MIDAS

Multimodal Interfaces for Disabled and Ageing Society

Project number: ITEA 2 - 07008

ITEA Roadmap application domains:
Major: Home
Minor: Nomadic

ITEA Roadmap technology categories:
Major: Human-Computer Interface
Minor: Data and Content Representation

WP N°: 1
Deliverable D1.3:
Usability requirements

Due date of deliverable: 28/02/09

Start date of project: 01/10/2008 Duration: 36 Months

Project coordinator name: Laure Chotard, Orange Labs

Organisation name of lead contractor for this deliverable: MOVIQUITY

Editor: Alberto Martinez **Revision:**

TABLE OF CONTENTS

1. Introduction

1.1. Objectives

This document is intended to provide recommendations about MIDAS interfaces usability. These interfaces must always keep in mind the social group which will use them, in order to adapt to its needs, capabilities and disabilities.

To facilitate it, this social group will be characterized, showing common or very usual characteristic for its members.

1.2. Change History

Date	Author	Update description	Doc. Version
26-02-2009	CITIC	Table of Content definition	1.0
28-04-2009	CITIC	First Draft compilation	1.1
25-06-2009	CITIC	Changes after partners review	Final

2. Identification and characterization of the MIDAS end-user

2.1. The elderly as a user group

2.1.1.1. The elderly in a social context

Only a few years ago, elderly care was under the responsibility of the old people's descendants. Old people's homes and home medical care were concepts not widely introduced in the great majority of the cases. The most common family model included the husband who contributed with a salary to family economy and the wife who worked at home. For this reason, the elder people care rested on female members' shoulders.

Nowadays, this family model has changed. Currently the most common situation is that both of the members of the marriage work, so the attention demanded to carry out elder care cannot be satisfied. This is why different alternatives to usual model were needed. A retirement home for elderly has been the most extended solution; an alternative to this solution is the concept of 'active ageing'. A formal definition of this concept would be: "Active ageing policies are those that aim to enable people, as they grow older, to lead independent lives (socially and economically) and to make a full range of choices in the way they shape their lives in all its life spheres".

This definition implies:

- Old people continue living in their own environment.
- Policies mentioned in this definition demand some kind of external support.

As shown in Figure 1, the number of people over sixty-five years old has increased during last century and this number is expected to grow up.

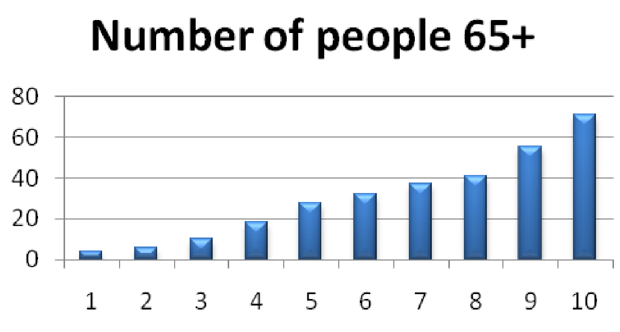

Figure 1.Number of people 65+

2.1.1.2. The elderly in a care context

The current situation of Information and Communication Technologies (ICT) makes possible the use of different tools to support the active ageing. The availability of broadband connections allows a wide set of possibilities to use different technologies. Restriction as having an ADSL line at the elder's home is not a serious issue, neither cost problems nor coverage difficulties.

As shown in Figure 2, the use of Internet is much extended, and is growing especially in the elderly segment.

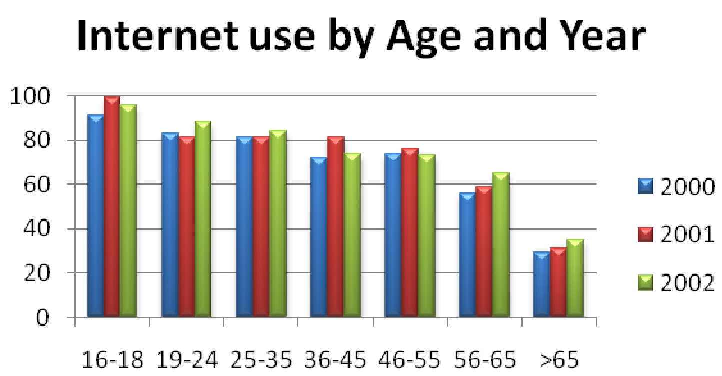

Figure 2. Internet use by Age and Year

Another fact that supports previous asseveration is the percentage of commercial trades made by Internet, which is growing every year; Figure 3 shows how this percentage is increasing.

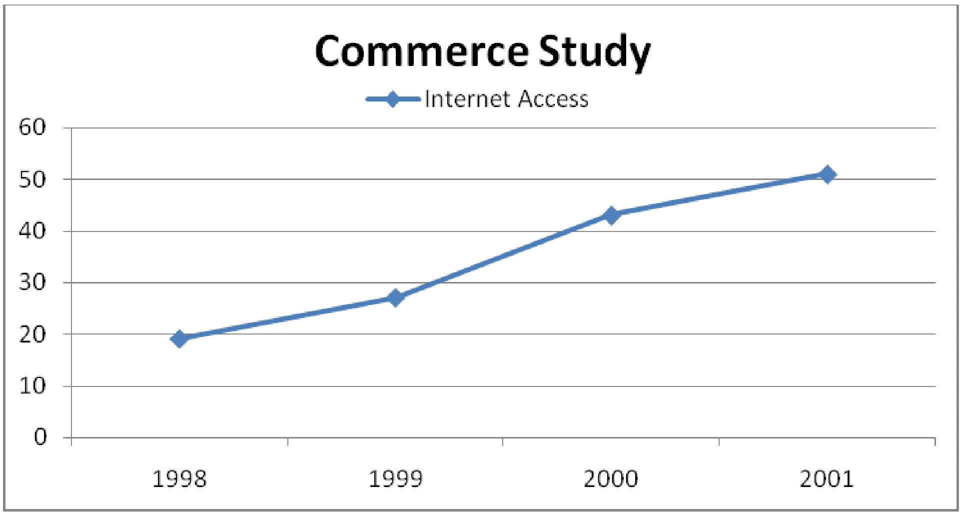

Figure 3. Percentage of trades made by Internet.

2.2. Elderly Disabilities

2.2.1.1. The elderly and their disabilities

The elders' physical and intellectual deterioration must be considered during the specification and design of any interface oriented to this social group. Except for accidents, health worsening develops slowly, and cannot always be noticed. These deteriorations can affect user perception and communication; therefore they must be taken into account so that interfaces usability feature is achieved.

This chapter describes disabilities fulfilling two conditions:

- Affect to a significant percentage of users.
- Influence or restrict sensorial capabilities

2.2.1.2. Memory loss

Technology usage does not only depend on memory, although it is one of the more important problems to analyze, when services and devices for elderly people are designed. The elder user must not only remember procedures involved in operating a device, but also could be required to initiate use at specific times, to manipulate incoming information, etc. Next sections show specific types of memory in order to know how these ones affect in elderly people.

Working memory declines

Working memory tasks require temporary storage and manipulation of information to carry out actions such as mental calculation, process, etc. Telephones with voice menu systems are an example of how this kind of memory can impact on the elderly's interaction with technology. Navigation through this type of menus, demands working memory processes, and if the structure of the menu system is very broad, the elderly could forget the content of the options because the working memory capacity is exceeded. Moreover, working memory decline can also reduce processing speed. Solutions for this issue could include:

- Reduce the number of options at each level of menu hierarchy.
- Place most commonly used options as first items.
- Reduce speed when showing different options.

Semantic memory remains intact

This type of memory refers to the storage of information that is accumulated during a lifetime. Remembering the meaning of a word, knowing the location of the doctor and recognizing symbols are examples of semantic memory, because this information is acquired through experience.

When new information is encountered, it is often interpreted in the context of previously acquired knowledge. Thus, design strategies which give importance to existing knowledge may result in more usable technologies, because operating devices are more intuitive, due to the consistency with prior knowledge.

Prospective memory deficits vary by task

Both previously discussed types of memory are forms of retrospective memory (memory for past events). Prospective memory refers to remembering things which have to be done in the future. An example would be to remember an appointment with the doctor. Event-based and time-based Prospective memory tasks vary depending on whether they are event-based or time-based tasks.

On the one hand an event-based task, like something in the environment, reminds a prospective task performance; an example would be an envelope on the table as a reminder to mail a letter. Environmental cues act in this context as mnemonic rules that increase the likelihood to remember the prospective task. On the other hand, time-based tasks lack in this environmental support, because this type of tasks has to be self-initiated, and requires to perform an action at a certain time, of after a certain period of time has elapsed. An example for this issue could be remembering to make a phone call at certain time. Elderly people reaction time is usually greater in time-based tasks than in event-time based tasks. Obviously, second type of tasks must be favored.

2.2.1.3. Attention loss

Attention encompasses a broad array of processes. Selective attention is the cognitive mechanism used to filter out irrelevant information, allowing relevant information to be processed in memory. Reading a book in a noisy cafe illustrates it: distractions have to be avoided by inhibiting the irrelevant information in the rest of the café, only processing the book's information. Due to working memory capabilities decline in the elderly, the likelihood of attention distractions increases. In any case, this deficit in selective attention may be attenuated if user has experience with target information.

Driving a car is a task highly dependent on selective attention; any distraction which prevents a driver from attending to important cues could be very dangerous. Thus, elimination of distraction elements in the design on internal environment cars would be a solution to improve driving performance of the elderly. Attention loss can also be caused by a cerebral illness like Alzheimer.

2.2.1.4. *Hearing loss*

In comparison to previous disabilities, the lack of hearing is an objective deterioration, which could be verifiable and measurable.

Auditory acuity decreases with age, and despite this fact, the elderly are not conscious of it. Moreover, only a few of them recognize this problem, and prefer to impute their auditory difficulties to foreign reasons.

Nowadays, this problem is not considered as important as vision ones. Nevertheless, some studies reveal people with hearing problems are unhappier than people with vision problems.

2.2.1.5. *Vision loss*

Diminishing of visual acuity is considered a logical result of age. This belief is not too far from reality. Some studies show that the percentage of people of sixty-five years old and over with visual defects and needing spectacles is over 90%. Moreover, it is very common that the elderly who need spectacles in order to correct vision problems don't always use them.

2.2.1.6. *Physical problems*

There is a well known set of diseases that affect to senior citizens in a higher ratio and restrict their mobility. These illnesses can be purely physical or can have a cerebral origin. In both cases, the result is that user mobility is affected. Among these illnesses there would be:

- Physical: myopathy, rheumatism, arthritis.
- Cerebral: apoplexy, paraplegia, cerebral palsy, Parkinson.

2.2.1.7. *Different profiles of elderly according to their disabilities*

According to main elderly disabilities list showed in previous chapter, the typical elderly profiles would be the elderly with:

- Mental processing difficulties: the elderly mental processing speed declines. This fact implies:
  - Interfaces with users must be very easy to use
  - User response time is high
- Cognitive problems: Elder's understanding to process information is lower
- Hearing troubles: This sense declines its accuracy along the years, especially in certain frequencies.
- Eyesight problems: Illness like astigmatism, myopia, farsightedness, eyestrain or cataract is much more frequent among the elderly.

- Physical problems: Illnesses that cause mobility restrictions are much more frequent in this social group.

2.3. The elderly and independent living

2.3.1.1. Elderly living independently

This is the main goal to be achieved for this social group: To be able to live a full and independent life, taking its own decisions. The concept 'active ageing' mentioned in chapter 2.1.1.1 is very important; in its definition, the key concepts are:

- Independent life
- Choice ability

Any effort in MIDAS project must be aimed for being a tool that improves the elderly's life and helps them to get an active ageing.

According to AAGIR grid (**A**utonomy, **G**erontology **G**roup **I**so **R**esources), there are six levels of dependency, where value one represents the most dependent level and six represents the least dependent one.

The dependency assessment is done according to:

A. Can completely perform it
B. Can partially perform it, irregularly, incorrectly
C. Cannot perform it or refuses it

The criteria taken into account are the following: consistency, orientation, self-washing, dressing-up, eating, eliminating, transfers, indoor movement, outdoor movement, communication at distance.

2.3.1.2. Threats to independent living

Threats to user independent living depend on its disability. Any task that exceeds user capability would generate a potential risk. Some examples can be seen below in order to illustrate these threats:

- Memory loss: Any task that demands to remember a large set of data is a serious threat for an elder.
- Attention loss: An output device, showing not only essential data would mean that the user attention does not concentrate on main information.
- Hearing loss: Quickly spoken instructions or with a low volume, may lead user not to understand them.

- Vision loss: A message with a small size font would be difficult to read for a user with eyesight troubles.

2.3.1.3. Consequent requirements for independent living

Interfaces design must fulfill a set of conditions to avoid threats expressed in previous chapter, specifically the following requirements should be achieved:

- Simple interfaces, very easy to use and understand.
- Interfaces must show only essential information.
- Audio information must be adapted to users with hearing problems.
- Visual messages may be understood by users with eyesight problems.

3. Review of Requirements in the home scenario

3.1. Usability in the home scenario

Home environment is the closest space in daily life. Therefore, solutions installed to aid home life must be specifically studied. Moreover, people with limited access to other environments, and people as they get older, gradually reduce their living space. Thus, the immediate environment which is their home becomes increasingly important.

In general, technology support at home should be non-invasive and helpful for an appropriate way of life, even having a personal "style", so that people can feel comfortable with the new devices, living on a similar way as they used to before having them.

The specific purpose of home environment would be to provide the welfare-related needs linked to survival and health. The home environment can also support other purposes such as employment, educational, recreational, health care, social participation. Therefore, it would be necessary, to keep this survival purpose, to try to improve aspects related to welfare, safety and self-care, allowing performing basic activities of daily living as well.

In this way, technological developments are improving people's capabilities in domestic environment, for example, ever more people can do things at home, thanks precisely to the information and communication systems (telemedicine, social participation, e-learning…). This is a great chance for many people with mobility problems, to stay in contact with the outside world and accessing to services through Internet, activities which otherwise would be very difficult. For this reason it is very important to look for new devices which can be adapted to the domestic environment, especially for those people with disabilities.

3.1.1.1. Cognitive usability

It is a well-known fact that everybody has ever been upset with some devices because they did not work in the expected way, so it is possible to notice that interacting with a device is not so obvious for common people, even if they do not have any kind of disability. Success stories in technology concern objects being very intuitive to use, almost self-explainable. For people suffering from cognitive disabilities, interacting with a device or a machine is even more complex. People forget they do not understand the way that things work. Another difficulty is to ensure tasks repeatability: an action triggered by the operator should always produce the same results. Man machine interface should be adapted to user profile since nobody behaves in the same way. It depends on the age, gender, user profiles and context amongst other.

The usability functionalities associated with cognitive terms would be focused in aid systems which could receive feedback from the user activity, and activate support and assistance systems if required (for example, if someone has not taken medication; a message would be sent to its family or to doctor supervisor directly from the system). Furthermore, they can act either as warning or as reminder systems. It would be also necessary to make the interacting with appliances easier using natural language, asking for orders confirmation, etc.

In short, it is possible to define the next requirements:

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.1.1	Tasks Repeatability: The same action should return the same response in order not to confuse the user with cognitive disabilities.	MANDATORY
3.1.2	The system should be adapted to the user's profile because the variety of different profiles, which have different needs.	MANDATORY
3.1.3	Application should try to be self-explicable and very intuitive	MANDATORY
3.1.4	An aid system monitored from outside and easy to use by the user, in order to control the user activity and warning him whenever he has to have medication or an important appointment	MANDATORY

3.1.1.2. Physical usability

The physical scene is a space that marks indoor as well as outdoor areas: terraces, courtyards and gardens. Home shall have sharing space suitable for social interaction: living room, dining room, terrace, study, kitchen, hall, as well as spaces suitable for the privacy and intimacy: bathroom, bedroom… In any case physical usability requirements of the user, imply the need to adapt the environment, and of course, to insert additional help systems, according to potential physical disabilities of the user. This means that people with moving, vision, or hearing (etc.) problems, should be able to use a help system. MIDAS focuses on multimodal interfaces aiming to develop a user friendly interaction for such special users. Requirements in this section are shown below.

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.1	Adapt the system to each environment	MANDATORY
3.2.2	A system easy to use by different user profiles: voice recognition, touching it, etc.	MANDATORY

3.1.1.3. Emotional usability

It can be stated that emotional usability requires fulfilling both previous two usability requirements fields (cognitive and physical). A user able to use the system both in cognitive and physical terms might not find it useful and/or pleasant. Every user of a product tries to cover, in this order, these three levels of satisfaction:

- Level 1. Functionality. The product achieves a finality, it solves a problem
- Level 2. Usability. The product is easy to use.
- Level 3. Pleasure. The product provides not only functional benefits, but also emotional benefits.

This point tries to cover this third level, in which the end user is completely satisfied with the use of a product.

To get more information see the Kansei Engineering.

3.2. Accessibility in the home scenario (7 universal principles for design)

This section aims to specify some specific usability requirements in home scenario, focusing mainly on seven principles for the design, which will be explained below.

3.2.1.1. Comparable use

The design should be functional and possible to sell to persons with different kind of capabilities. One of the ideas here would be to reach the acceptability of the new systems from the already accepted machine which everybody uses in its daily environment like TV sets, washing machine, etc., because these kinds of devices are used by the great majority of the people, avoiding in this way segregation or stigmatization problems. Another important matter would be to look for cooperation with end users' representatives in different countries in order to get the main requirements focusing on users' needs.

On the one hand, interfaces should provide inputs and outputs of information to people with functional diversity. They should be also compatible with assistive technologies, allowing easy connection as well. The system must provide at least two alternative input and output media. The input can be done through voice, touch, or a combination of any of these methods, the output can be made visual, auditory, tactile, or a combination of them in order to avoid discrimination about some user's profiles. On the other hand the appearance of the applications should be customizable, promoting the understanding of the information.

Some requirements in this case are defined below:

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.1.1	The system should allow either voice navigation or interaction with a voice navigation software	MANDATORY
3.2.1.2	The system should allow a text to voice converter, making easier navigation for people with vision problems	MANDATORY
3.2.1.3	The system must have an additional support to be able to distinguish among options when the information is based on color	MANDATORY
3.2.1.4	The system should have the possibility of including tactile feedback (textures, vibration) to the user	MANDATORY
3.2.1.5	Auditory signals should present either visual or tactile alternative	MANDATORY

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.1.6	The system should be able to connect to implants or devices such as a hearing aid	NICE TO HAVE
3.2.1.7	If a speech output system is implemented, the rhythm should be slow enough to allow understanding for people with hearing or cognitive problems	MANDATORY
3.2.1.8	The time showing temporal information should be enough for allowing its reading by people with vision or cognitive problems	MANDATORY
3.2.1.9	The diverse properties of the interface elements should be adapted for its usage by assistance technologies (e.g. text-to-speech converters)	MANDATORY
3.2.1.10	The system as-a-whole should respect the functionality of external or complementary assistance technologies	MANDATORY

3.2.1.2. Flexible use

In this case, the system must allow the user to customize the rate at which information is presented, including the ability to pause or stop the presentation if necessary, allowing in this way different rhythms of showing information. It should be advisable to incorporate accelerators (hidden for a novice user) so that the expert users can speed up their interaction with the interfaces, satisfying both of users' profiles. Some of requirements are shown below:

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.2.1	The system should allow both expert and novice profile using ways, and show different levels in message errors	MANDATORY
3.2.2.2	The system should allow both mouse and keyboards shortcuts interaction	MANDATORY
3.2.2.3	Accelerators use for expert users	NICE TO HAVE
3.2.2.4	Customizable rate of information controlled by the user	MANDATORY
3.2.2.5	The system should allow the usage of different sizes, colors, and types of text characters	NICE TO HAVE
3.2.2.6	There should be a control that allows pausing or stopping the audio, as well as adjust the volume	NICE TO HAVE
3.2.2.7	The system should have the possibility to increase the size of the text	MANDATORY

3.2.1.3. *Simple and intuitive*

The use of the design should be easy, attending user while taking into account its experience, knowledge, linguistics levels and ability for concentration. The dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information, diminishing their relative visibility. The system must provide support, which extends, supplements, or enhances the user's skills, prior knowledge and experience, without substituting them. Although it is better if the system can be used without documentation, it is necessary to provide help and documentation. Any information should be easy to search, focused on the user's task, list concrete steps to be done, and not be overly long. In this point it is very important to have a good cooperation and exchange information with end users, occupational therapists and physicians, in order to know their needs and what they consider simple and intuitive, because simple by developers and engineers could not mean simple by end users.Some requirements for this principle are shown below:

Nº	**Requirement Description**	**LEVEL OF IMPORTANCE**
3.2.3.1	The label for each field should be short and very representative of the meaning of that field	MANDATORY
3.2.3.2	The essential information for taking decision should always be shown on the screen	MANDATORY
3.2.3.3	The system should contemplate when the user is in a specific state, and notify and inform him about his options	MANDATORY
3.2.3.4	The users should be the ones who start the processes rather than the ones who answer to them.	MANDATORY
3.2.3.5	The important controls or keys must be bigger, or highlighted	MANDATORY
3.2.3.6	The online instructions should be easy to distinguish, and follow the users' actions	MANDATORY
3.2.3.7	The "Help" function must be visible by means of a key or a special menu	MANDATORY
3.2.3.8	The user must be able to easily shift between the program and the help dialogs	MANDATORY
3.2.3.9	The objects in a screen should have an elevated contrast, or there should be a way of easily increasing contrast	MANDATORY
3.2.3.10	The system should have a mechanism that allows to hide the decorative material in order not to disturb some users	MANDATORY

3.2.1.4. *Perceptive information*

The design communicates the necessary information in an effective manner to the user, attending the environmental conditions as well as the sensorial capacities of the user. The system should always keep users informed about what is happening, through appropriate feedback within a reasonable time. Furthermore, interfaces should speak the language of users, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Therefore they should follow the real-world conventions, making information appear in a logical and natural manner. Vocal synthesis should complement visual information to report to the end user, taking into account the possibility to set it as an option, so that the user can put it off, if he feels upset with a voice repeating things. User interactions with the system should improve the quality of performance of the task. The user should be treated with respect in a polite language. The design must be aesthetically pleasing, with both artistic and functional value, avoiding an excess of details.

Nº	**Requirement Description**	**LEVEL OF IMPORTANCE**
3.2.4.1	Each part of the interface should begin with a title or heading that describes the content of the screen	MANDATORY
3.2.4.2	There should be some kind of feedback for each action or operation	MANDATORY
3.2.4.3	Response times should be appropriated for each task	MANDATORY
3.2.4.4	The system response times should be appropriated to the user’s cognitive process	MANDATORY
3.2.4.5	The terminology used in the menus should be consistent with the user’s domain knowledge in relation to the task	MANDATORY
3.2.4.6	The icons should be specific and familiar to the user	MANDATORY
3.2.4.7	The options in the menus should be put in the most logic order, taking into the account the task, user, and item names	NICE TO HAVE
3.2.4.8	Notifications about keyboard, (e.g. “Push INTRO”), must be consistent with the actual name of the keys	MANDATORY
3.2.4.9	When an input in screen is needed, the terminology used for describing the task should be familiar to the user	MANDATORY
3.2.4.10	When the screen shows questions to be asked, the language of these questions must be simple	MANDATORY
3.2.4.11	The command language used must use the users’ slang, rather than technology-specific terms	MANDATORY
3.2.4.12	The system must be designed in such a way that keys with similar name do not perform opposed actions and/or eventually dangerous	MANDATORY

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.4.13	The system should use color in a discrete way. If color coding is used, the user must be able to disable it	MANDATORY
3.2.4.14	Vocal and visual information should exist, having vocal information as a selectable option	MANDATORY

3.2.1.5. Tolerance for mistakes

The design must minimize the risks and the adverse consequences of accidental or involuntary actions. In this issue, it would be an important requirement to prevent the occurrence of the mistakes by developing a careful system's design, taking into account possible sensitive errors process so that the users misuse can be foreseen before the mistake is done. Furthermore if errors appear, then it would be very important that error messages are expressed in plain language (no codes) in order to help user to recognize these errors instead of frightening them with strange codes, which they are not able to understand.

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.5.1	Sounds should be used to notify errors	MANDATORY
3.2.5.2	Message errors should allow the user to have control of the system	MANDATORY
3.2.5.3	Message errors must be expressed in a clear language, and must not lead to misunderstanding	MANDATORY
3.2.5.4	Message errors should communicate the severity of the error	NICE TO HAVE
3.2.5.5	Data entries should not be case sensitive and should clearly state which kind of data do they accept	MANDATORY
3.2.5.6	The system should be able to foresee if a user is leading to a possible error and then prevent him from it	MANDATORY
3.2.5.7	The function keys that potentially cause more drastic results should be apart from the most used ones	MANDATORY
3.2.5.8	Data fields and dialog boxes should be fulfilled with default values	NICE TO HAVE

3.2.1.6. Physical use

The design must be used efficiently, comfortably and with a minimum effort, enabling an efficient and safe use for people with disabilities. Moreover, the screens on which information is displayed should allow its use for people with vision problems, looking for a good colors combination, and avoiding reflections and shine problems. The controls and keyboards used in the devices must be operated by people with functional diversity without this implying a decline in the functions of the device.. The list of requirements for this point would be shown below:

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.6.1	Required strength to press the controls should be reduced	MANDATORY
3.2.6.2	Controls and screens must be easy to access and see from the point of view of someone in a wheelchair	MANDATORY
3.2.6.3	Color combinations should be chosen in order to maximize the visualization for people with vision problems.	MANDATORY
3.2.6.5	The surface should avoid reflections and shines.	MANDATORY
3.2.6.6	The usage of effort required for inputs should be minimized (i.e. To avoid the need for using keyboard and mouse at the same time, simplify the answers instead of the questions while using forms)	MANDATORY

3.2.1.7. Size and space

It is important to consider the right size and spaces in order to avoid either accessibility or mobility problems. Small devices should be designed, so that they can be moved in different places, but enough big to be read by the user as the TV screen case. Some requirements for the seventh principle:

Nº	Requirement Description	LEVEL OF IMPORTANCE
3.2.7.1	Conditions surrounding the devices must be adequate to its usage (i.e. absence of obstacles, right illumination,)	MANDATORY
3.2.7.2	The devices must have different textures in order to avoid sliding as well as allow users with vision problems to identify parts of the product.	MANDATORY
3.2.7.3	The interface should be susceptible to be used in different luminal environments.	MANDATORY

3.3. Multimodal interfaces for elderly in the home scenario

Multimodal interfaces provide the user with multiple modes of interacting with a computer system which offers a flexibility of interaction that goes beyond the conventional keyboard, mouse and screen interaction. For example, a multimodal interface can combine speech and gesture input, such as the well-known MIT Media Lab demonstration called "Put That There" of Bolt, or combine visual, auditory and haptic feedbacks such as driver assistance systems (DAS). Although multimodal interfaces have a high potential for innovation and usability, the current understanding about how to design, build, and evaluate multimodal user interfaces is still primitive. Some general recommendations can be found in the literature such as those proposed by Deatherage[1] concerning the choice between audio and visual presentation of information (Table 1) or the guidelines of the

ETSI Technical Committee Human Factors funded by the European Commission [2], summarizing the pros and cons of the different sensory channels (
Table **2**).

Use the audio modality if:	**Use the visual modality if:**
1. The message is simple	1. The message is complex
2. The message is short	2. The message is long
3. The message will not be referred to later	3. The message will be referred to later
4. The message deals with events in time	4. The message deals with location in space
5. The message calls for immediate action	5. The message does not call for immediate action
6. The visual system of the person is overburdened	6. The auditory system of the person is overburdened
7. The receiving location is too bright (sunlight, outdoor, etc.) or dark-adaptation integrity is necessary	7. The receiving location is too noisy
8. The user's tasks require him/her to move about continually	8. The user's tasks allows him/her to remain in one position

Table 1: General recommendations for the selection of audio versus visual modality (Deatherage, 1972)

Characteristic of the information	**Vision**	**Audition**	**Haptics**
the information is time related (e.g. information that represents duration, interval, synchronization, or rhythm)	0	++	+
the information is spatial (e.g. information that represents size or distance, e.g. the block on the scrollbar: the location and size provide information on the position in the document and the size of the document)	++	0	0
2D localization (the absolute and relative location in one or two dimensions, e.g. locating the trashcan on a desktop)	++	+	+
3D localization (absolute and relative location in three dimensions)	0	+	+
the information has no world equivalent (Including abstract or coded information, e.g. a cancel button or a hyperlink but, but also engine rpm)	++	++	0

Characteristic of the information	Vision	Audition	Haptics
the information is private (information is intended to be perceived by a specific user or set of users only)	0	-	++
the information is outside the primary area of interest or outside the area of spatial attention	-	++	+
the information requires an optimized reaction time (under optimal perception)	++	+	0
warning/alert (combination of perception, understanding and action)	-	+	++
the information represents changes over time (most common case is the representation of a processes, e.g. downloading)	++	+	+/?
cultural generality (is there a general meaning of the symbol across cultures)	-	+	+/?
Memorability (i.e. the ease of recognition and identification of a former perceived symbol later in time)	+	++	-/?
the information represents a real world physical object	++	-	0
the information should be persistence (i.e. the information is available after initial presentation)	++	--	++
the information concerns relative quantitative parameters (granularity of information on for example files sorted on size)	+	++	+
the information concerns absolute quantitative parameters	++	-	--
ambient processing (information must be conveyed in the periphery and processed in the background)	--	+	-
Large number of items in sensory or working memory (e.g. extended menus, or menu structure)	+	0	

Table 2: Match between the characteristics of the information and the sensory channel, ETSI EG 202 048

As illustrated by Nigay and Coutaz [3], the usability of multimodal interfaces can be characterized in terms of the relations they provide between the different modalities of interaction both for input (from the user to the system) and output (from the system to the user) using the CARE (Complementarily, Assignment, Redundancy and Equivalence) properties:

- Complementarity: Two modalities are complementary for a set of tasks if all these tasks cannot be performed using only one of them, i.e. both of them must be used to perform a task.
- Assignment: A modality is assigned to a set of tasks if all these tasks can only be performed using this modality, i.e. no other modality can be used for all these tasks. In contrast to "equivalence", "assignment" expresses the absence of choice for end-users.
- Redundancy: Two modalities are redundant for a set of tasks if they are equivalent and if both of them are used, either sequentially or simultaneously, to perform all these tasks. For example, if all user interface feedbacks, the audio and visual modalities are equivalent.
- Equivalence: Two modalities are equivalent for a set of tasks if all these tasks can be performed using either one of these modalities. Equivalence allows end-users to choose between multiple modalities of interaction to perform a given task. For example, if the user can enter data using either a keyboard or natural langue through speech recognition, keyboard input and speech input are equivalent for data entry.

As explained in chapter 2 "Identification and characterization of the Midas end-users", elderly people do not constitute a homogeneous group and show a wide diversity as regards to social context, physical status or disabilities. Based on his/her context (background, tasks, computer knowledge, abilities and disabilities, etc.), each Midas end-user may have personal preferences or specific needs on how he/she will interact with the system. For example, a given user may not want or be afraid to speak to a computer whereas a visually impaired user may prefer to use the voice modality to interact. Thus, the multimodal interfaces in the home scenario will need to be able to adapt themselves to each individual user according to his/her needs, abilities and preferences. To achieve this objective, it will be proposed the following recommendations:

- User inputs:
  - Complementarity should only be privileged in conjunction with equivalence to allow end-users to use different modalities to perform a task, i.e. use a modality for some aspects of the task and other modalities for other aspects.
  - Equivalence should be privileged to enhance flexibility of interaction: each user should be able to choose the modality he/she prefers.
  - Redundancy should be avoided if possible or strictly limited to non-reversal actions.
  - Assignment should be avoided if possible because it can lead to restrictive features not usable by everyone. However, if the end-user has a strong preference for one particular input modality, a posteriori assignment based on interface configuration is acceptable.

- System outputs:
  - Redundancy should be privileged to reinforce feedbacks and increase robustness by reducing misinterpretations of system behaviors. However, the use of multiple output modalities, especially if they are intrusive such as audio, may generate cognitive overloads.

- Complementarily should be privileged if end-user can perceive different modalities. Unlike redundancy, complementarily can leverage the advantages of each modality while minimizing overlap between information conveyed by each modality.
- Equivalence should be privileged to enhance flexibility of interaction: each user should be able to choose the modality he/she prefers.
- Assignment should be avoided if possible or strictly limited to end-users with highly reduced eyesight or hearing

4. Review of Requirements in the drive scenario

4.1. Usability in the drive scenario

Car controls have basically remained the same for 100 years--you have a steering wheel, accelerator pedal, brake pedal, and some type of transmission control. Car designers haven't had to deviate from that same basic setup, so maybe it's understandable that interface designs for car systems often lack basic usability.

As the Web grew in the 1990s, a lot of thought was put into usability issues. Jakob Nielson influenced Web builders with his “basic principles of usability” for Web design. They are:

– Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
– Efficiency: Once users have learned the design, how quickly can they perform tasks?
– Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
– Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
– Satisfaction: How pleasant is it to use the design?

These principles can also be applied to car interfaces, and they become much more important in an automotive venue, as bad interfaces can lead to accidents. The car interfaces comprise the hardware and software elements and it’s especially important for some disabilities related to elderly people or not.

4.1.1.1. Cognitive usability

Cognitive Science may be focused on distinct types of activities or situations, like language processing, abstract thinking, learning, etc. An important industrial application is Cognitive Ergonomics, focused on the aspects of human mental resources and procedures during the interaction with products, normally machines and technologically complex systems, as is the case of in-vehicle interfaces.

Driving is a task in which the physical demand is relatively low, but is mentally stressing, since there may be great quantities of information to perceive and process in small periods of time, and small errors can provoke tragic accidents. Therefore, Cognitive Ergonomics play an important role in the design of driver-oriented interfaces.

Mental activities during driving may be addressed to two kinds of tasks:

- The primary task of controlling the vehicle dynamics, adapting speed and direction to road events (other vehicles, pedestrians, intersections...), traffic indications (lights, speed limits and other signals), the planned route, etc.
- Secondary tasks, like conversation with other passengers, to control infotainment and comfort systems (radio, telephone, GPS, HVAC), and other activities unrelated to the control of the vehicle.

Road safety depends chiefly on the good performance of the primary task. Therefore it is crucial that driver's cognitive resources be focused on it, and that secondary tasks do not decrease the ability to control the vehicle. On the other hand, secondary tasks may be important to make driving a comfortable and pleasant experience; and in monotonous situations (low traffic, highways, etc.), the secondary tasks may help to keep mental workload over the minimum threshold to prevent inattention and lack of vigilance (especially in sleepy drivers). Thus, the solution cannot be oriented to simply remove secondary tasks.

Moreover, there are some secondary systems, like ADAS, GPS, etc., which can be an aid to the primary driving task. It could be acceptable that these devices attract the attention of the driver's mind, as long as the assistance that they provide compensates the distraction that it causes, and the overall performance is improved. For instance, a lane departure warning with a flashing light and a sound would distract user's vision and hearing off the road, but if the risk that it prevents is higher than the risk of that eventual distraction, overall safety would be improved.

All in all, Cognitive Ergonomics for in-vehicle Human-Machine Interfaces must achieve a good balance between both driving and control of secondary tasks. The cognitive procedures of young and elderly people in driving are essentially the same; reaction times of elderly drivers may just be slower, and they may have a lower performance. But the approach to secondary tasks may be different, not only due to variations in their cognitive abilities, but also to cultural circumstances.

For instance, a usual design guideline for in-vehicle HMI is to use the visual channel as less as possible, since it is the more demanded perceptual channel in driving. Thus, a common solution is to use voice-driven devices for other systems. This is a good concept for both young and elderly people, but the design of elderly-oriented speech systems should consider possible limitations of short-term memory, hearing in noisy environments, and the experience in the use of that kind of devices, too.
Finally, it will be defined special cognitive requirements for in-vehicle interfaces, although these guidelines are also convenient for any other kind of machine:

- **Time-efficiency**. Time demand is very high in driving, because reactions to sudden events must be extremely fast. Therefore, secondary tasks should be performable in short lapses.
- **Interruptible actions**. The driver should be able to abandon a secondary task suddenly in any moment, to focus on road events, and go back to it later without loss.
- **Multimodality**. Sensorial load (especially of the visual channel) is very high for the primary driving task. So it is convenient to "share" the information among the different senses, so that mental workload can be kept below "saturation".

Furthermore, it would be necessary to include general requirements for Human Machine Interfaces because of these interfaces in vehicles are HMI too: For this reason, they should provide contextual information and feedback of the performed actions, use recognizable vocabulary, reduce memory demands, keep constancy of elements in menus, be consistent in the procedures, ….

In short it is shown below a table defining the requirements and their importance levels:

Nº	**Requirement Description**	**LEVEL OF IMPORTANCE**
4.1.1.1	Response Time in actions and process from the system, should be extremely short in order to avoid a waiting time for acting by the driver	MANDATORY
4.1.1.2	The driver should be able to abandon any task suddenly so that he can focus on important driving events	MANDATORY
4.1.1.3	Information should be shared among different senses so that mental workload can be kept below "saturation"	NICE TO HAVE

4.1.1.2. *Physical usability*

In drive scenario, the physical scene is very homogeneous: Independently of the model of car, the physical scenario is very similar. In any case physical usability requirements of the user, imply the need to adapt the environment, and of course, additional help systems, to potential physical disabilities of the user. MIDAS focuses on multimodal interfaces aiming to develop a user friendly interaction for any elderly user without any particular disability and only one special user from physical disabilities point of view. This special user will be a person with serious damages to use legs. So, it is supposed that car-driver can't use the pedals and the automobile is governed through a steering joystick instead of the habitual steering wheel. Besides, in order to facilitate the driving the car-driver will carry out the execution of certain functionalities through voice commands. Car-driver would find the list of voice commands in the screen/head-up display when he is driving so he does not need to memorize anything.

The information here described is an overall list of requirements needed in order to design a car steering control device adapted to disabled people, maintaining same functions as in current cars. According to this, some geometric aspects must be considered, even inputs coming from users to handle this device. Designing a joystick to guide and control vehicles is a work normally dependent on the area to which it is applied. In case of movements must be short and precise, this device is commonly handled with fingers. This kind of devices must be narrow and short, with a little handle for fingers. Basically, if a soft control is required the device must be controlled using one hand, and if a hard control is needed the device will be handled using complete arm. Main aspects analyzed are as follow:

– **Handle design.** Main aim of a handle consists of providing force transmission or movement from users muscle and skeleton system to object handled. Following recommendations from Pheasant [4], it is possible to apply some guidelines which should be used to design this kind of interfaces:

Nº	Requirement Description	LEVEL OF IMPORTANCE
4.1.2.1	Strength must be applied where hand and handle interact with compression better than in sliding.	MANDATORY
4.1.2.2	Rims must be erased and other surfaces able to produce high localized pressures, even conforming finger surface.	MANDATORY
4.1.2.3	Must be circular sections. Other kind of geometries could provide more capacity to handle the device (hexagonal or octagonal) but are less comfortable.	NICE TO HAVE
4.1.2.4	Borders should be rounded with a curvature radius higher than 25 mm.	NICE TO HAVE

Nº	Requirement Description	LEVEL OF IMPORTANCE
4.1.2.5	Superficial finish should not permit sliding when powerful strengths are applied to device, even not permitting to be as rough to produce abrasive lesions.	MANDATORY

– **Physic dimensions**. Physical dimensions to take into account designing a joystick will be different if it is talking about a device controlled with full hand or only using fingers. Dimensions recommended could be different depending on target user. As a starting point, parameters from British people will be used:

	Complete hand		Fingers	
	Minimum	Maximum	Minimum	Maximum
Handle diameter (mm)	30	50	6.5	16
Command length (mm)	110	180	70	150

Table 3. Hand parameters from British people

– **Mobility range**. Joystick movement will be basically limited according to elbow mobility and driver wrist. Specifically, main joint movements are:

- Pronosupination to guide vehicle.
- Wrist abduction/adduction to brake and accelerate.

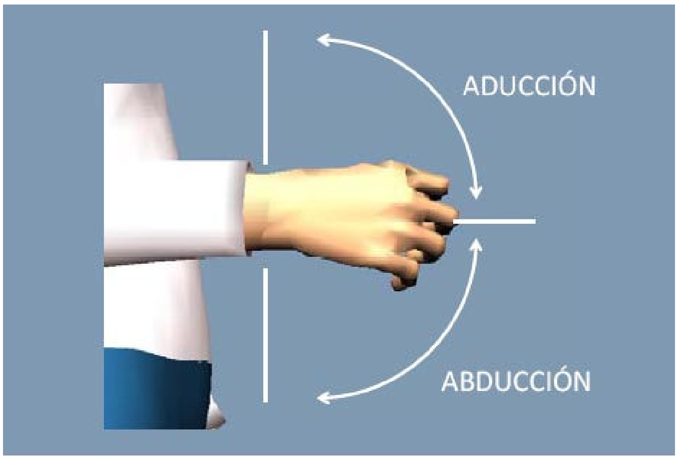

Figure 4.Wrist abduction/adduction movement

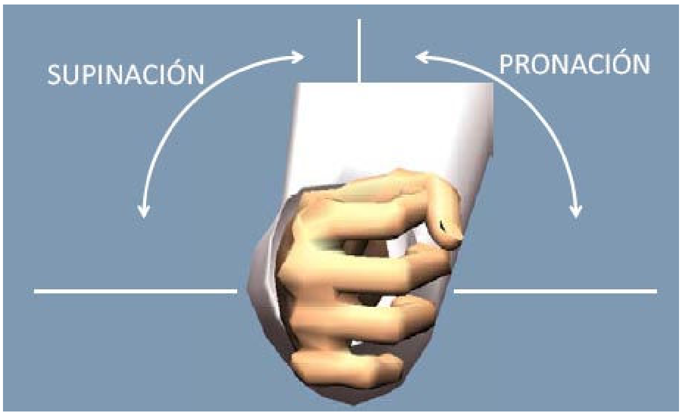

Figure 5.Pronosupination movement

Joint movement	Comfort zone limit
Radial deviation from wrist (abduction)	25º
Cubital deviation from wrist (adduction)	75º
Wrist supination	118º
Wrist pronation	73º

Table 4. Wrist Angles

– **Location.** Main guidelines are as follows:

Nº	Requirement Description	Level of importance
4.1.2.6	It should be warranty that control device is placed inside comfortable reach along its trajectory	MANDATORY
4.1.2.7	Access and control operation should not interfere with other controls	MANDATORY
4.1.2.8	It should warranty that major forces applied along axis merge with optimal member movement	MANDATORY
4.1.2.9	Articulations angles during control handle should follow values showed in table below in order to warranty an optimal comfort level	NICE TO HAVE

Articulation	Lower angle	Upper angle
Elbow flexion	80º	110º
Shoulder flexion	15º	35º
Shoulder Adduction-Abduction	-17º	44º

Table 5. Elbow and Shoulder Angles

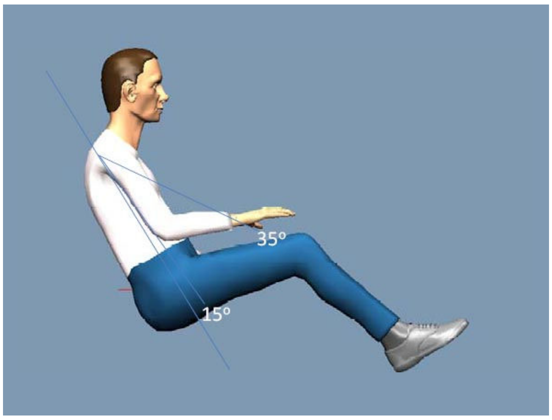

Figure 6.Angles arm

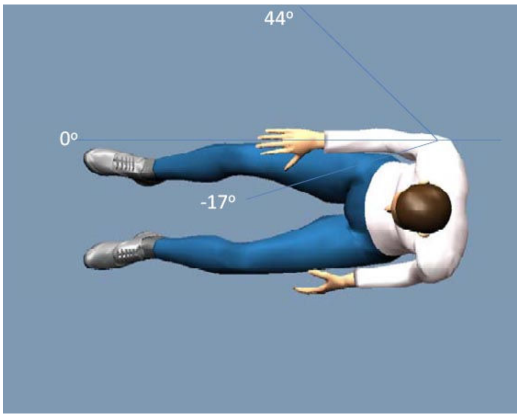

Figure 7.Angles shoulder

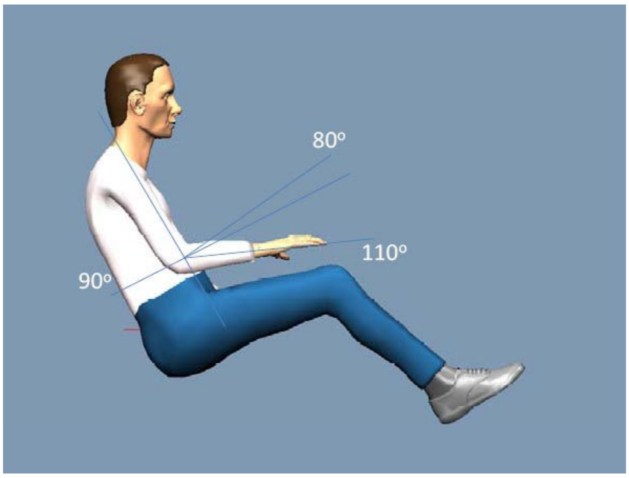

Figure 8.Angles elbow

Hereafter are shown lineal dimensions extracted from anthropometric angles in table above, which will permit to place optimally the joystick inside a vehicle:

Population	Height from middle hand to point H
Minimum (Percentile 5 women)	298 mm
Maximum (Percentile 95 men)	366 mm

Table 6. Anthropometric angles

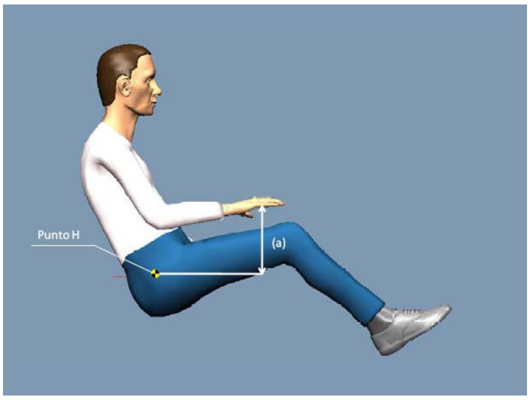

Figure 9.Height from middle hand

Height	Distance from middle hand to point H (a)
Minimum (Percentile 5 women: 1548 mm)	354 mm
Maximum (Percentile 95 men: 1870 mm)	454 mm

Table 7. Distance from middle hand to point H

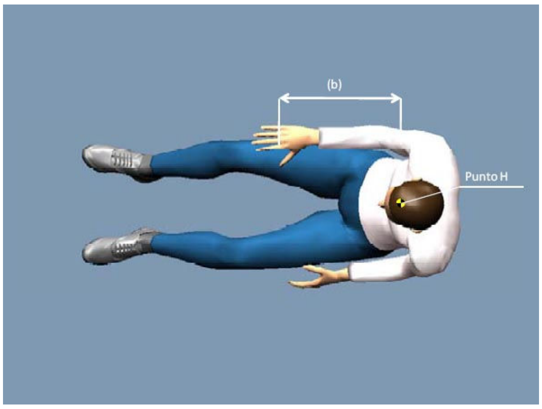

Figure 10.Distances from middle hand to point H

4.1.1.3. *Emotional usability*

Customer experience including behavior, social interaction and emotional response to and interaction with in-car devices are one of the key requirements too. Emotional usability requires fulfilling both the previous two usability requirements fields (cognitive and physical). In fact, considering "emotional factor" opens a new opportunity for generating greater sales and market share if it is successfully able to harness the unspoken emotional quality characteristics that consumers seek in a product and service. In MIDAS project, adopted solutions will increase autonomy for elderly and/or people with particular disabilities, associated to limitations related to ageing (visual-audition-mobility handicaps) via the multimodal interfaces targeted to the elderly/people with disabilities needs. In this point, the main requirements will be defined below:

Nº	Requirement Description	Level of importance
4.1.3.1	New steering function should provide more dynamism and fun regarding to common steering wheels	NICE TO HAVE
4.1.3.2	Acceleration function should provide full drive feeling to user, and consequently, full immersion to activity of driving	NICE TO HAVE
4.1.3.3	While guiding a car, disabled drivers should feel themselves equal from not disabled people	MANDATORY
4.1.3.4	Overall drivers should perceive full vehicle management	NICE TO HAVE
4.1.3.5	Drivers should perceive the system as an advanced technological device	MANDATORY
4.1.3.6	During autonomous driving, system should provide comfort feeling to user when handling secondary functions	NICE TO HAVE
4.1.3.7	Disabled people should feel motivated while driving	NICE TO HAVE
4.1.3.8	All car users should feel secure when managing this technological system	MANDATORY

4.2. Accessibility in the drive scenario (7 universal principles for design)

Oriented to a future driving scenario in which car will have a high level of technology due to permit driving in an automatic and semi-automatic way, the device to be developed, will take into account some requirements based on main 7 universal principles for design. This coming future maintain that disabled people when driving autonomous or semi-autonomous cars will be able to handle a car, as they cannot nowadays, where cars running have to be integrated with mechanic devices adapted to each disability need.

In this context, current accessibility in Drive Scenario, will be quite different than that projected in near future, obviously because main functions will be redesigned according to next powertrain characteristics and technological advances in bioelectronics, concluding in a new standardized car concept and, consequently in a new way to drive.

4.2.1.1. Comparable use

In this point it is looked for a functional design, able to be sold to people with different kind of capacities. The main requirements are shown below:

Nº	Requirement Description	Level of importance
4.2.1.1	Car devices should be handled even by not disabled people in a comfortable way	MANDATORY
4.2.1.2	System should enhance automatic shifter to be handled by users with one functional hand	NICE TO HAVE
4.2.1.3	Users with disabilities in one hand and both lower extremities should be able to drive	MANDATORY
4.2.1.4	System should enhance brake function to be handled by users with one functional hand	NICE TO HAVE
4.2.1.5	System should enhance accelerate function to be handled by users with one functional hand	NICE TO HAVE
4.2.1.6	Steering function should be adapted to different arm force profiles.	MANDATORY

4.2.1.2. Flexible use

In this point it will be defined some requirements trying to achieve a flexible use by different user's needs, focused on car environments:

Nº	Requirement Description	Level of importance
4.2.2.1	Manipulation of controls will be temporal due to user demands	MANDATORY
4.2.2.2	Car will be guided in manual and semi-autonomous way.	MANDATORY
4.2.2.3	Main car controls should permit driver to modify car behavior to his needs	NICE TO HAVE
4.2.2.4	Left-handed and right-handed users should be able to drive car using same device	NICE TO HAVE

4.2.1.3. Simple and intuitive

Provided information should not be irrelevant or rarely needed. Every extra unit of information competes with the relevant one and this is especially important in driving environments, where this information could distract the driver's attention. The main requirements are defined below:

Nº	Requirement Description	Level of importance
4.2.3.1	Secondary functions will be carried out in a simplified way	NICE TO HAVE
4.2.3.2	Users should drive normally on the road or street and in a comfortable way	MANDATORY
4.2.3.3	Electronic steering devices must be intuitive to use	NICE TO HAVE
4.2.3.4	System must allow disabled people to manipulate electronic devices in an easy way	NICE TO HAVE
4.2.3.5	Brake function must be enabled quickly	MANDATORY
4.2.3.6	Acceleration function must be performed intuitively	MANDATORY
4.2.3.7	Shift function must be performed intuitively	MANDATORY
4.2.3.8	Steering function must be performed intuitively	MANDATORY

4.2.1.4. Perceptive information

In this section, it will be defined some of the requirements which try to provide environmental information to the user in an effective way.

Nº	Requirement Description	Level of importance
4.2.4.1	Acceleration feeling could be perceived haptically	MANDATORY
4.2.4.2	Steering feeling will be perceived haptically	MANDATORY
4.2.4.3	Shifter information should be perceived visually	MANDATORY
4.2.4.4	Visual shifter information must be read easily	MANDATORY
4.2.4.5	Visual shifter illumination will be adapted and perceived according to overall light	NICE TO HAVE
4.2.4.6	Secondary visual information should be read easily	NICE TO HAVE

4.2.1.5. Tolerance for mistakes

In driving environments a mistake in driving devices may be very dangerous so it could cause an accident, for this reason, it will be fixed some requirements which try to achieve a tolerance for mistakes.

Nº	Requirement Description	Level of importance
4.2.5.1	Reliability in main electronic steering device to continue performing main functions even when an electronic failure is found	MANDATORY
4.2.5.2	Reliability in electronic brake control to continue performing function even when an electronic failure is found	MANDATORY
4.2.5.3	Under an electronic failure, acceleration control must be reset and put under full user control	MANDATORY

Nº	Requirement Description	Level of importance
4.2.5.4	Under an electronic failure, steering device must be put under full user control	MANDATORY

4.2.1.6. *Physical use*

In this section, requirements look for a design which can be used in an efficiently and comfortable way, trying that the user makes the minimum effort as possible.

Nº	Requirement Description	Level of importance
4.2.6.1	Full control of vehicle using one or two hands	MANDATORY
4.2.6.2	Secondary functions should be performed using speech interface	NICE TO HAVE
4.2.6.3	Steering system should be complemented by an ergonomic armrest	MANDATORY
4.2.6.4	An additional device to control secondary functions should be integrated into system	NICE TO HAVE
4.2.6.5	Force required to steer will be adapted to every user needs.	NICE TO HAVE
4.2.6.6	Force required to accelerate will be adapted to every user needs	NICE TO HAVE
4.2.6.7	Force to be applied for every user over brake should be taken into account	NICE TO HAVE

4.2.1.7. *Size and space*

The right size and space for the access, reach, manipulation and use, postures and user's mobility in car environment, are some of the issues taken into account in order to define the next requirements.

Nº	Requirement Description	Level of importance
4.2.7.1	System should enhance accessible driving to people with disabilities in lower extremities	MANDATORY
4.2.7.2	Main driving functions should be grouped inside upper extremities reach range	MANDATORY
4.2.7.3	Vehicle seats should be comfortable and adjustable enough as to permit user accommodation to easily manipulate steering device	MANDATORY
4.2.7.4	Overall system should be stored when users don't use it and facilitate mobility inside car	NICE TO HAVE
4.2.7.5	System should facilitate user's access in vehicle by not being integrated inside entry user trajectory	NICE TO HAVE

4.3. Multimodal interfaces for elderly in the drive scenario

In this section interfaces in the drive scenario will be described, recollecting information generated in previous points. Multimodal interface focussed on elderly in drive scenario will consider solutions and devices based on the corresponding technologies in order to offer an easier Man Machine Interface, focusing on touching screens and voice command recognition technologies.

At the moment, there is a wide range of graphical technologies but not all of them are applicable in the automotive industry, either for price, for size, for weight or for basic technical characteristics' reasons. Among the technologies that nowadays have current representativeness in vehicles in production, touch screens will be the best option considered for MIDAS multimodal HMI in this scenario.

Although not very elegant, the most usable interfaces are touch screen LCDs. Most touch screen LCDs appear in American and Japanese brands. Unlike trying to match the movements of a hardware knob with onscreen menus, touch screens have onscreen buttons that you can push. There is virtually no learning curve. If the user wants to enter a destination into the navigation system, just push the button labelled "Destination entry." These systems usually have hard buttons along the sides of the screen, but these are usually just to select the car system you want to control and are labelled as such.

With a touch screen LCD, it all comes down to software design, making the use easier. For example, when entering an address, the user would merely have to touch the appropriate letter on the screen, which is much more efficient than selecting letters with a knob. The only drawback with a touch screen is that users have to be able to reach it. If the dashboard slopes away out of arm's reach of the driver, then users would have to rely on a remote system like iDrive.

In this point voice interface appears trying to solve this reaching problem. Voice interface is the least distractive interface for driver interaction with de HMI, nevertheless it could already be distractive if dialog does not fit the actual needs. As a voice subsystem can be divided in two main categories:

- Resources and dialog. Resources cover the well-know technologies of Text to Speech (TTS) and Automatic Speech Recognition (ASR). These technologies are however in this way of evolution with several challenges.

- Dialog has as main function to interact with user as a co-driver helping driver to access information or services. So, dialog needs access to all information sources: originated by the car, by pluggable gadgets or by external information systems. Dialog would be able also to set or control any of the resources like ordering the reading of an SMS or initiate a phone call. All this functionalities will be available through an OSGI Framework and any HMI Manager to help service to be improved from vocal services to multimodal services.

Main functionalities of dialog system would be:

- Activate speech recognition when "push to talk" button is pressed.
- Chose appropriate vocabulary to be recognized considering all available information that could be categorized with semantic ontologies in different driving states.
- Determine when is appropriate for a text to speech message considering driving states. Messages to confirm commands or generated by alarms inside or outside
- Request information to the driver required by services for no ambiguity command.
- Cooperate with other subsystems like graphical and tactile interfaces for multimodal services.
- Voice dialog configuration through external xml service configuration file.
- Control of service and interaction priority

In any case only solution based on "Commands recognition" would be considered in order to obtain a multimodal HMI easy to use by elderly people.

5. Conclusions

In this document the principal recommendations and requirements has been defined in order to achieve the best usability features in multimodal interfaces, for elderly and disabled people, focusing on home and drive scenarios mainly. Midas aims to provide a set of services taking always into account how these special peculiarities affect the system usability. These services have as goal to accomplish independent lives and choice ability for this social group.

These interfaces for elderly and disable people should follow the same recommendations than general interfaces; so, they should be simple, intuitive, only showing essential information, etc. Furthermore, they should have two alternatives in order to be used by people with different disabilities, having a flexible use too, and taking into account that there will be different users' profiles as well.

On one hand, interfaces in home scenarios should have different options for novel and expert users, showing simple information in natural language so that they can be understood by all of them. Moreover, they should have mistake tolerance, separating different options which can cause drastic results if the user was wrong, requiring reduced strength for pressing controls, and having suitable size in order to be adapted to each home environment.

On the other hand, interfaces in drive scenarios should be time efficiency, because users need to pay attention in driving events, they should be multimodality, having different alternatives for different disabled users, and allowing interruptible actions, so that the user can stop a process whenever a more important event happens. Furthermore, these interfaces should be able to be handled by not disabled people, being simple and intuitive, so nobody can feel discrimination. In this scenario, mistake tolerance should provide a good reliability in all the processes and electronic devices, since a mistake in this environment, could cause an accident. These interfaces should be able to be handled just with one hand, trying to increase the number of different user profiles, which can use them. Finally two solutions have been proposed in this environment. One of them has been the use of touch screens, and the other one has been the use of voice commands recognition systems.

6. References

[1] Deatherage, *Auditory and other sensory forms of information presentation.* In H.P. Van Cott and R.G. Kincade (Eds.), Human engineering guide to equipment design, 1972.

[2] ETSI EG 202 048, *Guidelines on the multimodality of icons, symbols and pictograms*

[3] Coutaz, J. & Nigay, L. & Salber, D. & Blandford, A. & May, J. & Young, R. (1995). *Four Easy Pieces for Assessing the Usability of Multimodal Interaction.*

[4] Pheasant S. Bodyspace. *Anthropometry, Ergonomics and the Design of Work.* Ed. Taylor and Francis, 1996.

Additional bibliography:

- Charness, N. & Czaja, S. J. (2005). *Adaptation to new technologies.*
- Czaja, S. J. & Lee, C. C. (2003*). The impact of Internet on Older Adults.*
- Czaja, S. J. & Lee, C. C. (2003). *Designing Computer Systems for Older Adults.*
- Mayhorn, C. B. & Rogers, W. A. & Fisk, A. D. (2004). *Designing Technology Based on Cognitive Aging Principles.*
- Mitzner, T. L. & Fisk, A. D. & Rogers, W. A. & Mayhorn, C. B. (2006*). Ergonomics and Aging.*
- Hurwitz, I. M. (1962). *The elderly and their disabilities.*
- Aymerich Andreu, M. & Casas Aznar, F. (2005). *Calidad de vida de las personas mayores En Gerontología: actualización, innovación y propuestas.*
- Junestrand, S. & Passaret, X. & Vazquez, D. (2004). *Domótica y hogar digital.*
- IBV/CEAPAT. (2003) *Libro Blanco 'I+D+I al servicio de las personas con discapacidad y las personas mayores'.*
- Grau Sabaté, X. (2004). *Tecnología y discapacidad visual: necesidades tecnológicas y aplicaciones en la vida diaria de las personas con ceguera y deficiencia visual.*
- RED.ES/FUNDACIÓN VODAFONE ESPAÑA (2007). *TIC y Dependencia.*
- De la Peña González, A. I. & Gil Agudo, A.M. & Jardón Huete, A. (2006). Evaluación funcional de Robot Portable de Ayuda a Personas Discapacitadas.
- Berjano, E. (2005). *Dependencia y calidad de vida en las personas mayores.*
- Bolt, R. A. (1980). *Put-that-there: Voice and gesture at the graphics interface.*
- Van Cott, H. P. & Kincade, R. G. (1972). *Deatherage, Auditory and other sensory forms of information presentation.*
- Leroux, C.; Laffont, I.; Biard, N.; Schmutz, S.; Désert, J.F.; (2007),*Robot grasping of unknown objects, description and validation of the function with quadriplegic people, in 'Proceedings of the 2007 IEEE 10th International Conference on Rehabilitation Robotics, Noordwijk, The Netherlands'.*
- Rémazeillles A, Leroux C, Laffont I*, Vision-based grasping of unknown objects to improve disable people autonomy RSS 2008*
- Anthony Rémazeilles, Christophe Leroux, Gérard Chalubert sam: *A robotic butler for handicapped people,* Ro-Man 2008, August 1-3, Munich.

- Anthony Rémazeilles, Christophe Leroux, Gérard Chalubert, Laurent Delahoche*, Automatic grasping task with a catadioptric sensor for disabled people* ICARCV, Dec 2008, Hanoï
- Andonian B. Rauch W and Bhise V. *Driver Steering Performance using Joystick vs. Steering Wheel Controls. Society of Automotive Engineers*. 2003-01-0118. 2003
- Branneby P, Palmgren B, Isaksson A, Petterson T and Franzen S. *Improved Active and Passive Safety by using Active Lateral Dynamic Control and an Unconventional Steering Unit*. The thirteeth international Technical Conference on experimental safety vehicles. US Departmen of Transportation, National Highway Safety Administration. Paris, France. 1991.
- Clemo K. The *effects of steering adaptations on vehicle control*. British Department of Transport. 2005.
- Curry E, Southall D. *Disabled drivers' ability braking. British Department of Transport*. 2002.
- Eckstein L. Investigation of the Sidestick *Control Concept at the Daimler-Benz Driving Simulator*. Daimler-Benz AG. Sttutgart, Germany. 1997.
- Haslegrave CM. Ergonomic *Design of Car Controls*. Autotech Congress Seminar 39. Nov. 1991.
- International Standard Organisation. *Passenger cars -- Driver hand-control* reac. ISO 3958. 1977.
- International Standard Organisation. *Tractors, machinery for agriculture and forestry, powered lawn and garden equipmen*. ISO 3789. 1982.
- Kee D, Karkowski W. *The boundaries for joint angles of isocomfort for sitting and standing males based on perceived comfort of static joint postures*. Ergonomics, 2001, vol. 44, No. 6, 614-648.
- Kember P. *Strength abilities of disabled drivers and control characteristics of cars.* Contractor Report 215. Transport and Road Research Laboratory. Department of Transport. 1991.
- McCormick EJ and Sanders MS. *Human Factors in Engineering and Design*. McGraw Hill, 1983.
- Noi S, Nagiri S, Amano Y. *Evaluation of Active Safety Performance of Man-Vehicle System*. 16th International Technical Conference on the Enhanced Safety of Vehicles. Canada. 1998.
- Östlund J, Peters B. Manoeuvrability characteristics of cars operated by joysticks. Swedish National Road and Transport Research Institue. VTI meddelande 860A. 1999.
- Östlund J. *Joystick-controlled cars for drives with severe disabilities. Swedish National Road and Transport Research Institute.* 1999. Ref: VTI rapport 441A.
- Peters B, Östlund J. Joystick *Controlled Driving for Drivers with Disabilities. A Driving Simulator Experiment.* Swedish National Road and Transport Research Institute. VTI rapport 506A. 2005
- Pheasant S. *Ergonomics standards and guidelines for designers*. British Standards Institution. 1987.
- Society of Automotive Engineers. *Driver Hand Control Reach.* SAE J287. SAE Handbook, part 2. 1977
- Turnburg A. *Active Steering makes the Driver and Car a Safer Team*. SAAB Automobile AB. Trollhattan. 1991.
- Woodson WE. *Human Factors Design Handbook*. McGraw-Hill Book Company. 1981.

Consortium

	ORANGE LABS France www.orange.com	Project Coordinator : Laure Chotard, Orange Labs laure.chotard@orange-ftgroup.com	
	CEA LIST France www.cea.fr		**CITIC** Spain www.citic.es
	CNRS France www.lifl.fr		**ENERGY SISTEM SOYNTEC** Spain www.energysistem.com
	FICOTRIAD Spain www.ficosa.com		**GEOMOBILE** France www.whereru.eu
	I&IMS Spain www.ims.es		**INTUILAB** France www.intuilab.com
	KATRON Turkey www.katron.com.tr		**KIT** South-Korea http://www.kitvalley.com/
	LI2G France www.chu-grenoble.fr		**MORGAN CONSEIL** France www.morganconseil.com
	MOVIQUITY Spain www.moviquity.com		**THALES ALENIA SPACE** France www.thalesaleniaspace.com
	ROBOSOFT France www.robosoft.fr		**ROBOTIKER-TECNALIA** Spain www.robotiker.es
	SIEL BLEU France www.sielbleu.org		**TELEFONICA I+D** Spain www.tid.es