (see Fig. 2).

5.3.3 Process of Adaptation for novice elderly users

Traditionally, adaptive interfaces have been focused on a series of selected elements to build up the adjustment of the interface during their usage. Brusilovsky and Millán [4] reviewed the five most popular features to be considered in adaptive web systems as well as how to model the context of user's work. Following, we will describe those features that appertain with some considerations to novice elderly users. In that article, the authors presented the *Knowledge* as the understanding of the subject being taught or the domain represented by the system. It was a changeable feature by learning (increased) or forgetfulness (decreased), from session to session or even in the same session. This last particular feature of variance of the knowledge depending on the learning process involved in the interface use and on the memory functioning applies straightforwardly to elderly users. *Goals* represented what the user wants to achieve, and they were catalogued to let the system recognize them. Goal and task hierarchy follow this line of research and are a central part of the AGILE interface. *Background* constituted a set of features related to the user's previous experience outside the core domain of a specific web system. In our particular case of novice elderly users, only the minimum information necessary to be understood and used across the variability of possible backgrounds is shown. Inside the *Individual Traits* they included *Cognitive* and *Learning styles* [4]. The former affected the way information was organized and presented, the latter the way people preferred to learn. Both components are used in the new style presented, but conveniently modified for the specific target users. That is, the presentation and organization of the information is simplified as much as possible and the learning requirements are minimal. Regarding the *Context of work*, it also applies to the new style in the form of the *environment* and *human dimensions*. About the *environment dimension*, the physical context around the user plays a vital role during the whole interaction process, becoming another part of the interaction. The *human dimension* contained the important feature of cognitive load, taken into account in the design of the interface. In conclusion, all these features presented above are a starting point for the construction of a new interaction style suitable for novice elderly users and then presented.

5.3.4 Specific variables for novice elderly user

The proliferation of new contexts of use and technologies require a redefinition of the relationships between users and machines. Transactions are no longer only about data extraction, they are often interactions for different goals such as buying a ticket in a train station ticket machine, scanning a passport at the airport, a web transaction for first time, etc. A novice elderly person is a type of user with no Information and Communication Technology (ICT) experience. They have even less incentive to learn than one-time users (i.e., a user who uses an interface only once in a lifetime). Anecdotal evidence suggests that they are likely to say: “I am too old to learn new skills” [38]. Their cost of learning is increased because the time to acquire new skills is higher compared with younger population with undegraded cognitive skills. Consequently for elderly users, the cost and motivation of learning is the first serious obstacle to successful use of same technology in the near future, an easier task and common incentive for younger users. We argue that assistive information and communication technologies can play a vital role in the issue of traditional exclusion to elderly users from the mainstream.

Hence, they may not have interest in any fine details of software or hardware, and so their motivation for such use can be only increased by didactical and guided methods. Guidance during the process, assistance in case of error and demonstration of goal achievement are the core of the interaction for this type of users. Even if successful learning of the use of the interface is achieved, the future use, if any, should be considered as ‘first’ in terms of memory and functionality recalling. A set of relevant variables related with such technology use is described below:

1. Motivation: reason that triggers the use of the system.
2. Familiarity: user’s acquaintance of the interface and analogous systems.
3. Skill level: the capability that the user has regarding employing of technology in general or computer related systems in particular.
4. Cost of learning use: the effort necessary to achieve a sufficient level of knowledge to use the interface.
5. Learning procedural aspects: the requests for the user to learn methodical aspects in order to satisfactorily use the system.

Two additional variables associated with time are critical in understanding the novice elderly user: *experience on the interface* and *frequency of prospective use*. The former identifies the prior experience the user has with the interface. In case of occasional use, such as the one of novice elderly, the value is near zero. This means that whether the user has had an encounter with the same or analogous technology, the difficulties they experience on learning and, in many cases, their absence of motivation, make it unwise to rely on user memory recall as the sole mechanism to recognize how to use the interface. It is recommended to consider that the user, then, faces an unknown interface. The latter variable, frequency of prospective use, is an explicit reference to the probability or guarantee about the use of the same system by the same user in the near future. Because the likelihood of use in the future of the same interface cannot be inferred with fair level of probability, this constrains the probability to be always less than 1, and in terms of implications to design for learning, very near to zero. In conclusion, the ranges of values for the two factors (variables associated with time) are characteristically defined for novice elderly users: experience on the interface (≈ nil) and the probability of prospective use ($0 \approx P(\text{prospective use of same interface}) < 1$).

5.3.5 Design variable values for novice elderly users

Once described the user variables involved in design of the AGILE interface, we need to specify their values. Considering all said until now, for the novice elderly user those values are:

- motivation: very low or none
- familiarity: very low or none
- skill level: very low
- cost of learning use: high or very high
- learning procedural aspects = f(AGILE interface implementation)
- experience on the interface: none
- capacity: inherent to the user
- performance = f(capacity, environmental factors)
- environmental factors = f(AGILE interface implementation) + others_not_considered

We explain the values selected for the target users. In first instance, the motivation value has been already argued that it is *very low* or *none,* a distinctive feature of elderly users. Motivation to use new technology is not present unless it is well explained the purpose, benefits and eased the attached learning of how to use it. Familiarity with the interface or analogous systems and skill level values are also *very low*, also *or none* in the former variable, typical of novice users. About the cost of learning value of *high* or *very high* it has been also described as a characteristic of elderly users, due to their cognitive limitations or deteriorations by age. The value of the learning procedural aspects, that means the request of the interface for the user to learn methodical aspects of use, it is in dependency of the AGILE interface implementation. Experience on the same interface is *none* due to the challenge of first time users we want to face; capacity value is inherent and intrinsically determined by the specific user and performance's value is in function of the capacity of the user together with the environmental factors. In the evaluation shown later, the only environmental factor studied is the implementation and effectiveness of the AGILE interface.

5.3.6 Implications of the variables and their values on designing for novice elderly users

The previous selection of the variables and their values has several important implications in the interface design and interaction.

a) *Learnability*: the interface should be developed taking into account the fact that the number of sessions the same user is going to perform is limited to 1. This means that possible future interactions are not accounted. Mechanisms of learning functionalities of the interface, by retention, or by repetition, are extremely limited. Better than expecting the user to acquire how to use the system, it is recommended to spend time and effort in showing the user how to achieve their required goals. A recommendation would be the correct use of the metaphor to establish intuitive links with the real world elements (see Carroll's work on the metaphor [6]).

b) *Guidance*: where possible, efficient mechanisms of guidance through the interaction should be provided. This aspect is addressed to compensate the deficiency of the learnability. For instance, in each stage of the process a clear map of steps achieved and possibilities of the interaction flow would be valuable for inexperienced user in general.

c) *Assistance*: there should be an effective help system, valuable to demonstrate critical points in the interaction in terms of complexity or novelty. This system should also be useful in any case of error or impossibility to achieve a goal. This aspect is related straight away with user's feedback, and will have an influence on the notion user takes from the interaction process and the system.

The adaptation process is therefore applied in the design stage. Firstly, there is an adaptation of contents, where only elements relevant for the user interaction are shown in the interface. The purpose is to reduce at minimum distractions that can induce time waste during irrelevant inspection or meaningless interpretation of such elements. Secondly, the adaptation occurs in the guidance system employed. There will be an appreciable area dedicated for the guidance system, responsible of directing user's attention to the interactive interface elements in each transaction's step. Finally, mechanisms of assistance will provide user with procedures to be helped and amend information in an effortless way. This approach could be seen as a cross-adaptation process in terms of the adaptive presentation and adaptive navigation support that Brusilovsky [3] used in the taxonomy of adaptive hypermedia methods and techniques, but placed in a static fashion in the interface design stage.

5.3.7 Goals as determinants of user behaviour

Newell and Simon [39] described user's goals as the determinants of user behaviour. User interaction is motivated and driven by goals, applying their knowledge and limited by the task architecture and their cognitive capacity:

> *He [the user] attempts to accomplish his goal as effortlessly as possible, within the constraints imposed upon him by the structure of the task, by what he knows, and by his own information-processing limits.*

For Moran [35], all the actions a user performs are impelled to accomplish a goal. He enumerated four different factors that determine and help to predict user behaviour. These determinants can be altered to improve user performance in a given situation (and presumably, to increase user satisfaction and reduce user frustration): altering user interface → changing the task structure; instructing the user → teaching to increase their knowledge; assistance for user's limitations → efficient error recovery; automation of subtasks → to ease the accomplishment of major tasks.

He gave an example describing two common issues on the human user:

> *Two examples of processing limits are the human's limited short-term memory capacity and his tendency to make errors occasionally (for a variety of reasons). These limits covertly manifest themselves in the human propensity to break larger tasks down into smaller tasks, which puts fewer demands on memory and which tends to limit the scope of errors.*

5.3.8 The immediacy of the Goal in the occasional use

Occasional interactions with technology have defined characteristics, which should be taken into account during their design. Among others, the unfamiliar environment where they take place; whether the interaction occurs outdoors introducing external factors such as noise, distractions or weather conditions; etc. Above all, in this work we highlight goal achievement as a determinant factor to shape and underpin the interaction with technology in our everyday lives. The importance of achieving the goal in every interaction imposes restrictions at all levels. In the case of an occasional use, such as buying a ticket in a train station in a ticket machine, or scanning a passport at the airport, learning how to perform the transaction correctly cannot rely on future uses of the interface as seen on desktop programs (i.e., next day or session). Novice elderly users should be considered in this aspect of occasional use, because even whether they learn how to use the system in a diary repetitive task, it can be easily forgotten.

The case of a user travelling everyday by train could be considered as an example. Would a user who has to take occasionally a train and thus use a ticket machine be considered as an occasional user? What about the first time they use the ticket machine? In this particular situation, the probability of prospective use could be inferred to be greater than zero. However, in the first use of the machine the user has no previous knowledge accumulated through the experience, and the learning in future uses cannot be helpful in the actual transaction, maybe only in the future ones. The same circumstances occur in the subsequent transactions. In every transaction with a ticket machine, getting a ticket from the machine is an immediate goal, which cannot rely on the future use of the interface in the next session. So, every user of these types of machines should be catalogued as occasional, no matter the number of future sessions, which are interpreted as none during a specific transaction. Desktop applications can rely on the difficulty of finding the specific option hidden in some menu in a finite, but greater than one, number of sessions. There, error is assumed and expected to be improved in next try. Goal achievement is as important as learning the best ways to perform functions, and in case of error, solution cannot be relied on learning in future uses. Performance on every interaction should be maximized. In the case of an everyday user of a self-service ticket machine, the transaction's goal and time are critical, more than to learn how to do it in the best way.

In this chapter we argue that novice elderly users in transactions succeed the premises of an occasional user, with learning, memory and interactivity issues accentuated by the elder state of such users.

5.4 AGILE Model: Assisted Interaction with No Learning nor Experience Required

5.4.1 Philosophy

In this work, a new interaction style is proposed, based in the hierarchical task analysis and namely AGILE Interaction. It pursues the ease of use, but taking into account the lack of traditional mechanisms of learning by repetition or retention. This style sacrifices the possibility of developing the execution of processes in parallel and other typical advantages of WIMP interfaces [64]. It works towards simplifying, ideally, the syntax of knowledge to optimize the use of the system and its semantics. The user should be able to interact without a previous intensive study of them. Semantics should be sufficiently intuitive to allow the user to correctly interpret the interface structure with a minimum effort. Thus, the interface contains essentially short but meaningful descriptions and an overall clear language and content. An effective approach to develop this concept is the correct and effective use of the metaphor. The metaphor is a pillar of any current interface design. It is, in essence, a vehicle to transfer a concept, knowledge or idea to the user. In the context of users with no experience and reduced cognitive function, such as elderly, this transference becomes critical to effectively transmit, interpret, and reorient if necessary, the meaning that the metaphor represents. As a consequence, it is crucial to include a new dimension of literality into the metaphor to achieve a correct use of the AGILE interface. This literality will be introduced by two elements: a virtual agent will represent the assistant part of the interface, explaining and indicating the options in each step. The second element will be, wherever possible, a representative icon of the option accompanying the text. These two elements represent the faithful connection between the explanations and decisions making inside the interface with the reality outside the interface.

5.4.2 Learning from Traditional Interaction Styles

Traditional interaction styles may bring some useful characteristics to put up a suitable interaction style for the elderly user. For instance, *direct manipulation* [18, 54] is already placed in almost any interface in greater or lesser extent. The immediate handling of objects is primarily connected with how we see and use object in the world and it becomes a critical feature of this new interaction style. In addition, the active component of *questions and answers* [43, 51] and the tutored approach of the *wizards* [8] make them very recommendable for elderly users. Other features from other styles like form filling should be used only when absolutely necessary (i.e., authentication with introduction of password), and even in those cases any alternative with the same effectiveness and minimum text input should be examined. For instance, the interface should offer best ways to deal with the information than the traditional typing, where the environment allows to it (i.e., if the source of target destinations for a trip is publicly available, a predictive search considering the default location where the user currently is, will save time and effort). Command language is manifestly discarded for lack of experience and the complexity and time required learning how to use it.

5.4.3 Methodology

To overcome the habitual short sightedness of information and communication technology (ICT) designers [11], this work is oriented to prevail over functional limitations [19] of users. This perspective incorporates into the interface design what really matters for user with specific requirements: the capacity of doing an assisted and guided definite task. Based on the variables previously described (in section 3, second paragraph) and taking on board their implications for designing, the specific aims of this methodology are:

i. Simplifying the decision making on every transaction step.
ii. Guiding the user in all the steps of the interaction process.
iii. Assisting and demonstrating the use of interactive components on the interface.

To simplify the decision making, there is a transformation of the task tree structure, flattening its depth to transform the transaction in a process with greater number of decision steps but with much lower complexity in each decision. The number of steps has been increased reducing the complexity of each. Many times in digital transactions the steps are overloaded of multiple decisions and information, which often overwhelmed the senses of the user, especially during the first-time uses.

To achieve aims ii and iii, innovative ways of assistance and guidance are proposed. First, a virtual agent implements the personification of the assistance concept. Using animation principles, quick and effective demonstrations of 'what to do?' and 'how to do it?' are shown by the virtual agent. In addition, user's attention is directed to relevant items or areas on the interface by head, gaze cues and gestures of the agent. This paradigm is based on multi-frame animated physical cues used to orient attention of the user [32] on digital and touch interfaces [33] in combination with animation principles to predict perception on the observer [57]. In the following list, focused on overcoming any of the deficits (stated on the left), principles are stated on the right as resources for the design of the interface and will be used with discretion over the iteration of the interface design:

- Attention→ simple layout; Physical Cues [36, 37]; Animation Principles [56].
- Touch → touch screen, customizable size of items, input redundancy: mouse, track pad, keys, phone.
- Reading → avoid meaningless text buttons, use icons, speakers.
- Vision → animation principles: Exaggeration, Silhouette [57].
- Sound → text and sound, indications, flashes.
- Emotion → simple, exaggerated characters.

Having identified these principles, we discuss how some of these are employed in the AGILE interface design.

5.4.4 AGILE initial prototype description

The initial prototype divided the screen into four different areas of interest in a landscape screen mode (see Fig. 3).

Goals Area: this area is placed in the top of the screen. Its purpose is to show the hierarchy of active goals in each moment. It starts showing the immediate goal to achieve (i.e., goal A), and a sequence of sub goals (i.e., goal B, goal C, etc) necessary to accomplish the former (goal A). Each time a goal needs other subgoals to be accomplished, the goals' list would be updated, showing the subsequent subgoals. This area is not intended to allow any type of interaction. Thus, its role is merely informative.

Assistance Area: it shows the sequence of steps necessary to accomplish the actual goal. Steps are ordered, sequenced, and numbered. However, there is only one step activated at any time (noted by bold font type), rest of the steps appears deactivated (noted by a non-bold font type). In addition, a virtual agent (a female assistant character was chosen for this prototype) who would be in charge to point out which is the current step. The virtual assistant's main aim is to assist in the use of the interactive components of the interface. It is also a vehicle to orient the attention of the user to the relevant areas of the interface, where the demonstration or posterior interactivity will occur. This area is intended to receive interaction from the user in order to confirm the finalization of the step (all the interactions inside that step are accomplished and finished by the user).
Interaction Area: the area designed to receive most of the interaction from the user. It also shows the information relative for the interaction flow (physical layouts, measures, etc). Item selection, form filling and direct manipulation will occur in this area.

Fig. 5.3 First schematic prototype of AGILE interface, shown in a tablet. It consists, from left to right and top to bottom, on a map of goals, a map of steps, an assistive area and an interaction area

5.5 AGILE Prototype Evaluation

5.5.1 AGILE prototype evaluation methodology

The evaluation of the prototype was distributed in three different parts. First, the developing of a prototype with the aims previously exposed in the Methodology: simplification of decision making, guiding the user, and assisting and demonstrating the use of the elements of the interface. Second, the prototype was tested on a digital transaction that occasionally users perform. The device chosen is a portable device (tablet) and the input channel was the touch. Target users were novice elderly users, with little or no experience on touch devices and little or none with other technological devices such as computers. Third, the iterative design and test of such prototype based on the analysis and conclusions obtained from the evaluation.

5.5.2 Iteration 1: AGILE prototype in MS Power Point with Human assistance

The first iteration of the prototype consisted in a preliminary evaluation of a MS Power Point (MS Power Point 2008 for Mac, v. 12.1) presentation, shown on a PC, about a Kitchen Design application (see Fig. 4), inspired by the IKEA kitchen planning tool [20]. Controls were set up to advance to the next slide whenever the user selected an option available. The total number of steps (slides) presented was eight (8). When the user got 'stuck' in any step, the researcher helped, carefully explaining how to perform the corresponding action. Typically the most common problem was how to do a selection (press a specific button), when there was more than one element active on the screen.

The number of participants was four (4) with an average age of 74 years. They gave informed consent from the Computer Science Languages and Systems department from the University of Malaga, Spain. Participants were not disabled and their cognitive abilities were typical of that age, with no special impairments described. They were given instructions of building their own kitchen using the application. The researcher would assist the participant only if they were stuck for certain time in the same step, or operation.

Conclusions of this iteration showed that the map of goals was not seen or useful at all. Instead, it was disturbing normal interaction because when participants were asked if they perceived it, only two of them did, and they did not find it meaningful. The same happened with the step map, which was getting in the way when users thought they had to click on the speech bubbles, disrupting the interaction instead than informing it. The trend from the user was to think that everything appearing on the screen was clickable and relevant for the current task, instead of distinguishing what was informative and what interactive.

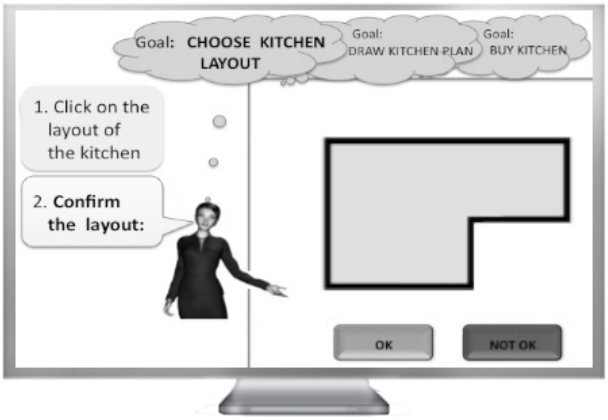

Fig. 5.4 First prototype of AGILE interface, shown in a PC with MS Power Point. It can be appreciated, from left to right and top to bottom, clouds with name of goals (map of goals); speech bubbles (map of steps); a virtual agent (assistive area); a confirmation task (interaction area.)

5.5.3 Iteration 2: AGILE prototype in iPAD2

Based on the previous iteration, an evaluation was carried out on the evolved AGILE prototype. The prototype was tested in a portable device, a tablet device (iPad2) and it was implemented in iOS (see Fig. 5).

5.5.3.1 Evaluation Process for Comparison with other digital transaction

A post event evaluation was done in order to refine the early prototype. The evaluation was carried out comparing the transaction in the AGILE interface versus another train ticket purchase in a rail website (see Fig. 6), using the same tablet device. Each user made two transactions, one on each different application, with a counterbalanced design. This evaluation was carried out in Scotland (UK) at elderly users home and in Malaga (Spain), at a health centre and adult learning centre. In total, the number of participants tested was 11. The age range was between of 58 and 83 years (average age in Scotland was 77 years, in Spain was 69.58 years, overall was 70.93 years) with no disability described, and with cognitive and physical impairments typical of those ages. All participants gave informed consent under the regulations of the School of Health and Social Sciences of the University of Abertay Dundee in English, translated into Spanish where necessary. To make the test more suitable, the absence of Spanish translation for the rail website lead to the selection of other website, a common web store (see Fig. 7) and the transaction changed to a book purchase. The adjusting in the AGILE version was done minimizing the differences with the AGILE version previously developed for the train ticket. This resulted in the same characteristic screens and tasks, but a reduction in the number of steps due to the book purchase transaction properties.

Fig. 5.5 The second iteration of the prototype of AGILE interface for the train ticket transaction, shown in an iPad2. Note the absence of Goals and Steps maps. There still remain the virtual agent (assistive area) and the region with buttons (interactive area)

There were a camera recording (Panasonic SDR-H85 with tripod) and Eyetracking (SMI Eye Tracking Glasses [58]: non-invasive video based glasses-type eye tracker, 30HZ binocular, spatial resolution 0.1º, gaze position accuracy 0.5º over all distances, 3-point calibration, HD scene camera and audio recording) during the test. All transactions were performed on the same tablet device (iPad2 with iOS version 4.3.5 and the interface designed using Objective-C language in XCODE 4.2, SDK 5.0), in a controlled room with absence of noise, disturbance and any other potential disruptions. Instructions of the transactions were the same (distinguishing between train ticket layout and data and book purchase layout and data, respectively) and provided in a sheet of paper, constantly visible for the participant in all trials. AGILE interface versus rail / book buying website tests were counterbalanced across participants.

Fig. 5.6 The rail website that participants had to use to buy a train ticket transaction. In particular, when the user had to select the service time, type of ticket and price.

The evaluation methodology worked toward adding quantitative and qualitative data to enrich evaluation results and refine the prototype as much as possible. First, the whole interaction process was recorded in a video camera, pointing to the tablet device to record users' touch interaction. All the operations, questions and answers during and after the interaction were recorded. Second, some participants were eye tracked to facilitate the analysis of the performance with the tablet. After both transactions, participant were asked a qualitative questionnaire about their experience overall, particular issues and recommendations about both applications.

5.5.4 Results of the Test of Train Ticket Transaction on Rail Website on iPad2

Analysis of the camera recordings showed that the transaction time was almost double on a rail website. Comparatively, the number of comments and assistance provided by the human helper was four times less than the one provide using the AGILE prototype. Furthermore, the content of the assistance was more loaded on the rail website, while in the AGILE comments were merely short confirmations or reminders to follow the instructions provided.

In addition to this quantitative difference, the major findings were qualitative. Comments and answers to the questionnaire described the problems the users faced during the use of the rail website. Mainly, problems were found in how to use the controls for inserting text (some participants missed the physical keyboard and it took them some time to realize there was the possibility to have one displayed on the screen when a text box was selected), for selecting time and dates (very little space for their fingers) and how to scroll down or up the page to find the button to carry out the next step on the transaction. In addition, there was a screen where the button to go to the next step was not initially displayed and it only appeared when a train service was selected, increasing the confusion of "what to do next" in that specific step.

Fig. 5.7 Detail of the website used for the book purchase transaction. In particular, when the book title had been found and the Quantity had to be introduced (on the right side of the screen above the rectangular button *Añadir Cesta* (in English "add to the basket "))

5.5.5 Results of the Test of Book Purchase on Website on iPad2

Similar results were obtained from the book purchase test transaction using a book buying website in Spanish. Despite there were only three screens to go through, the time elapsed was again so much longer (an average of 10.1 minutes (SD = 0.68) compared with an average of 3 minutes (SD = 0.5) in the AGILE interface). The complaints were about the overloaded interface, with too many unnecessary elements no relevant for the current task. Publicity, and the display of elements not required were all major distractions for participants. They argued that they had to spend much time reading messages and inspecting elements, with the high risk of clicking on them and moving into undesired screens. Also only one participant could find the search bar without help. The rest of the participants had to be guided by the researcher to successfully introduce the title of the book.

5.5.6 Discussion

The evaluation of the AGILE prototype (see Fig. 8) has brought different and important findings. The early prototype has shown how the goals map is irrelevant for users when they face an unknown transaction. At first glance, it was relevant to know where the user is in the transaction flow, but when there are too many new elements on the screen, so the priority of that knowledge does not seem to be the most important aspect of layout. Furthermore showing the goals map seems to be completely irrelevant for the current operation the user is performing.

A similar situation occurs with the Steps map. Many users were distracted with the steps, and semantically, they did not bring any useful meaning for the current operation. It was a distraction more than a help. This early prototype gave us the opportunity to refine the interface for the next iteration, removing the Goals and Steps maps from the interface on the next interface design iteration.

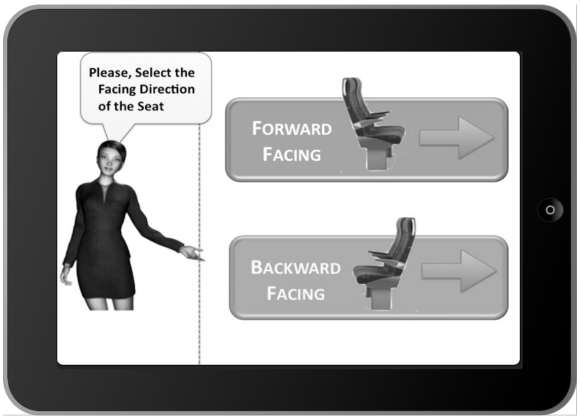

Fig. 5.8 One of the screens of the second iteration of the AGILE interface for the train ticket transaction. In particular, the *Facing Direction* choice.

In the evaluations on the tablet device, the comparison with a website to do a similar train ticket or book purchase transaction was very helpful. The problem of small screen space or using controls can be partially solved whether the website implements the best controls available for such operations, such as the ones that Apple Corporation provides for time and dates (scroll wheels) on iOS devices. However, again how to use these controls are not publicly known for every user who faces the interface, for example, novice elderly users. Such is the case, that when participants were asked whether they knew the existence of accessibility features such as the 'Zoom in or out' using two fingers to do the pinch gesture on the screen, they were surprised and argued that "I was not born knowing that, nobody taught it to me. Now it is too late". The concept of the virtual agent is to overcome this problem. In the prototype shown the agent is explaining clearly, and with good manners, the instructions in every step. In addition, prospective implementations of the AGILE interface will include the animation of such agent, presenting it in coordination and in sequence with the relevant items on the interactive screen. Tutorials before each screen could be provided to explain how to perform it.

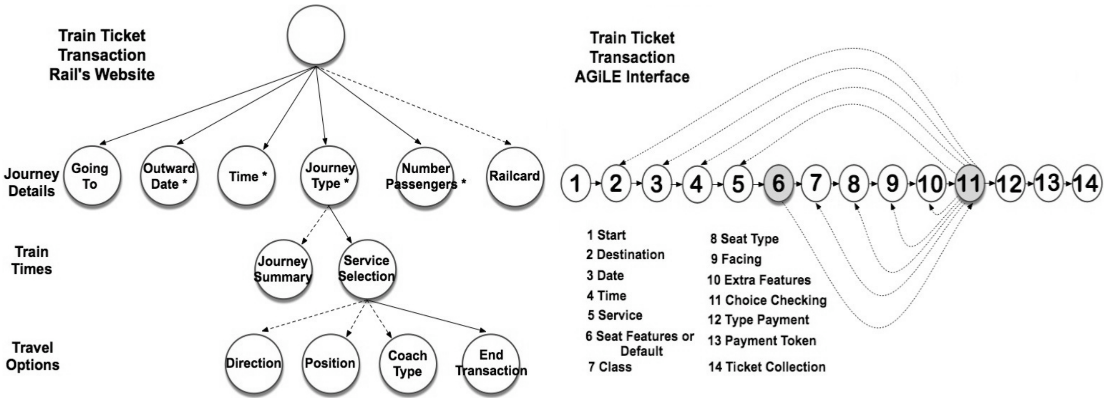

Fig. 5.9 (a) Task Tree representing the tasks in the rail website with 12 tasks: 7 compulsory with 5 with default values, and 5 optional. (b) Task tree of the same digital transaction in the AGILE interface with 14 tasks of which 14 were compulsory and none with default value. Note the possibility to go forward on step 6 and backwards on step 11.

Another conclusion from the evaluation test is the performance of the transaction. At first instance, the transformation into AGILE interface of the train ticket transaction has increased the number of steps (from seven compulsory, to fourteen) (see Fig. 9). However, the questionnaire answers brought the conclusion that in fact the AGILE interface was preferred in case of having to choose one application to purchase. It seems that despite the number of steps was increased, the approach of the AGILE interface in general and the simplicity of the decision making in particular have had a positive direct influence in the user satisfaction. In addition, the way that users could amend the decisions made (on step 11), or quickly go to last screen whether user was in a hurry and wanted the default values on all the subsequent screens to not waste time (step 6), were learned and used intuitively with no effort.Despite the overall positive preference on the AGILE version of the interface (11 participants preferred the AGILE version, 0 the other), some critical reflections must be mentioned about AGILE interface. First, the

AGILE version did not have a text input option. Instead, the search was predefined and elements showed were already known (destination city in the train ticket and book title in the book purchase). Second, there was a step in the AGILE interface that distinctly took more time for participants to perform and learn how to use. It was the clock in the train ticket application or counter of number of same items in the book purchase application (see Fig. 10). Some participants were 'stuck' until they found how to change the value, which was deliberately set up on zero. At the beginning, evaluators thought that the problem came from the digital numbers, which could be improved using other type of numbers. However, eyetracker data showed that for instance one participant was stuck in that step, looking to the numbers, then look at the speech bubble and the agent, and back to the numbers again. It was a clear cycle of not knowing what to do next (see Fig. 11).

The participant touched the numbers trying to change their value, and for a long time after he did not realize that the green triangles above and below the numbers increased and decreased the value respectively. In addition, the most pressed arrow was the bottom one, probably for their proximity to the 'OK' button. Another issue with the arrows was that some users simply pressed or held their finger down on the arrow waiting to see the value increased automatically when the button was held down. That option was deliberately discarded on the design process, thinking that maybe it was found only in recent technology and thus too advanced for novice elderly users. However, the questionnaire brought the reason for such behaviour: some videos and microwaves counters have the option of keeping the button hold to increase the value automatically and faster, as do many digital alarm clocks. All these differences would have influence in user preferences.

Fig. 5.10 One of the screens of the second iteration of the AGILE interface for the train ticket transaction. In particular, the *Time to Travel* choice.

It could be argued that better than using a website run on a tablet, the test should have run a specific mobile versions of the same website. Clearly this would have increased the performance and suitability of such application on portable devices. However, many retail and transport companies do not have separate applications, and many first time users may not seek to download specific apps even if they are available. Thus, we still considered the comparison fair for the following reasons. In the case of a specific application developed for mobile platform, the differences would be on the suitability of controls and maybe some differences in the number and size of the elements shown. In that hypothetical situation, it would still be far from optimal because the main problems found will remain: there will still be a lack of knowledge on the users of how to use such controls, like the accessibility issues, which are normally unknown for many users, because nobody would have taught the users how to use them, such as scrolling wheels for time and date, or pinch gesture to zoom in and out, etc. In this case, user performance would increase in line with their intuition. Thus, the necessity of assistance, clear explanations and concise messages are essential for the correct use of the interface for first time users, and particularly for those with no technological experience. These problems were overcome as far as possible in the second iteration of the AGILE interface. The virtual agent expressed a polite and clear message in the speech bubble and pointed to the relevant area where interaction occurs. The size of the buttons, look and feel of the interface, and the few options for selection (2 option in most of the cases, 4 options in two cases and only once with 8 options; not counting the calendar where technically the number of options would be around 30 depending of the month), are also part of the approach.

To overcome these issues and generally improved the performance, a third iteration would introduce animation on the virtual agent and its extremities, and on-the-fly quick tutorial for explaining the use of complex controls. In tablet devices, an 'incorrect' tap of the numbers rather than the increment or decrement should generate an advisory message politely suggesting that the arrows can be used to dial up the required number. In addition, an order on the sequence of interface's elements presentation should be introduced. First, the agent would appear and then its speech bubble would appear, and after that, the elements on the interactive area. So, the prominence of the agent and the message with instructions would be increased. Finally, the introduction of the sound would be carefully implemented.

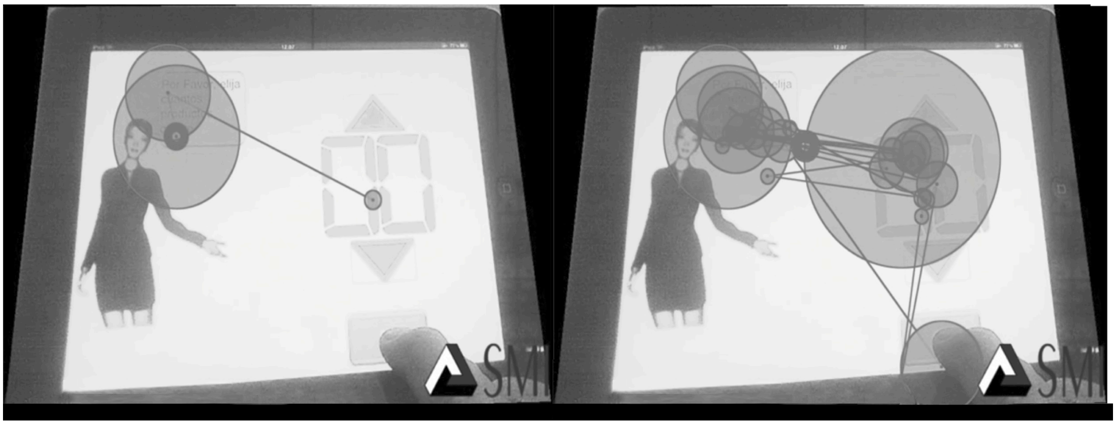

Fig. 5.11 Detail of the AGILE interface for book purchase. In particular, the number of books to be purchased. The line represents the scanpath of the participant (74-years old), this is, the trajectory the participant's gaze draws on the scene recording. The circles represent the fixations of the participant, and the size of such circles means the fixation duration. On the left it can be seen how, from the number of items, the gaze goes to the speech bubble and agent. On the right hand side, the cycle is clearly visible going switching between counter of items and speech bubble, with very few lines directed to the 'OK' button. The participant touched the number, instead of the arrows above and below, trying to increase the number of items. Without a doubt, the lack of information to show the participant how to operate the control is a design error.

5.6 Conclusions and Future Work

In this paper we have described the ordinary model of user that many Graphical User Interface (GUI) designers have in mind, the average user. Particularly, each situation provides an intuitive cataloguing of the conceived average user in its own context. Then we have questioned whether this stereotype truly reflects the wide spectrum of users and whether it is ultimately useful for the design of any interactive system.

Subsequently, a review of the traditional approaches in design was made to explore the variables, in which users with special needs, such as elderly, were based, to ascertain whether they covered the whole spectrum of actual users. Because of the permanent change on the context where the technology is used and the constant evolution of user stereotypes, those commonly accepted procedures were revisited with a target update, to accommodate new trends and user profiles.

Without asserting what sort of the approach is better for HCI interface design ((i) designing for one uniform user group; (ii) designing different interfaces for different user groups; (iii) designing an adaptive interface [2]), the interface adaptation has been done in the design stage. We have placed the user and their needs as an essential component of user interface design. A new interaction style has been described, ideally conceived for users with no IT experience nor time to learn, the AGILE interaction style (see Fig. 12), focused to adapt to the idiosyncrasy of a non-archetypical user, in this case the novice elderly user. This type of user meets some peculiarities, such as no motivation to learn; or absence of memory even in the same session, exacerbated by the lack of didactical approach commonly found in many GUI. We have covered this issue by the use of an effective guidance and assistance system for every step of the interaction process. The assistance has been implemented in a virtual agent, in charge of guiding the user in the current goal achievement, and in lecturing how to perform operations on the interface by simple and effective animations. Physical cues and gestures orient the user attention to relevant areas of the interface to enhance interactivity. The simplicity of the interface layout becomes essential, as well as the effectiveness of the assistance and concise use of the metaphor. Reducing the number of items on any one screen has the benefit of minimizing the risk of change blindness from the observer of the interface (e.g. [50]). Even simultaneously presented items can be difficult to segment and parse appropriately when there are too many items

[53]. By minimizing comparisons and items, decisions and detections have been maximally facilitated. For instance, to ease the touch and vision, big size and clear icons have been selected accompanied by text descriptions (as recommended in [21]).

Fig. 5.12 One of the screens of the second iteration of the AGILE interface for the train ticket transaction. In particular, the *Type of Seat Extra Features* choice.

This work has carried out transnational novice elderly user testing using touch interface on tablet devices, with video camera recording, eye tracking recording where possible, and qualitative questionnaires. The evaluation process has brought helpful findings as the suitability of the AGILE interface for occasional digital transactions, such as buying a train ticket or purchasing a book. A clear validity of the style presented has been successfully evaluated on our target users, the novice elderly. Among the most valuable features demonstrating their suitability, we highlight the simplicity and clarity, guidance and error-minimized that the AGILE interface presented during the whole interaction process. Simplicity in the effortless of decision making exhibited in each step, with a minimum cognitive load attached. Clarity in the display of only indispensable number of elements necessary to accomplish the transaction, with large buttons, legible font and overall concise messages. Guidance in the succinct instructions given by an agent in each step, placed in a wide and visible region inside the interaction area. Error-minimization by restricting the possible options user has in each step, without affecting the effectiveness of the goal accomplishment and therefore satisfaction involved. All these features could be adapted in the design process whether the target user group varies, for instance, maximizing the use of the sound channel for a blind user, or the assistance method to show how-to do a gesture in the case of not knowing how to do it, etc. However, these revisions of the interface should always be part of the design process, carefully tested and iterated. It is the ultimate goal of this style to present a consistent interface among users with no technology experience, lessening unpredicted changes during its use to maximize stability and productivity of the interface.

A third iteration of the interface would be needed to avoid problems on design and effectiveness, with certain elements such as the clock / counter and the increase operation associated. Animations of the virtual agent, quick tutorials of such controls and order of the sequence of elements revealed are to be included in it.

The content of this work is the corner stone of a new approach on interface design. Furthermore, development will explore different types of tasks, widening in variety and complexity to present new challenges for designers, modifying or updating any of the principles exposed here. Finally, testing the interaction paradigm with users with other cognitive limitations, such as dementia or Parkinson's, and finding exemplary interactive elements for their interface is on the agenda of the authors.

Acknowledgments Martinez is grateful for support from the Alison Armstrong Studentship at Abertay University. We are grateful to Sensomotric Instruments (Teltow, Germany) SMI [58] for assistance with the use of eye-tracking equipment (especially to Stefanie Gehrke and Jose Barreiros); also, for extensive training received by Richard Lilley from Tracksys Ltd. (Nottingham, UK). Special thanks to María Ángeles López at the Centro de Salud Nueva Málaga (Málaga, SPAIN) and to Purificación Roldán at the Educación Permanente SEPER (Málaga, SPAIN) for their effective collaboration in the elderly user testing. Besides, thank to Dr Paula Forbes and all the members of the User Centre Group of the University of Dundee (Dundee, UK), who were a profound motivation for the development of this work. This research has been inspired by the European Project FP7 iAGE, in which authors from Abertay University contribute.

References

[1] Americans with Disabilities (1990) Act of 1990 incorporating the changes made by the ADA Amendments Act of 2008. http://www.ada.gov/pubs/adastatute08.pdf. Accessed 1 August 2011

[2] Aykin NM, Aykin T (1991) Individual differences in human-computer interaction. Comp. and Ind. Eng., 20(3): 73–379. doi: http://dx.doi.org/10.1016/0360-8352(91)90009-U

[3] Brusilovsky P (2001) Adaptive hypermedia. User Model User-Adap Inter 11(1):87–110. doi: http://dx.doi.org/10.1023/A:1011143116306

[4] Brusilovsky P, Millán E (2007) User models for adaptive hypermedia and adaptive educational systems. In: Brusilovsky P, Kobsa A, Nejdl W (eds) The Adaptive Web, Methods and Strategies of Web Personalization. LNCS Vol. 4321:3–53. Springer, Heidelberg

[5] Card SK, Moran, TP, Newell A (1983) The psychology of human-computer interaction, CRC

[6] Carroll JM, Thomas JC (1982) Metaphor and the cognitive representation of computing systems. IEEE Trans on Systems, Man and Cybernetics, 12(2):107–116

[7] Chisnell D (2007) Where technology meets green bananas. Interact 14(2):10–11. doi: http://dx.doi.org/10.1145/1229863.1229876

[8] de Jesus Stoll MT, Wickham DP et al (2005) Use of conceptual diagrams to support relationships between launchpads and its wizards, US Patent 6,968,505

[9] Fourney DW, Carter JA (2006) A Standard Method Of Profiling The Accessibility Needs Of Computer Users With Vision And Hearing Impairments. In Hersh MA (ed) Procs of Conf. and Workshop on Assistive Technologies for People with Vision and Hearing Impairments, Technology for Inclusion CVHI Kufstein, Austria

[10] Fowler M and Highsmith J (2001) The AGILE manifesto, Software Development, 9(8): 28–35

[11] Glinert EP and York BW (1992) Computers and people with disabilities. Communications of the ACM, 35(5): 32–35. doi: http://dx.doi.org/10.1145/129875.129876

[12] Goldsmith S (1976) Design for the Disabled. Royal Institute of British Architects

[13] Hanson VL (2010) Influencing technology adoption by older adults. Interacting with Computers, 22(6): 502–509. doi: http://dx.doi.org/10.1016/j.intcom.2010.09.001

[14] Hargittai E (2010) Digital Na(t)ives? Variation in Internet Skills and Uses among Members of the "Net Generation". Sociological Inquiry, 80(1): 92–113. doi: http://dx.doi.org/10.1111/j.1475-682X.2009.00317.x

[15] Hawthorn D (2000) Possible implications of aging for interface designers. Interacting with computers, 12(5):507–528. doi: http://dx.doi.org/10.1016/S0953-5438(99)00021-1

[16] Hewett TT (1986) The role of iterative evaluation in designing systems for usability. In: M D Harrison and A F Monk (eds) Proceedings of the 2nd Conference of the British Computer Society, human computer interaction specialist group on People and computers: designing for usability, Cambridge University Press, New York, USA, 196-214

[17] Hix D, Hartson H (1993) Developing user interfaces: ensuring usability through product and process. John Wiley and Sons, New York, USA

[18] Hutchins EL, Hollan JD, Norman DA (1986) Direct manipulation interfaces. In: Norman DA, Draper SW (eds) User-centered system design:87-124, Erlbaum, Hillsdale, NJ

[19] Hyppönen H (2001) Industry awareness and transfer in Europe and the USA. In: Roe, PRW (ed) Bridging the Gap? Access to telecommunications for all people. Commission of European Communities

[20] IKEA kitchen planning tool http://www.ikea.com/ms/en_US/rooms_ideas/kitchen/download1.html. Accessed: 1 April 2012

[21] ISO 9241-171:2008: Ergonomics of human-system interaction -- Part 171: Guidance on software accessibility. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39080. Accessed: 1 April 2012

[22] ISO 9241-210:2010: Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems. http://www.iso.org/iso/catalogue_detail.htm?csnumber=52075. Accessed: 1 August 2011

[23] Jacko JA, Vitense H (2001) A review and reappraisal of information technologies within a conceptual framework for individuals with disabilities. Universal Access in the information Society 1(1): 56–76

[24] Jette AM (2006) Toward a common language for function, disability, and health. Physical Therapy 86(5): 726–734

[25] John BE, Kieras DE (1996) The GOMS family of user interface analysis techniques: Comparison and contrast. ACM Transactions on Computer-Human Interaction 3(4): 320–351. doi: http://dx.doi.org/10.1145/235833.236054

[26] Kinsell K, He W (2009) An Aging World: 2008. US Census Bureau, Int. Population Reports

[27] Langdon P, Thimbleby H (2010) Inclusion and interaction: Designing interaction for inclusive populations. Interacting with Computers 22(6): 439–448. doi: http://dx.doi.org/10.1016/j.intcom.2010.08.007

[28] Langdon P, Persad U, John Clarkson P (2010) Developing a model of cognitive interaction for analytical inclusive design evaluation. Interacting with Computers 22(6): 510–529. doi: http://dx.doi.org/10.1016/j.intcom.2010.08.008

[29] Ling R (2008) Exclusion or self-isolation?: Texting and the elderly users. The information society, 24(5)

[30] Madden R, Hogan T (1997) The definition of disability in Australia: moving towards national consistency. Canberra: AIHW

[31] Marschollek M et al (2007) ICT-based health information services for elderly people: past experiences, current trends, and future strategies. Informatics for Health and Social Care 32(4): 251–261. doi: http://dx.doi.org/10.1080/14639230701692736

[32] Martinez S, Sloan R, Szymkowiak A, Scott-Brown K 2010 Using Virtual Agents to Cue Observer Attention: Assessment of the impact of agent animation. The Second Int. Conf. on Creative Content Technologies CONTENT 2010: 7-12. November 21-26, Lisbon, Portugal

[33] Martinez, S. et al., 2012. Animated Virtual Agents to Cue User Attention. International Journal On Advances in Intelligent Systems 4(3&4):299–308

[34] Mcdonough FA, Administration GS (1986) Public Law 99-506, Section 508 Electronic Equipment Accessibility for Disabled Workers. Public Law: 219-222

[35] Moran TP (1981) Guest Editor's Introduction: An Applied Psychology of the User. ACM Comput. Surv. 13:1-11. doi: http://dx.doi.org/10.1145/356835.356836

[36] Mori G, Paternò F, Santoro C (2002) CTTE: support for developing and analyzing task models for interactive system design. Software Engineering. IEEE Trans on Soft Eng 28(8): 797–813

[37] Newell A (1993) Interfaces for the ordinary and beyond. IEEE Software 10(5):76–78. doi: http://dx.doi.org/10.1109/52.232406

[38] Newell AF (2006) Older people as a focus for inclusive design. Gerontechnology 4(4):190-199. doi: http://dx.doi.org/10.4017/gt.2006.04.04.003.00

[39] Newell A, Simon HA et al (1972) Human problem solving. Prentice-Hall Englewood Cliffs, NJ

[40] Newell AF (2008) Accessible Computing–Past Trends and Future Suggestions: Commentary on "Computers and People with Disabilities." ACM Trans on Access Comput, 1(2): Article 9

[41] Nicolle C, Abascal J (2001) Inclusive design guidelines for HCI. In: Procs of INCLUDE 2001, 18-20 April, London

[42] Nicolle C, Peters B (1999) Elderly and Disabled Travelers: Intelligent Transp. Systems Designed for the 3rd Millennium. Transp Hum Factors 1(2): 121–134. doi: http://dx.doi.org/10.1207/sthf0102_1

[43] Nielsen J (1993) Iterative user-interface design. Comp 26(11): 32–41. doi: http://dx.doi.org/10.1109/2.241424

[44] Nielsen J (1993) Usability engineering. Academic Press, San Diego

[45] Nielsen J (1995) Usability engineering. Morgan Kaufmann, Burlington, Massachusetts

[46] Pieper M, Morasch H, Piéla G (2003) Bridging the educational divide. Univers Access in the Inf Soc 2(3): 243–254. doi: http://dx.doi.org/10.1007/s10209-003-0061-y

[47] Porrero IP (1998) Improving the quality of life for the European citizen: technology for inclusive design and equality. IOS Press, Amsterdam, Netherlands

[48] Potosnak K et al (1986) Classifying users: a hard look at some controversial issues. ACM SIGCHI Bulletin, 17(4): 84–88. doi: http://dx.doi.org/10.1145/22339.22353

[49] Pullin G, Newell A (2007) Focussing on extra-ordinary users. In: Procs of the 4th Int Conf on Univers Access in Hum Comp Interact: coping with diversity:253–262

[50] Rensink RA et al (2010) To see or not to see: the need for attention to perceive changes in scenes. Soc 8(5): 368-373

[51] Rogers Y, Sharp H, Preece J (2011) Interaction design: Beyond human-computer interaction. Wiley, New Jersey

[52] Savidis A, Stephanidis C (2004) Unified user interface design: designing universally accessible interactions. Interact. with Comp., 16(2): 243-270. http://linkinghub.elsevier.com/retrieve/pii/S0953543804000025 Accessed: 18 November 2011

[53] Scott-Brown KC, Baker MR, Orbach HS (2000) Comparison Blindness. Vis Cogn, 7(1-3): 253-267

[54] Shneiderman B (1983) Direct manipulation: A step beyond programming languages. IEEE Comp 16(8): 57-69. doi: http://dx.doi.org/10.1109/MC.1983.1654471

[55] Shneiderman B, Plaisant C (2005) Designing the User Interface: Strategies for effective Human-Computer Interaction, 4th edition. Addison-Wesley, Boston

[56] Sloan RJS (2011) Emotional avatars: choreographing emotional facial expression animation. Dissertation, University of Abertay

[57] Sloan RJS, Martinez S, Scott-Brown K (2012) Using the principles of animation to predict allocation of attention. Predicting Perceptions 2012, Edinburgh, UK, 17-19 April 2012

[58] SensoMotric Instruments (SMI): http://www.smivision.com/ (Accessed: 5 September 2012)

[59] SensoMotric Instruments (SMI) glasses: http://eyetracking-glasses.com/ (Accessed: 5 September 2012)

[60] Stevens JC (1992) Aging and spatial acuity of touch. J of Gerontology 47(1): 35–40

[61] Stevens JC et al (1998) A multimodal assessment of sensory thresholds in aging. The J of Gerontol. Series B: Psychological Sciences and Social Sciences 53(4): 263

[62] Swiffin AL et al (1985) Pal: An effort efficient portable communication aid and keyboard emulator. In Procs of the 8th Annual Conf. on Rehabil Technol:197–199

[63] United States Department of Education Questions & Answers Title IV--Rehabilitation Act Amendments Of 1998 section 508: Electronic And Information Technology. http://www.justice.gov/crt/508/archive/deptofed.pdf (Accessed: 1 August 2011)

[64] Van Dam A (1997) Post-WIMP user interfaces. Commun of the ACM 40(2): 63–67. doi: http://dx.doi.org/10.1145/253671.253708

[65] Whiteside J, Bennett J, Holzblatt K (1988) Usability engineering: Our experience and evolution. In M. Helander (ed) Handbook of Human-Computer Interaction: 791-817. North Holland, Amsterdam

[66] WHO (2001) ICF Int. Classification of Functioning, Disability and Health, World Health Organization

[67] Zajicek M (2006) Aspects of HCI research for older people. Univers Access in the Inf Soc 5(3): 279–286. doi: http://dx.doi.org/10.1007/s10209-006-0046-8

[68] Ziegler J (2008) Interactive techniques. ACM Comp Surveys, 28(1):185-187