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D1.1 DEFINITION OF END USERS AND TECHNICAL REQUIREMENTS v4.0

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Abstract: Compiled by the members of Work Package 1, this document contains detailed information about the needs and requirements of elderly persons in the use of white goods in their familiar environments. This report includes also the definition of the technological developments to be done in the project to improve a longer independent life of the elderly.

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1. INTRODUCTION

This deliverable is the result of WP1: definition of end users and technical requirements. Specific objectives of this WP are:

- To identify the specific needs that the elderly persons have in the use of “white goods”, considering the different existent levels of physical and cognitive disabilities in the elderly persons.
- To identify the possible support that the “white goods” could provide to elderly people for a longer and better independent life. This support is concretized in specific functionalities that the resulting system from the project will have.
- To define what are the main technological developments (in HMI, RFID, neuronal networks) to be carry out in later WPs to answer the identified needs of elderly persons in using “white goods”.

Each of these tasks correspond respectively to sections 2, 3 and 4 of the current document.

2. IDENTIFICATION OF THE END USER NEEDS IN THE USE/SUPPORT OF WHITE GOODS

The number of elderly people is increasing strongly in Europe and in fact the number of people 80+ will grow by 180% by 2050. Furthermore, families will not be able to solve on their own the problem of care for elderly people. The probability that elderly people have to be looked after by nursing homes is quite high due to their difficulty of carrying out independent activities or due to household accidents. For this purpose there is an European policy to improve and increase the independent life of elderly people.

Old age affects functioning of sense organs, information processing capacity; it reduces speed and increases timing of precise movements. A higher "thinking time" is necessary to interpret complex display scenarios and makes it difficult to do 2 things at once, reduces attention over long periods of time, etc.. Consequently, domestic appliances that usually have been a big help in their independent daily life owing to their new functional limitations, become barrier in their life.

The elderly people suffer from disabilities getting worst with the years. These disabilities will make the daily tasks to carry out more difficult. Main disabilities (42%) prevent to carry out home tasks whereby about a fourth part of the household accident takes place in the kitchen where the "white goods" are key elements. Facing this situation, the project consortium has decided to perform the EASY LINE+ project in order to develop prototypes suitable for the market of advanced white goods: the aim is to support elderly people with or without disabilities to carry out a longer independent life at home and to compensate their loss of physical and/or cognitive abilities.

This section outlines the methodology followed for the identification of the user needs regarding the use and support of the white goods. We have faced this task from different perspectives. On one hand we used Alan Cooper's **Persona concept** to easily understand the current situation of the elderly in Europe (Section 2.1). From European statistics we created ten personas that are of big usefulness to do a user-centred design of the technological design. On the other hand we also did several end-user interviews

with different approximations. We analyzed all the **tasks done in the kitchen and their implications regarding the disabilities** a user might have according to the WHO's ICF (International Classification of Functioning) and the household appliances themselves (Section 2.2). Of course, several **interviews** were also performed; we did both open-interviews to know let the user express their need and other with defined questions to target limitations on white goods and activities performed in the kitchen (Section 2.3).

2.1 Using the personas concept to understand the current situation of elderly in Europe

Lots of professionals use Personas to test web sites, systems etc, but very often personas end up being too vague to guide a product's focus. They often lack the detail to be useful in guiding low-level design trade-offs. And, as typically done, personas have been too narrowly focused. Alan Cooper popularized personas as a valuable design tool, but many people who adopted them failed to take into account the context of Cooper's practice, which had fairly specific needs.

Cooper's goals for personas were to:

- Allow the development team to live and breathe the user's world.
- Allow the team to filter out personal quirks and focus on motivations and behaviours typical of a broad range of users, while still relating to users as individuals.

There are two different types of personas: *primary personas*, which represent the main target group and *secondary personas*, which can use the primary personas' interfaces but which have specific additional requirements. Even though personas are fictional characters, they need to be created with rigor and precision; they tell stories about potential users in ways that allow designers to understand them and what they really want.

A persona generally includes a name, a picture, demographics details (e.g. age, education, ethnicity family status etc.), environment, and sometimes, a quote that sums up what matters most to the persona with relevance to your system. Usually, we get information for the creation of personas by analyzing what

designers have learnt about the users, including: interviews, surveys, usability testing, focus groups etc.

In summary, Personas are archetypal users; they tell stories about potential users in ways that people in the design team can understand the users and what they want. Working with Personas is one of the best ways to provide the developers with valuable insights and an efficient way of keeping the stakeholders in mind throughout the system design with the aim of making and simplifying design decisions. They are a valuable tool for developing a usable, useful and relevant system – providing focus and clarity for all the team.

2.1.1 Building Personas to Enhance User-Centred Design

“User-centred design puts the user at the heart of the design process so that the resulting is easy to use. ‘Personas’ are a way of bringing the user alive – constantly reminding the development team who they are designing for.” [1]

The data used to build the personas came from two sources:

1. To help the development of the personas, we used real data from statistics found on the websites *Eurostat* and *EIAA* which provide key figures on Europe. We used global European values as the main source of information, however some other local based (UK, Spain, France, etc) statistics were examined and compared to enrich the sampling when some data was missing.
2. In addition we conducted a workshop on Technology for Assisted Living that gathered a group of experts from different related fields (telecare, smart home technologies etc.). On this workshop we also gathered relevant information to support the creation of the personas.



[Eurostat](#) is the Official Office of the European Communities which collects figures from the different European statistics offices with the purpose of providing comparable and harmonized data.



The European Interactive Advertising Association ([EIAA](#)) is a unique European trade organization for sellers of interactive media. The primary objectives of the EIAA are to champion and to improve the understanding of the value of online advertising as a medium, to grow the European interactive advertising market by proving its effectiveness, thus increasing its share of total advertising investment.



"Technology for assisted living" workshop

The workshop on Technology for Assisted Living was held at NEWI the 27th of September 2007. Many experts came to exchange their views, opinions and experience about the needs of elderly and the disabled people.

Among the lively dialogues, six particular breakout discussions were debated:

1. Sensory impairment
2. Cognitive needs
3. Well-being
4. Physical disabilities
5. Telecare
6. Every day living

The EasyLine+ project was mentioned and presented to the assembly.

2.1.2 Analysis of data retrieved

After gathering all users' related data that is potentially useful for the system's development, we performed an exhaustive analysis to select the information bits that were most relevant with the intention to define a development's scope more according to the user needs. The analysis was based on the initial requirements of the system supported by the workshop were the experts shared knowledge and experiences regarding user matters. The criteria used and distributed to the 10 personas are listed as follow:

- Age
- Education
- Employment
- Impairment and disability
- Dependency
- Mobile users
- Internet users
- Etc.

Most of the statistics were not up-to-date however there were some predictions which helped us to build personas not only related to actual users but to the type of user of 10-20 years from now. The next sub points show examples of statistics retrieved from the sources aforementioned.

2.1.2.1 Age

For example, in 2001, there were 62 million elderly people aged 65 and over in the EU compared with only 34 million in 1960. By 2010, the latter ratio is expected to rise to 27%. Over the next fifteen years, the number of 'very old' people aged 80 and over will rise by almost 50%.

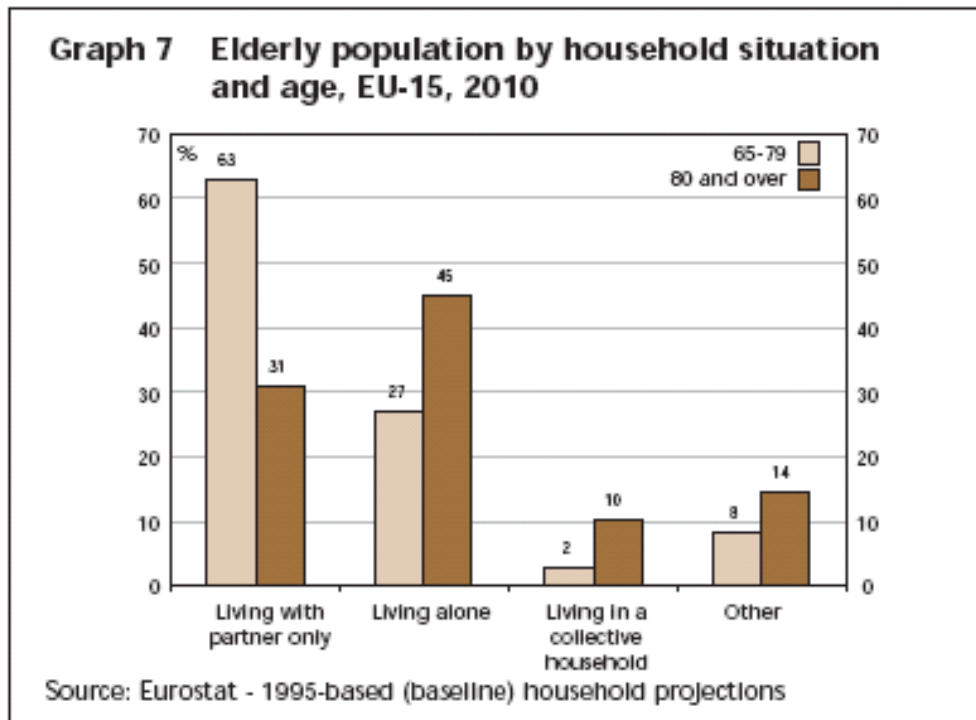


Figure 1. Elderly population by household situation and age, EU-15, 2010

2.1.2.2 Education

Attainment levels of the population have improved significantly over the last thirty years, particularly among women. Today 75% of young people aged 25-29 in the Union have an upper secondary qualification. At the same time, however, 19% of people aged 18-24 leave the education system with only lower secondary education at best.

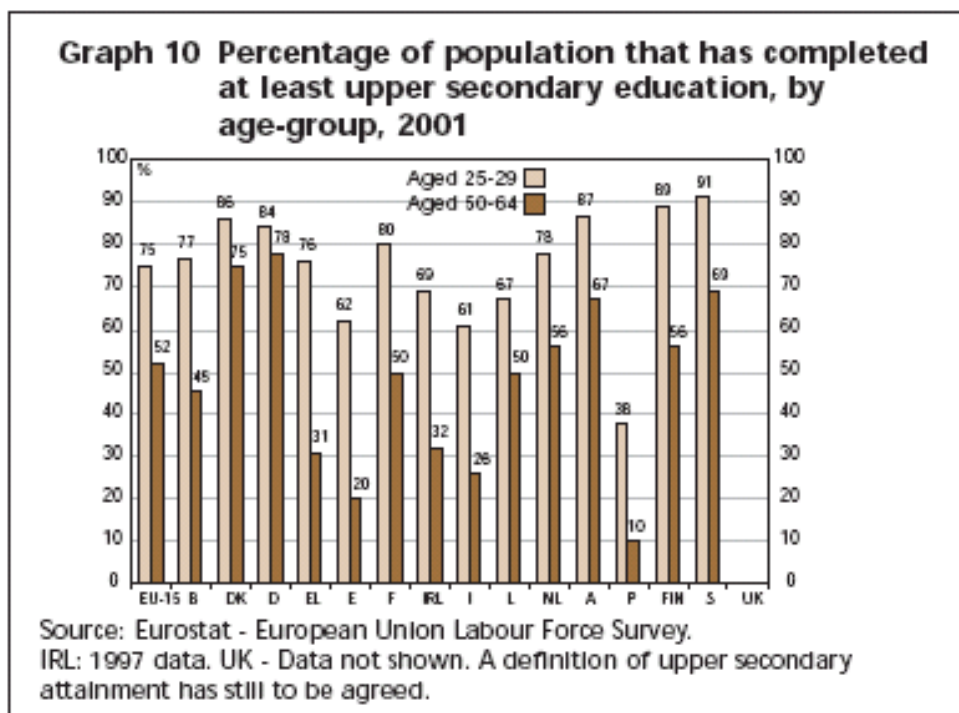


Figure 2. Percentage of population that has completed at least upper secondary education by age group, 2001

2.1.2.3 Employment

Although in the past four years, the EU employment rate of 55-64 year-old men rose by 1.5 percentage points to stand at 48.7% in 2001, it is still below the 1991 rate (51.2%). In contrast, the comparable female rate increased steadily to reach 29% in 2001. Overall, 8.6% of the population aged 55-64 were in employment in 2001. In 2001, men exit the labor force on average at the age of 60.5 while women did so about 1.5 year earlier. The overall exit age was 60 years.

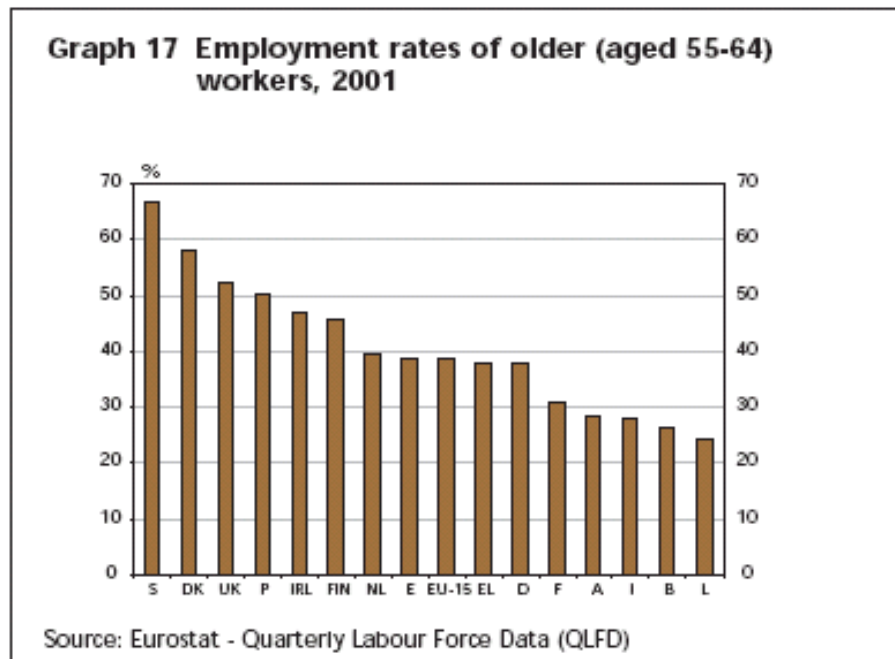


Figure 3. Employment rates of older (aged 55-64) workers, 2001

2.1.2.4 Impairment and Disability

In 1999, approximately the 21% of the elders aged 65+ and 29% of the ones aged 75+ were severely laden during daily activities, increasing their level of dependency. Predictions say that these values will keep on increasing in the following decades, in other words, it is most likely to happen that around 33% of the future elder population in Europe will have severe difficulties to carry out their domestic tasks.

International Classification of Impairments, Disabilities and Handicaps (ICIDH)

ICIDH published by the World Health Organisation (WHO) distinguishes: impairment, disability and handicap (WHO, 1980).

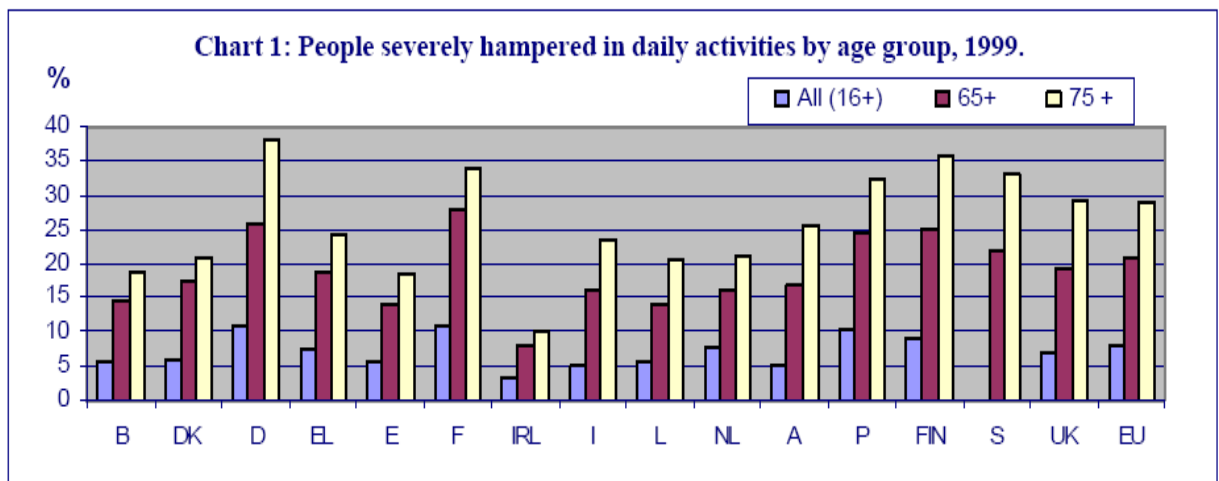
Impairment	Disability
Any loss or abnormality of psychological, physiological or anatomical structure or functions.	Any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner of or within the range considered normal for a human being.
<ol style="list-style-type: none"> 1. Intellectual impairments 2. Other psychological impairments 3. Language impairments 4. Aural impairments 5. Ocular impairments 6. Visceral impairments 7. Skeletal impairments 8. Disfiguring impairments 9. Generalised, sensory, and other impairments 	<ol style="list-style-type: none"> 1. Behaviour disabilities 2. Communication disabilities 3. Personal care disabilities 4. Locomotor disabilities 5. Body disposition disabilities 6. Dexterity disabilities 7. Situational disabilities 8. Particular skill disabilities 9. Other activity restrictions

PEOPLE WITH SEVERE LIMITATIONS

Table 1: People severely hampered in daily activities by age group; Percentage of the same age group, 1999

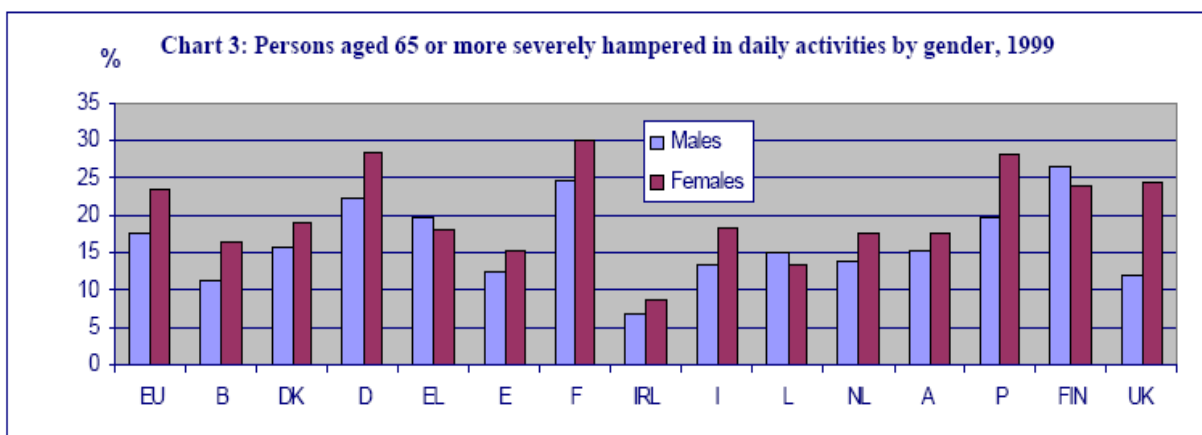
	B	DK	D	EL	E	F	IRL	I	L	NL	A	P	FIN	S	UK	EU
% (Percentage, same age group)																
Age																
All (16+)	6	6	11	7	6	11	3	5	6	8	5	10	9		7	8
65+	14	18	26	19	14	28	8	16	14	16	17	25	25	22	19	21
75+	19	21	38	24	19	34	10	24	20	21	25	32	36	33	29	29

Source: Eurostat (ECHP 1999) and S1. The data covers private households. The Irish data might underestimate the true value.
 Note: For comparison the Survey of Income and Program Participation in the US gives: all (0+): 10%, 65+: 34%.²



Source: Eurostat (ECHP 1999) and S1. Data covers private households.

Figure 4. people with severe limitations, 1999

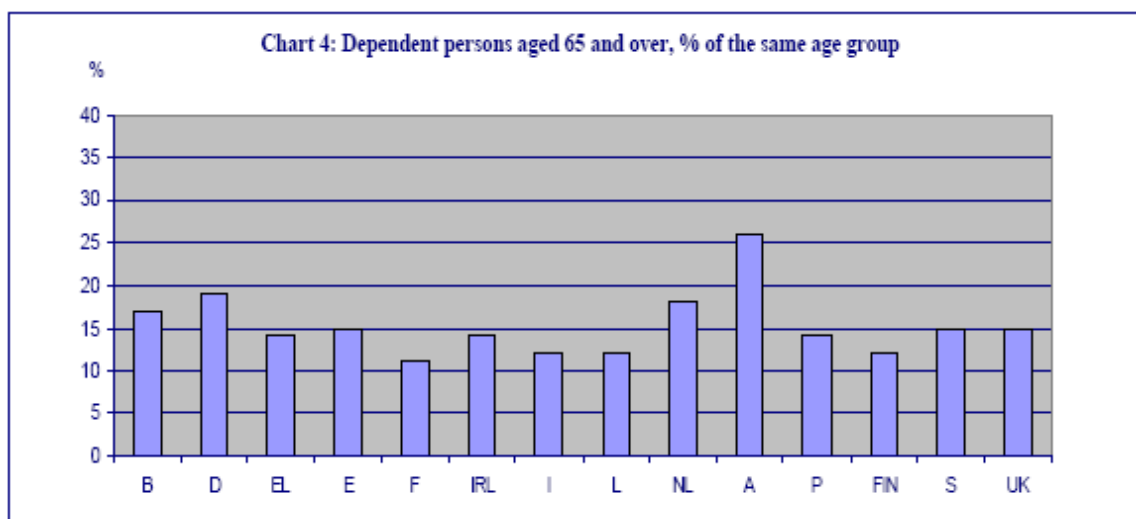


Source: Eurostat (ECHP 1999). Data for Luxembourg: 1996. Private households.

Figure 5. persons aged over 65 severely hampered in daily activities, 1999

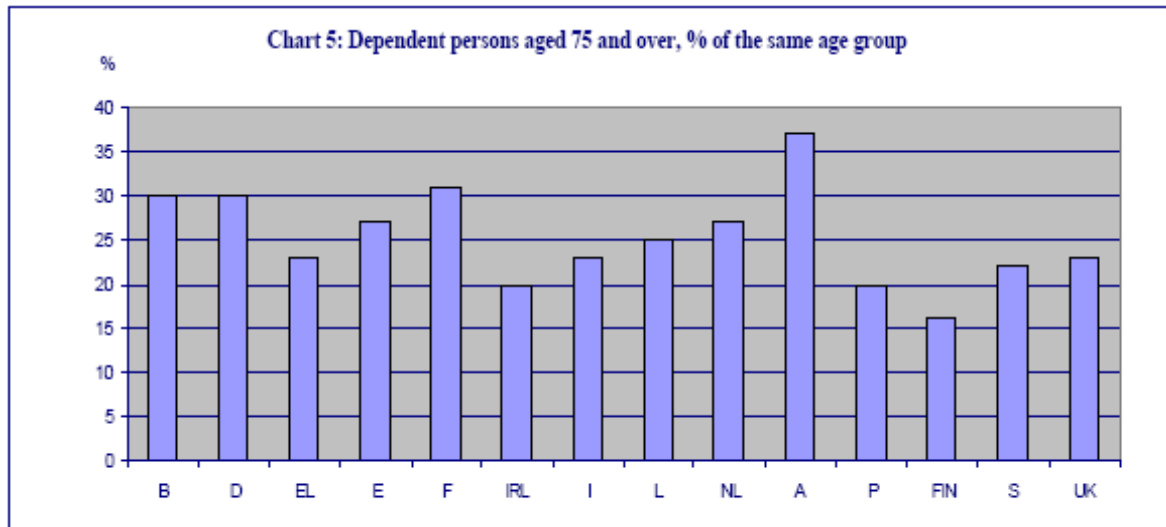
2.1.2.5 Dependency

In 2001, there were 62 million elderly people aged 65 and over in the EU compared with only 34 million in 1960. By 2010, the latter ratio is expected to rise to 27%. Over the next fifteen years, the number of 'very old' people aged 80 and over will rise by almost 50%.



Note: See Table 2 for the definitions, the population covered, the sources and the explanatory notes. The survey for Austria has adopted a relatively wider definition.

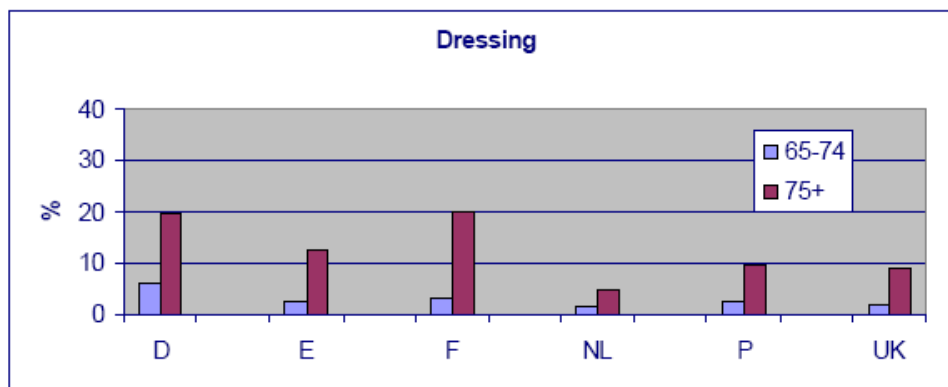
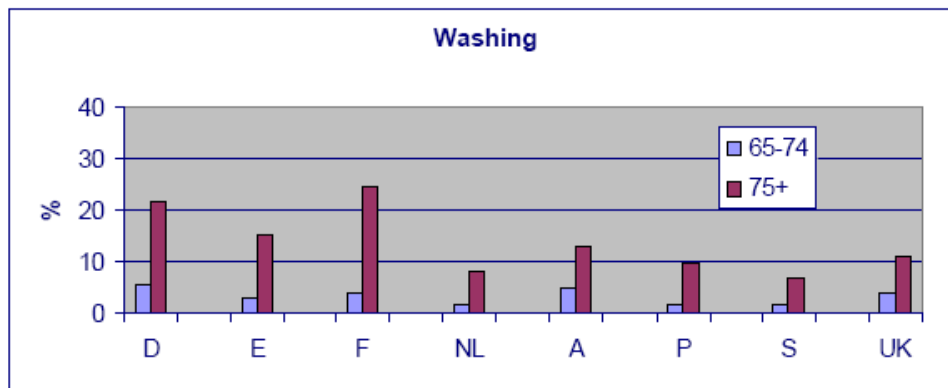
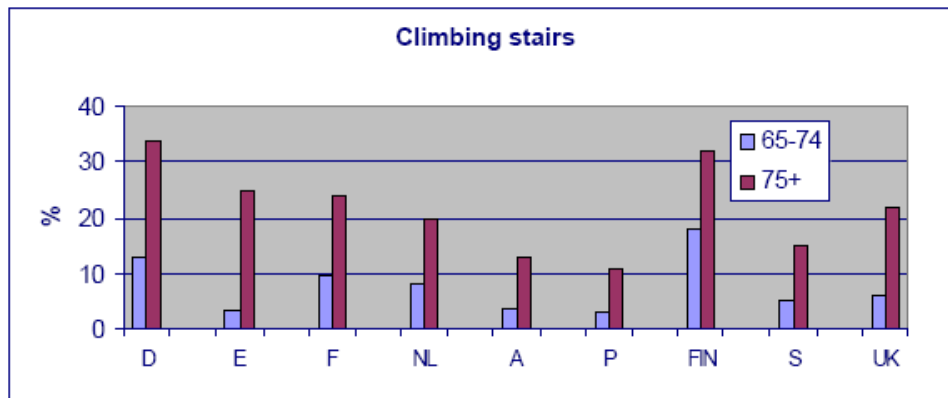
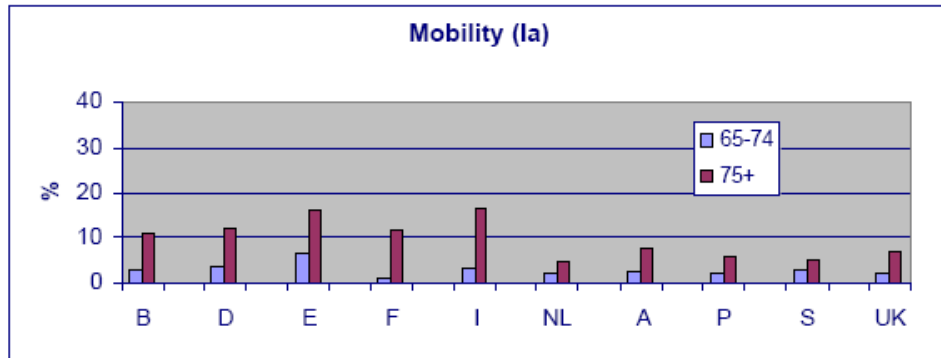
Figure 6. dependent persons aged 65 or more, 1999



Note: See Table 2 for the definitions, the population covered, the sources and the explanatory notes. The survey for Austria has adopted a relatively wider definition.

Figure 7. dependent persons aged 75 or more, 1999

Chart 9: Nature of dependency by age group. Number of people with a specific dependency as a percentage of the population covered of the same age group.



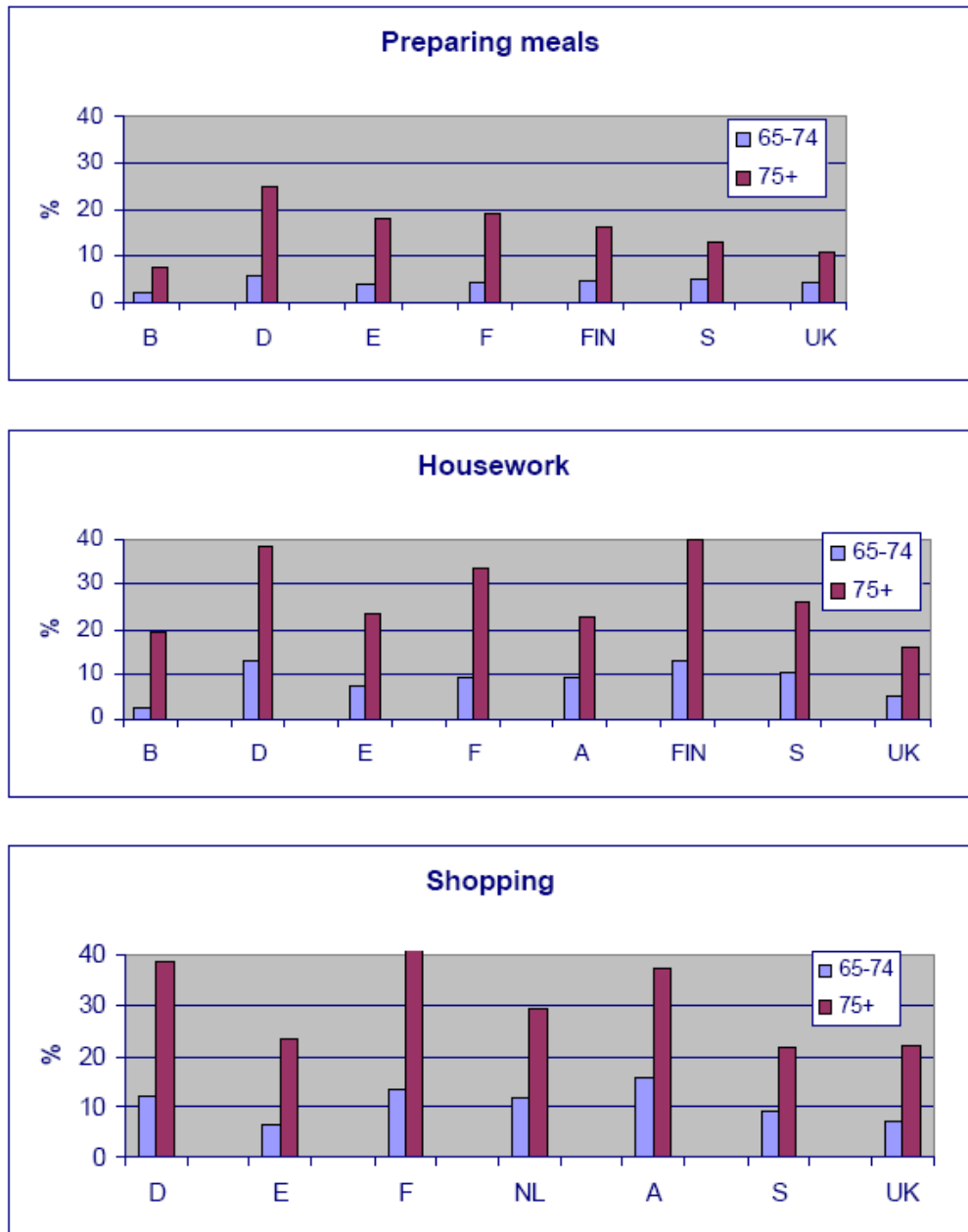
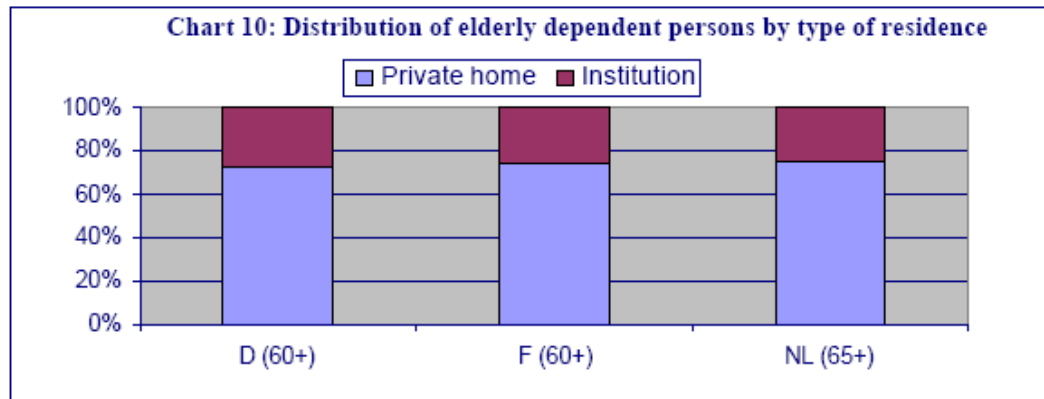


Figure 8. nature of dependency by age group



Sources: see Table 14.

Figure 9. Distribution of elderly dependent persons by type of residence

2.1.2.6 Mobile Users

“3 in 10 men aged 80+ own a mobile phone.”

In 2002 around three in ten men aged 80 and over and nearly one in five women in England said they owned a mobile phone. Use of mobile phones and the Internet can help older people to remain independent by making it easier for them to communicate with their family and friends or to access public and commercial services. While Internet access is greater at younger ages, around one in ten men aged 80 and over and just over one in twenty women reported using the Internet in 2002.

Mobile phone ownership: by age and sex, 2002

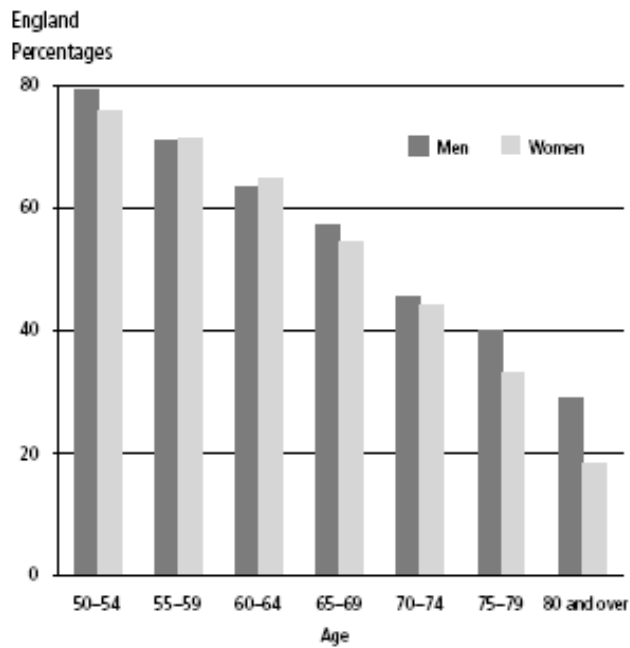
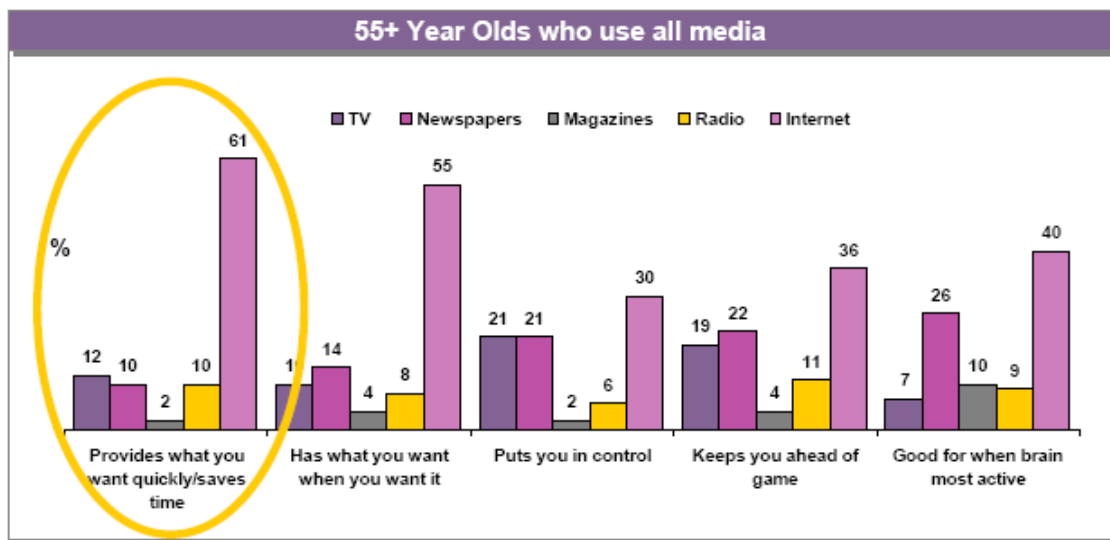


Figure 10. Mobile phone ownership: by age and sex, 2002

2.1.2.7 Media usage by elderly people



[Base: All 55+ Year Olds using all media (n=412)]

Figure 11. 55+ year olds who use all media, 2004

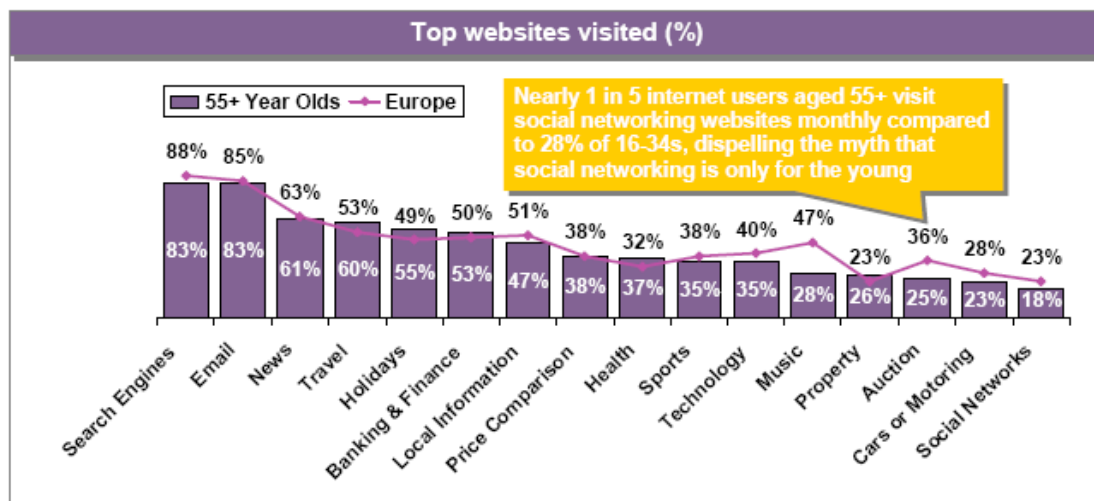


Figure 12. Top websites visited by old Internet users, 2004

Top 10 products/services bought online	55+ year old internet users
Travel tickets	47%
Holidays	32%
Books	29%
Concert/festival/theatre tickets	24%
Electrical goods	18%
Clothes	15%
CDs	11%
Car hire	9%
Cinema tickets	9%
DVDs	8%

[Base: All 55+ Year Olds using the Internet (n=711)]

Figure 13. Top of ten products/services bought online, 2004

2.1.3 Creating the personas

The most accurate way of creating personas, also called “cast of characters”, is to go through a phase of observation of real users within the environment in which the system will exist and eventually interview them with the intention of finding a common set of motivations, behaviours and goals among the end-users. However, this method is expensive and time-consuming. A low-cost

approach is to create them based on Norman's assumption personas where designers use their own experience to identify the different user groups. Norman explains that these assumption-based personas help designers to be aware of legitimate information that can have an effect on the system's design.

The personas creation process employed consists of two steps:

- **Sampling:** Originally we used the European population, specifically the elderly and impaired as the overall audience. Following the public European statistics from the EC we grouped the audience into different groups having similar characteristics (e.g. people of certain age, studies, acquisitive power, disabilities, etc).
- **Analysing:** After identifying the relevant characteristics among all the data gathered. Based on probabilistic values, we apply randomly the relevant characteristics from each group into ten Personas.

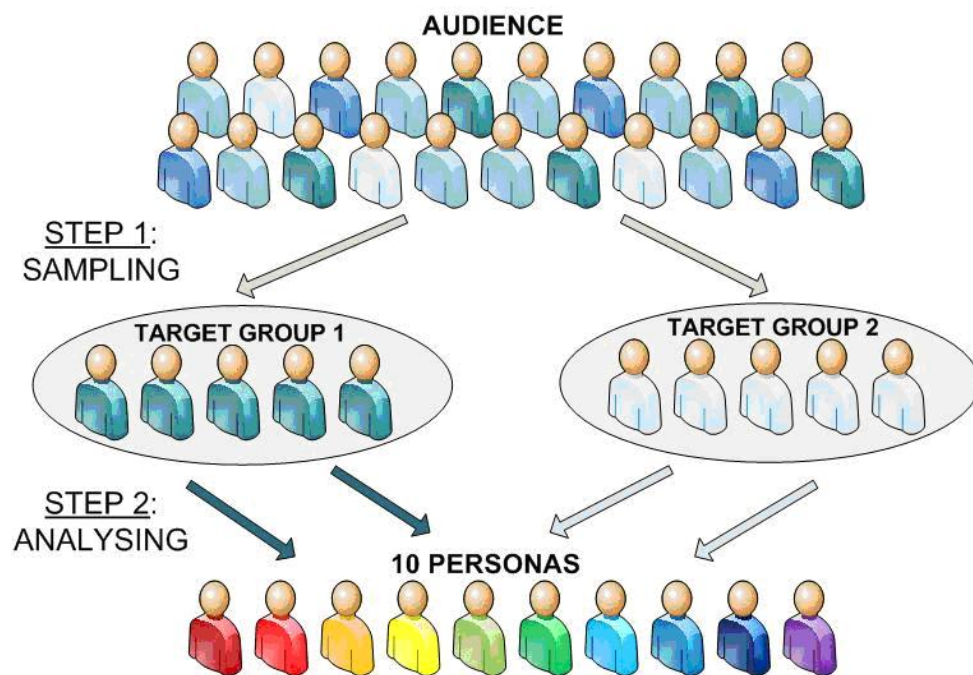



Figure 14. Persona creation method

As a result, we have defined ten data-driven personas, based on European statistics (taken from both Eurostat and EIAA websites). Age, education, work, family situation, impairments, technology background and so on were randomly assigned to each personas based on these EU statistics. The ten personas (of

different ages, from different countries and considering European indicators) are presented as follows:

- Hanna, 67 years old, Sweden
- Francesca, 73 years old, Italy
- Emilie, 86 years old, Belgium
- Mikkel, 73 years old, Denmark
- Katharina, 65 years old, Germany
- James, 69 years old, UK
- Nikos, 82 years old, Greece
- Joanna, 80 years old, Poland
- Manolo, 65 years old, Spain
- Juliette, 70 years old, France

Details of the personas created are in Annex I. The figure below represents one of the Personas created.



Hannah, 67 years old, Sweden

“I am looking for technologies that can bring me closer to my children...”

Retired, Ex-secretary in a bank	Suffers from mild impairment
Has a less upper secondary education	Suffers from osteoarthritis
Widowed, 1 daughter, 2 grandchildren	Owns a computer, no mobile phone.

Hanna used to work in a bank as the director’s secretary. She is a computer literate but never was interested in becoming a power user. Her arthritis started when she was 55 due to the repetitive typing movements on the keyboard.

Hanna was married for 38 years when her husband died a couple of years ago of a lung cancer. She is now living by her own in a quiet residential area in the south of Sweden. She spends most of her time at home doing common household tasks that she hates to do. She enjoys listening to the opera, taking long walks with her dog Bandit, meeting and playing cards with her friends every weekend, cooking and talking for hours on the phone with her daughter Michelle who lives at two hours driving from her. Living alone is not easy, and Hanna likes to get company: her daughter visits with her 2 grandchildren Adam and Erika as often as they can but not as much as Hanna would like.

Hanna wears glasses to correct her visual impairment but she only wears them when she needs to read or do something that requires seeing up close... like playing cards with her friends. Her vision of things at distance is good. She installed a glass magnifier on her computer monitor so she does not have to wear her glasses and she is able to check her emails without any difficulty.

Figure 15.A sample of a Persona

2.2 Analysis of tasks performed inside the kitchen considering ICF (International Classification of Functioning)

The approach followed by UNIZAR was a survey that aims to identify the main problems and needs that the elderly and people with disabilities have when interacting with white goods. We aim to identify the issues that would allow maximizing mobility, accessibility, usability and safety inside the kitchen, in order to overcome disabilities -whether they are sensory, motor or cognitive- achieving greater independence and quality of life. We specifically focus in four different areas related to different appliances: food storage, cooking, dishwashing and washing machine.

After analyzing the different tasks each appliance should do, we realized that interacting with the washing machine includes tasks that can be generalized to the other appliances. For example, door opening and closing and clothes loading and unloading have the same implications for the oven, fridge, dishwasher and microwaves, just changing clothes by food or crockery. Similar happens with the cognitive, sensory and physical implications of program selection and process monitoring in hobs, dishwasher, oven, etc.

The resulting tasks are the following:

- a) Organization and classification of clothing
- b) Door opening and closing
- c) Clothes loading and unloading
- d) Measuring detergent, softener and others products
- e) Program selection
- f) Washing process monitoring
- g) Maintenance, cleansing of filters and trays

This conclusion is supported by a detailed study of how a person with disabilities (physical, sensory and cognitive) faces each of the tasks. In this study we first **identify the subprocesses involved**. Following, the **capacities required to**

execute this task according to WHO's ICF¹ (International Classification of Functioning) are analyzed. Finally, the **physical, cognitive and sensory aspects of elderly people affecting the execution of the task** and corresponding appliance requirements are pointed out. Next we show those implications for each of the functions.

Organization and classification of clothing
<p><u>Subprocesses involved</u></p> <p>a) Grouping of clothing to be washed</p> <p>b) Classifying clothing according to colour for correct washing</p> <p>c) Execution of tasks prior to loading washing-machine (undoing buttons, turning trousers inside out...)</p>
<p><u>Capacities required to execute this task (according to CIF classification)</u></p> <p>↗ B1561 visual perception: mental functions for discerning shapes, colour, etc.</p> <p>↗ B210 visual functions</p> <p>↗ B2102 quality of vision: colour perception</p>
<p><u>Actions according to degree of difficulty</u></p> <p>↗ All: Warning, audio or visual, when full loading has taken place so as not to exceed weight limit</p> <p>↗ ³/₄: System for identifying clothing colours</p>

¹ The ICF is WHO's framework for measuring health and disability at both individual and population levels. The ICF was officially endorsed by all 191 WHO Member States in the Fifty-fourth World Health Assembly on 22 May 2001 (resolution WHA 54.21) as the international standard to describe and measure health and disability. It allows the assessment of functioning at the level of the whole human being, in day-to-day life.

ICF provides a taxonomy of domains classified from body, individual and societal perspectives by means of two lists: a list of body functions and structure, and a list of domains of activity and participation. Since an individual's functioning and disability occurs in a context, it also includes a list of environmental factors.

<p>↗ ½: Specific user training</p>	
<u>Aspects of elderly people affecting the execution of the task</u>	<u>Appliance requirements</u>
<p>PHYSICAL</p> <p>↗ Loss of strength: from age 55 onward there is a progressive loss of muscular strength</p>	<p>↗ Classifying clothes must not involve stressful motions, such as stretching, pushing hard, wide or unnatural twisting motions affecting joints, etc.</p> <p>↗ Clothes weight alarm for optimum loading of machine.</p>
<p>COGNITIVE</p> <p>↗ Discerning shapes, colour, etc.</p>	<p>↗ Aid in classification</p>
<p>SENSORY</p> <p>↗ Loss of vision:</p> <ul style="list-style-type: none"> ○ From age 40 onwards, the frequency of presbyopia increases (loss of focusing capacity on nearby objects) ○ Ageing leads to deterioration of the optical properties of the eyeball (loss of transparency and yellowing), which in turn reduces the sharpness of images on the retina (they become more blurry) and alters them chromatically (the colour green becomes harder to distinguish, while the colour red does not). ○ Ageing also leads to deterioration of the nerve mechanisms which respond to variations in light levels (adaptation to changes in the latter becomes slower and it is easier to be temporarily blinded by sharp variations). ○ Added to this, ageing also reduces the joint capacity of both eyes to combine information, and therefore, to differentiate between short distances, thus 	<p>↗ Use of brightly coloured labels</p> <p>↗ Use of non-reflecting surfaces</p> <p>↗ Specific clothes colour identification systems and training for the user</p> <p>↗ Highly visible colours for the colour-blind and elderly people with low level colour perception</p>

<p>reducing hand to eye coordination.</p> <ul style="list-style-type: none"> o Certain ophthalmologic illnesses become more frequent: cataracts (opacity of the cornea), glaucoma (increase of intraocular eye pressure) and macular degeneration. 	
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Opening and closing of doors

Subprocesses involved

- a) Access to washing-machine door
- b) Grasping and opening the door
- c) Closing of the door

Capacities required to execute this task (according to CIF classification)

- ↗ D445 Use of hand and arm: execution of coordinated actions required to manipulate and move objects using hands and arms, such as twisting of door knobs, reaching for and carrying objects
- ↗ D440 Fine motor hand skills: execution of coordinated actions such as manipulating and picking up small objects, letting go, pressing a button with a finger, holding an object between thumb and index finger

Actions according to degree of difficulty

- ↗ Minimising use of strength/movement
- ↗ -Facilitating grasping and manipulating the door's opening mechanism. New design
- ↗ -Guaranteeing the mechanism's security.

<p>↗ -Maximum opening of door, reminder to close it</p>	
<u>Aspects of elderly people affecting the execution of the task</u>	<u>Appliance requirements</u>
<p>PHYSICAL</p> <p>↗ Loss of articular mobility</p> <ul style="list-style-type: none"> ○ Bone problems ○ Rheumatism ○ Osteoporosis: greater skeletal fragility (suffered by a large proportion of women over 65) ○ The presence of degenerative processes such as arthrosis or arthritis, which limit joint mobility and cause pain during motion, is widespread. 	<p>↗ Minimising use of strength/motions</p> <p>↗ Facilitating grasping and manipulating the door's opening mechanism through the use of levers or handles</p> <p>↗ Size, shape and texture of objects must make the latter easier to operate and grasp for people with little muscular strength and/or possible joint problems, as well as possible tremor complications</p> <p>↗ The door must be accessible without having to bend over, higher than usual</p> <p>↗ Sharp movements must be avoided</p> <p>↗ The door must not close on its own after opening</p>
<p>COGNITIVE</p> <p>↗ Difficulty in executing complex tasks with both hands</p>	<p>↗ Guaranteeing the mechanism's security.</p> <p>↗ Light and sound "open safety catch" warning, provided with aid button</p> <p>↗ Must be able to open appliance with one hand to simplify the task</p>
<p>SENSORY</p> <p>↗ Visual impairment:</p>	<p>↗ Easily locatable opening</p> <p>↗ Light and sound warning to indicate door hasn't closed</p>

Loading and unloading clothes

<p><u>Subprocesses involved</u></p> <p>a) Access to inside of washing-machine b) Putting clothes into washing-machine c) Taking clothes out of washing-machine</p>	
<p><u>Capacities required to execute this task (according to CIF classification)</u></p> <p>↗ D445 Use of hand and arm ↗ D4105 Bending: forward, sideways, such as in crouching to pick something up. ↗ D415 Maintenance of body position: during the time necessary to complete a task.</p>	
<p><u>Actions according to degree of difficulty</u></p> <p>↗ Minimisation of handling and moving weight ↗ Laundry basket with wheels. Equally apt for placing washed laundry container on top to be moved and hung on the line to dry ↗ Design folding funnel system, extraction of drum, incline drum, etc.</p>	
<p><u>Aspects of elderly people affecting the execution of the task</u></p> <p>PHYSICAL</p> <p>↗ Loss of balance: difficulty in maintaining a specific posture ↗ Loss of trunk flexibility: frequently as a result of spondylosis (bone deposits between vertebrae) and spondyloarthritis (swelling and fusion of vertebrae) ↗ Loss of strength: elderly people, when standing up for protracted periods of time, may suffer leg and back fatigue ↗ Tremors</p>	<p><u>Appliance requirements</u></p> <p>↗ Guarantee edges of appliance are rounded. ↗ Minimisation of handling and moving weight ↗ Avoid bending of trunk, thus simplifying sedestation during the task. ↗ Sufficiently large door to facilitate task in case of tremor complications</p>
<p>COGNITIVE</p>	
<p>SENSORY</p> <p>↗ Visual impairment ↗ Hearing impairment</p>	<p>↗ Audio or visual warning of complete loading so as not to exceed the weight allowed by the washing-machine</p>

Measuring detergent and other products	
<u>Subprocesses involved</u>	
<ul style="list-style-type: none"> a) opening the tray b) picking up detergent or other products c) pouring product into tray d) closing tray 	
<u>Capacities required to execute this task (according to CIF classification)</u>	
<ul style="list-style-type: none"> ↗ D445 Use of hand and arm ↗ D430 Lifting and carrying an object, such as a cup or a glass from one place to another, and returning it to its place, such as depositing a water vessel on the floor. ↗ D440 Fine motor hand skills: holding a dosage measure in order to pour 	
<u>Actions according to degree of difficulty</u>	
<ul style="list-style-type: none"> ↗ Extraction of detergent tray. Improve or redesign ↗ Detergent or other products: measurement control ↗ System which facilitates depositing liquids in their proper place (dosage measure in drawer) 	
<u>Aspects of elderly people affecting the execution of the task</u>	<u>Appliance requirements</u>
PHYSICAL <ul style="list-style-type: none"> ↗ Loss of strength and flexibility, accompanied by difficulties in executing fine motor movements with hands (digital pincers) ↗ Tremors 	<ul style="list-style-type: none"> ↗ Facilitating extraction of detergent tray ↗ System for facilitating the deposit of liquids in their proper place ↗ Measurement control of detergents or other products ↗ Facilitating pouring of products, lightening the weight load to be lifted.
COGNITIVE	<ul style="list-style-type: none"> ↗ Assistance in determining quantity of product to be used, and where to pour each product.
SENSORY <ul style="list-style-type: none"> ↗ Visual impairment ↗ Hearing impairment 	<ul style="list-style-type: none"> ↗ Clarity in product classification – trays.

Programme selection and monitoring of washing process

Subprocesses involved

- a) selecting a programme
- b) initiating the programme
- c) monitoring the programme
- d) stopping the programme

Capacities required to execute this task (according to CIF classification)

- ✎ D2101-2 carrying out a single complex task independently: unassisted execution of a complex task with more than one component which must be performed simultaneously.
- ✎ D177 Decision-making: choosing one option amongst several, making the choice and assessing its effects.

Actions according to degree of difficulty

- ✎ Readability of characters or symbols, including Braille
- ✎ Cognitive simplicity: panel based on redundancy or incompatibilities in the sequence of actions
- ✎ Communication of the end of actions or errors and ways to rectify the latter.
- ✎ label-based symbols to improve the identification of programmes (Braille included)
- ✎ Monitoring of programmes through luminous, acoustic or other signs.
- ✎ Relating each type of fabric with the appropriate temperature, and using a single button
- ✎ Information system regarding the process: a button allowing the user to know when the washing is complete or how much time is left for it to be finished.
- ✎ Highly discernible colours for the colour-blind or elderly people who have problems to distinguish colours.
- ✎ Always use red for when something goes wrong (it's an almost universal association)
- ✎ The buttons for choosing type of clothing must have a different shape from the one that initiates the washing process (simplifies mental representation and minimises error margins)
- ✎ Buttons for choice of temperature will increase possibilities of error if they are located at the same height and have the same shape.
- ✎ Special care must be taken when selecting audio indication systems; they must also have cancelling properties for those people who do not require them (they could be confusing)

<u>Aspects of elderly people affecting the execution of the task</u>	<u>Appliance requirements</u>
<p>PHYSICAL</p> <ul style="list-style-type: none"> ➤ Hand mobility limitations, including difficulty in twisting, traction and precision movements. Difficulty in grasping buttons and exerting pressure. The most complicated wrist movement is lateral motion in both directions. 	<ul style="list-style-type: none"> ➤ Buttons or controls which are easy to grasp and offer little resistance ➤ Label-based symbols to improve identification of programmes (Braille included) ➤ Relating each type of fabric with the appropriate temperature, and using a single button
<p>COGNITIVE</p> <ul style="list-style-type: none"> ➤ Memory loss ➤ Alzheimer ➤ Senile dementia 	<ul style="list-style-type: none"> ➤ Communication of the end of actions or errors and ways to rectify the latter; cognitive simplicity: panel based on redundancy or incompatibilities in the sequence of actions ➤ Information system regarding the process: a button allowing the user to know when the washing is complete or how much time is left for it to be finished. ➤ Always use red for when something goes wrong (it's an almost universal association) ➤ The buttons for choosing type of clothing must have a different shape from the one that initiates the washing process (simplifies mental representation and minimises error margins) ➤ Buttons for choice of temperature will increase possibilities of error if they are located at the same height and have the same shape. ➤ Special care must be taken for selecting audio indication systems; they must also be able to have cancelling properties for those people who do not require them (they could be confusing) ➤ Reducing the need to make choices in tasks requiring a series of steps

	<ul style="list-style-type: none"> ➤ Avoid the use of acronyms and abbreviations, indicating wherever possible, the name of each programme in order to facilitate its identification.
<p>SENSORY</p> <ul style="list-style-type: none"> ➤ Presbiacusia, or hearing loss brought on by ageing. ➤ Visual impairment 	<ul style="list-style-type: none"> ➤ Readability of characters or symbols, including Braille. ➤ Reduction of risks derived from “unwanted actions” and/or the consequences derived from them (for example, accidental contact with a control should not involuntarily turn on the apparatus, nor should it involuntarily allow the latter to remain in motion due to oversight) ➤ Indication of the washing process with some ongoing luminous sign, to complement the sound of the washing-machine. ➤ Visible location of controls ➤ Tactile information on controls to facilitate identification.

Maintenance, cleansing of filters and trays

Subprocesses involved

- a) Extraction of filter
- b) Cleansing of filter
- c) Extraction of tray
- d) Cleansing of tray

Capacities required to execute this task (according to CIF classification)

- D 4101 Kneeling
- D4152 remaining in a kneeling position
- D4104 Standing up
- D4402 manipulating
- D4453 Twisting hands or arms

Actions according to degree of difficulty

- Improving strength and twisting to remove filter cover
- Locating it closer to an appropriate and functional area in terms of height and reach
- Automatic Cleansing

2.3 Surveys in Spain

After the analysis described in previous section we decided to make two different surveys. First one is very much detailed focusing in the tasks to be performed in the kitchen when interacting with white goods but just particularized for the washing machine (Annex II). Second one is more generic about the rest of the appliances: dryer, refrigerator, dishwasher, oven and hobs (Annex III).

We performed 43 surveys in the area of Zaragoza (rural and urban) within an average age of 71 years old. 34,88% of the people were female while the 65,12% were male. Besides the obvious old age associated limitations, the explicit disabilities the users have are Parkinson, memory problems, arthrosis, rheumatoid arthritis and osteoporosis.

2.3.1 Task analysis

The specific results of the washing machine arranged by task are the following:

TASK: CLOTH ORGANIZATION AND SELECTION (*People who perform the task, percent*)

- a) Group the dirty clothes together (37, 86%)
- b) Arrange the clothes by color or type (35, 81%)
- c) Perform other actions before loading the washing machine (unbutton shirts, turn inside out trousers...) (36, 84%)

TASK: OPENING AND CLOSING OF DOOR. (*People with difficulties, percent*)

- a) Accessing the door (14, 32%)
- b) Opening the door (13, 30%)
- c) Closing the door (5, 12%)

TASK: LOADING AND UNLOADING OF CLOTHES (*People who perform the task, percent*)

- a) Accessing the washing machine: *Sit to perform the task* (8, 19%)
- b) Loading of clothes: *Load the clothes one by one* (36, 84%)

- c) Unloading of clothes: *Bend while unloading* (11, 26%).

TASK: DETERGENT DOSAGE AND OTHERS (*People with difficulties, percent*)

- a) Opening the detergent drawer (6, 14%)
- b) Handling the products: *Put them into the drum* (13, 30%)
- c) Putting the product into the deposits:
- *Difficulties recognizing products* (6, 14%)
 - *Load difficulties* (5, 12%)
 - *Difficulties when extracting drawer* (13, 30%)
- d) Closing the drawer. (6, 14%)

TASK: PROGRAM SELECTION AND WASHING PROCESS (*People with difficulties, percent*)

- a) Selecting the program:
- *Access difficulties* (3, 7%)
 - *Handling difficulties* (3, 7%)
 - *Comprehension difficulties* (10, 23%).
- b) Starting the program. *Difficulties handling the button* (3, 7%)
- c) Stopping the program:
- d) Others:
- *Not sure if it is working* (8, 19%)
 - *Never use some programs* (24, 59%),
 - *Always use the same program* (22, 51%).

TASK: MAINTENANCE, CLEANING FILTERS/DRAWERS...

- *Need help to perform* (16, 37,2%)
- *Never do* (8, 18,6%)
- *Access difficulties* (11, 25,58%)
- *Lack of strength* (17, 39,5%)

Following we show other practical outcomes this study implies; proposal of solutions from the perspective of Design for All or Universal Design. Products that do not exclude anybody from their use, benefit all ages, conditions and levels of ability (empowering mobility, accessibility, usability and safety). Specifically, the results will help in fulfilling the following basic principles:

- i. Equitable use: Each design is useful and commercial regarding people of varying ability
- ii. Flexibility of use: Design must involve a wide range of individual preferences and capacity
- iii. Simple and intuitive use: Design must aim for easily understandable use, regardless of the experience and knowledge of users, their language skills, or their level of concentration at the moment of use
- iv. Perceptible Information: Design must communicate the relevant information effectively to the user, regardless of the surrounding conditions or the keenness of his senses
- v. Error tolerance: Design must minimize the hazards and negative consequences of accidental or unintended action
- vi. Reduced physical effort: Design must lead to efficient and comfortable use, reducing effort or fatigue to a minimum
- vii. Size and space for access and use: Adequate size and space must be offered to access, reach, manipulate and use regardless of body size, position, mobility

Qualitative results from each of the appliances are the following

2.3.2 Cold Storage

Within this category we include the appliances use for refrigeration. We have considered five different "states of interaction" between the user and the refrigerator:

- Opening/ closing
- Loading/ unloading

- Use of controls
- Cleaning
- Safety

We first present the most habitual features that refrigerators have nowadays.

Then we identify the needs that a person with loss of skill and strength in hands, reduced attention span and impaired vision may have.

Finally we identify the possible modifications that can be done in order to facilitate the person in the previous "states of interaction".

1. Most habitual features of present "non-adapted" refrigerators

- Dimensions: As wide and low as possible. (175 x 70 cm)
- The necessary electronics from other models will be included to have the sensors and optic alarms (presently in freezers to check rises in temperature) and acoustic (open door) alarms
- Reversible opening on doors (on installing)
- Automatic thawing
- Drawers with adjustable temperature and humidity according to height
- Vertical handle

2. Identified user needs or difficulties with present refrigerators

	Opening/ Closing	Loading/ Unloading	Use controls of	Cleaning	Safety
Loss of skill and strength in hands	<ul style="list-style-type: none"> ▪ New handle substituting the present vertical type. The horizontal type has been ruled out, since it is less ergonomic ▪ Lever system 				
Reduced attention span	<ul style="list-style-type: none"> ▪ Acoustic and optic alarm to warn of door left open on refrigerator or freezer 				
Impaired vision		<ul style="list-style-type: none"> ▪ Serigraphy/ tampography of trays and drawers with symbols embossed and in contrasting colors ▪ Plastic stands for tray edges with magnifying effect and labels for identifying trays ▪ Plastic or methacrylate vertical strip or panel to be placed on the side of trays, serigraphed 	<ul style="list-style-type: none"> ▪ Alternative reading and identifier system (e.g ONCE Voilà embossable labels) 		

		with embossed symbols and contrasting colors			
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3. Desired characteristics of refrigerators

	Opening/ Closing	Loading/ Unloading	Use of controls	Cleaning	Safety
Modification / Action upon product Accessories and complements	<ul style="list-style-type: none"> ▪ New hinge allowing opening of door at different degrees: 90°, 135° and 180° ▪ On installation, choice of how to open (left or right) ▪ Rail system opening for freezer drawers ▪ Click-clack mechanical opening. Must ensure airtight closure, since a single closing point is most likely ▪ Mechanical pedal-operated opening 	<ul style="list-style-type: none"> ▪ Include additional lighting, halogen or krypton: vertical or lateral ▪ Removable trays and drawers with telescopic rails ▪ Modification of molds on door shelves or frames for trays in order to include embossed symbols ▪ Painting of such symbols in contrasting colors ▪ Include reading system for embossable labels as refrigerator accessory ▪ RFDI label reader integrated in the refrigerator 		<ul style="list-style-type: none"> ▪ Titanium or stainless finish not showing prints ▪ Easily removable trays and door shelves ▪ Include stand to place in Easy Line range dishwashers 	<ul style="list-style-type: none"> ▪ Acoustic and optic alarm to warn of door left open on refrigerator or freezer or cuts in power supply

	<ul style="list-style-type: none">▪ Electromagnetic button-operated opening (The electromagnetic force generated must overcome suction effect)▪ Autoclose - servoclose Mechanical system that accompanies the last stretch for correct closing of the door	<ul style="list-style-type: none">▪ Rotating trays▪ Plate carrier▪ Racked side drawers▪ Folding upper trays mounted on guiding arms▪ Food classification : Boxes/ containers/ to ease proper sorting out of food▪ Label kit with embossed symbols and contrasting colors for easy identification...▪ Removable work tray between refrigerator and freezer▪ Support system allowing placement of food and containers in front of refrigerator			
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2.3.3 Washing Machine

Within this category we include the appliances use for doing the washing. We have considered five different “states of interaction” between the user and the refrigerator:

- Opening/ closing
- Loading/ unloading
- Use of controls
- Cleaning
- Safety

We first present the most habitual features that washing machines have nowadays.

Then we identify the needs that a person with loss of skill and strength in hands, reduced attention span and impaired vision may have.

Finally we identify the possible modifications that can be done in order to facilitate the person in the previous “states of interaction”.

1. Most habitual features of present “non-adapted” washing machines

- Dimensions: width 60 cm. Mounted upon 30 cm. Base when possible
- Window: 180° opening, 30 cm. diameter
- Installation free
- Front loading (ideal for loading from a wheelchair) or top loading (for those unable to bend or kneel or who lack space: 40 cm. wide instead of 60 cm.)
- 900 rpm. Minimum spin-dry
- 6 kg. capacity
- Necessary electronics from Digital Vision models to have necessary sensors and optic and acoustic alarms
- Aquastop
- Without digital display

2. Identified user needs or difficulties with present washing machines

	Opening/ Closing	Loading/ Unloading	Use of controls	Cleaning	Safety
Loss of skill and strength in hands	<ul style="list-style-type: none"> ▪ New opening handle (in the development phase in Germany) ▪ Modify position on the upper part of the window 	<ul style="list-style-type: none"> ▪ Support/work tray when washing machine and tumble dryer are mounted vertically ▪ 30 cm. base ▪ Trolley for sorting out and transporting clothes ▪ Stool for sitting while sorting out, loading and unloading of clothes 			
Reduced attention span			<ul style="list-style-type: none"> ▪ End of program call accessory: apply domotics, bluetooth,... 		
Impaired vision		<ul style="list-style-type: none"> ▪ Embossed detergent deposits with contrasting colors ▪ Supply or integrate reader/detector for clothes color (on the basis of the ONCE reader) ▪ Identifying label set for classifying clothes: 	<ul style="list-style-type: none"> ▪ Embossed and colored labels in order to ease identification and programs and steps to be followed ▪ Cover for placing over present control panels 		

		<ul style="list-style-type: none"> ▪ Labels easy to place on clothes ▪ With embossed symbols and contrasting colors 	in order to show only standard programs and identify options with embossments, visible symbols, and contrasting colors		
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3. Desired characteristics of washing machines

	Opening/ Closing	Loading/ Unloading	Use of controls	Cleaning	Safety
Modification / Action upon product Accessories and complements	<ul style="list-style-type: none"> ▪ Reversible doors able to open from left or right (to be determined at the moment of installation, depending on location) ▪ Electro-mechanical button operated opening ▪ Automatic opening system at the end of the program 	<ul style="list-style-type: none"> ▪ Integrate reader/detector of clothes colors in frontal control panel (on the basis of the ONCE reader) ▪ Removable deposit in the detergent drawer for measuring out detergent and softener, to be placed directly in the basket of the washing machine ▪ Set of nets for organizing and sorting out clothes ▪ Set of pins for sorting out socks ▪ Supply washing machines with 3 in 	<ul style="list-style-type: none"> ▪ Light and sound call to inform of end of program ▪ Control panel with expert and basic modes: retractable (as in video remote control) ▪ Electromechanical buttons ▪ Revised and common control panel logic for the whole range 		

	<p>and waiting period. Thanks to this, it is only necessary to pull the door open gently to 180°</p> <ul style="list-style-type: none"> ▪ Servo-closing ▪ Vertical door opens to 90° to be used as work tray ▪ Diagonal opening and access : hybrid of top and frontal loading 	<p>1 tablets: detergent + softener + ironing aid (Bold or Persan Carrefour type)</p> <ul style="list-style-type: none"> ▪ Supply arielita type dosage accessory ▪ RFID label reader or bar code label reader integrated in washing machine ▪ Re-loadable detergent/softener deposit (viscosity still to be validated with detergent brands) ▪ Electromechanical (DVD type) deposit opening ▪ Removable basket on rails ▪ Inclined basket ▪ Functional for giving the basket a last turn once it is empty, to check that there are no clothes stuck to the sides 	<ul style="list-style-type: none"> ▪ Single remote control for monitoring and activating Easy Line range appliances ▪ Front of control panel inclined 45° ▪ Possibility of retracting, hiding or disconnecting buttons with expert functions ▪ Entirely automatic: excepting on/off. Applying IQ or Logixx electronics 		
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2.3.4 Cooking (stoves, oven and microwaves)

Within this category we include the appliances use for cooking including stoves, oven and microwaves. We have considered five different “states of interaction” between the user and the cooking appliances:

- Opening/ closing
- Loading/ unloading
- Use of controls
- Cleaning
- Safety

We first present the most habitual features that cooking appliances have nowadays.

Then we identify the needs that a person with loss of skill and strength in hands, reduced attention span and impaired vision may have.

Finally we identify the possible modifications that can be done in order to facilitate the person in the previous “states of interaction”.

1. Most habitual features of present “non-adapted” cooking appliances

- Dimensions: Depending on type of disability and kitchen installation restrictions, one of the following will be chosen:
 - Built-in
 - Under worktop
- Retractable rails telescopic Quadro
- Include electronics from higher range models in order to have automatic disconnection system
- Servo-closing
- Cold door
- Self-cleaning oxylic surface

2. Identified user needs or difficulties with present cooking appliances

	Opening/ Closing	Loading/ Unloading	Use of controls	Cleaning	Safety
Loss of skill and strength in hands		<ul style="list-style-type: none"> ▪ Accessories to ease food preparation, cooking, etc.. (accessory portfolio to be included for each task still to be determined) 			
Reduced attention span		<ul style="list-style-type: none"> ▪ Accessories to ease food preparation, cooking, etc.. (accessory portfolio to be included for each task still to be determined) 			
Impaired vision	<ul style="list-style-type: none"> ▪ Removable cover with holes to ease placing of pots on burners ▪ Embossed serigraphy for burners marking heated areas ▪ Slight positive or 	<ul style="list-style-type: none"> ▪ Accessories to ease food preparation, cooking, etc.. (accessory portfolio to be included for each task still to be determined) 	<ul style="list-style-type: none"> ▪ Embossed and colored labels in order to ease identification and programs and steps to be followed ▪ Cover for placing over present control panels in order to show only standard programs and identify options with 		

	negative embossment of glass surfaces <ul style="list-style-type: none"> Adhesive stops delimiting location of burners (heat resistance of materials still to be verified) 		embossments, visible symbols, and contrasting colors		
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3. Desired characteristics of cooking appliances

	Opening/ Closing	Loading/ Unloading	Use of controls	Cleaning	Safety
Modification / Action upon product Accessories and complements	<ul style="list-style-type: none"> Horizontal 180° opening door for column-mounted ovens (like Bosch HBN 33L550) Servo-closing system of vertical opening doors 	<ul style="list-style-type: none"> Illuminate heated area in induction tops (same solution used for induction) Pot placement system located on extractor, with acoustic or light signals 	<ul style="list-style-type: none"> Control panel with expert and basic modes: retractable (as in video remote control) Electromechanical buttons Revised and common control panel logic for the whole range 	<ul style="list-style-type: none"> Include glass trays to ease cleaning 	<ul style="list-style-type: none"> Illuminate heated area in induction tops (same solution used for induction) Visual and acoustic alarm when stove is left on or a certain temperature inside cooking vessels is reached

	<ul style="list-style-type: none"> ▪ Button-operated rail opening system (DVD type) ▪ Retractable door (Neff type) ▪ Revolving door carousel or half-moon ▪ Elevating carriage and trays with guiding arms ▪ Ergonomic handle (leibehr type) 		<ul style="list-style-type: none"> ▪ Single remote control for monitoring and activating Easy Line range appliances ▪ Front of control panel inclined 45° ▪ Possibility of retracting, hiding or disconnecting buttons with expert functions ▪ Automatic recipe programming : EPS system 		<ul style="list-style-type: none"> ▪ Visual and acoustic alarm when left on ▪ Smoke/temperature detector alarm ▪ Cooking vessels with infrared temperature control
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2.3.5 Dishwasher

Within this category we include the appliances use for washing crockery. We have considered five different “states of interaction” between the user and the dishwasher:

- Opening/ closing
- Loading/ unloading
- Use of controls
- Cleaning
- Safety

We first present the most habitual features that dishwashers have nowadays.

Then we identify the needs that a person with loss of skill and strength in hands, reduced attention span and impaired vision may have.

Finally we identify the possible modifications that can be done in order to facilitate the person in the previous “states of interaction”.

1. Most habitual features of present “non-adapted” dishwashers

- Dimensions: width 60 cm. mounted upon 30 cm. base where possible. In case space is limited, narrow 45 cm. model is included
- Installation free
- Necessary electronics from high range models in order to have the optic and acoustic sensors and alarms considered necessary: Active sensor to determine degree of dirtiness of the water; Automatic identification of use of 3 in 1 tablets; Horizontal handle; Servo-closing, block at different opening degrees; Aquastop
- Height adjustable upper trays (rackmatic)
- Half load in both trays
- Built-in duo and comfort baskets
- Holder for washing refrigerator/oven trays and diffuser piece
- Auto-cleaning of salt deposits

2. Identified user needs or difficulties with present dishwashers

	Opening/ Closing	Loading/ Unloading	Use of controls	Cleani ng	Safe ty
Loss of skill and strength in hands	<ul style="list-style-type: none"> ▪ New ergonomic handle: lever or wide horizontal handle type for both hands 	<ul style="list-style-type: none"> ▪ Bow-shaped, waist-high handles for lower tray (still to be verified with basket supplier) 			
Reduced attention span			<ul style="list-style-type: none"> ▪ End of program call accessory: apply domotics, bluetooth,... 		
Impaired vision		<ul style="list-style-type: none"> ▪ Different colors with high contrast to differentiate each area: glasses, dishes, etc. 	<ul style="list-style-type: none"> ▪ Embossed and colored labels in order to ease identification and programs and steps to be followed ▪ Cover for placing over present control panels in order to show only standard programs and identify options with 		

			embossments, visible symbols, and contrasting colors		
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3. Desired characteristics of dishwashers

	Opening/ Closing	Loading/ Unloading	Use of controls	Cleaning	Safety
Modification / Action upon product Accessories and complements	<p>Automatic opening system at the end of the program. Thanks to this, it is only necessary to pull the door downwards gently once the program is completed</p> <ul style="list-style-type: none"> ▪ Opens completely and automatically ▪ Rail/ drawer system opening / (to avoid water spill) ▪ Servo-closing / auto-lock 	<ul style="list-style-type: none"> ▪ Special compartment in upper trays for placing 3 in 1 tablets ▪ Place detergent deposit or tablet loader at the upper edge of the door (rather than at the center of the door) ▪ Same location for control panel as for high range models ▪ Top dispenser ▪ Modify location of salt compartment ▪ "Mono" baskets to 	<ul style="list-style-type: none"> ▪ Light and sound call to inform of end of program ▪ Control panel with expert and basic modes: retractable (as in video remote control) ▪ Electromechanical buttons ▪ Revised and common control panel logic for the whole range ▪ Single remote control for monitoring and activating appliances 		

		<p>organize the service of a single person</p> <ul style="list-style-type: none">▪ Elevating lower tray (mechanical telescopic guides and arms)▪ Collapsible baskets and holder for refrigerator and oven trays	<ul style="list-style-type: none">▪ Front of control panel inclined 45°▪ Possibility of retracting, hiding or disconnecting buttons with expert functions▪ Entirely automatic: excepting on/off. Applying IQ or Logixx electronics		
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2.3.6 Generic issues

This section details generic issues common to all white goods such as instructions, installation manual, assistance and maintenance.

1. Instructions and Installation Manual

Regarding the instructions manual it would be necessary to include recommendations for installation according to type of appliance, place of installation, kind of disability and recommended accessories.

The preferred format is integrated in menus (on screen and F1 type keys or printers) and controls vs. traditional devices. Also a Quick Start Guide with "comic book" format may be appropriate to summarize the basics, even if it were longer than the present one for washing. Other generic characteristics the booklet may have are:

- Two sections of the booklet: Installation and operation
- DVD together with booklet (available on request) or even issue regularly
- Booklet carefully presented, attractive, with explanatory text for all ranges
- Abbreviated instructions, in lively colours and on a single page
- Explanation of how to unblock the safety device for children (problem common to all ranges)
- It would be convenient to read the booklet with the technician

If the product is finally a high-tech product with electronics and displays indicating multiple functions, the technician may start up the appliance selecting the functions best adapted to the user's disability, thus personalizing it; in such a case we should define a wide gamut of start-ups, with different operations combining type of appliance and user's disability.

Some specific considerations that should appear in the manual of each appliance are the following:

WASHING:

- Explain the functions of the different keys and guide through the steps for each function
- Indication of duration of washing times
- Steps to follow to program the washing machine
- In case installation is not free of charge, highlight that catches must be removed in case of unassisted installation

OVENS:

- How to use and program
- How to program
- No problems for extractors (simple operation and installation by technician)

SMOOTH-TOP STOVES:

- How to activate double area from control (all-purpose oven)
- Touch control tops: how to use sprint / booster function and how many burners it serves
- Explain Thermocontrol System (Balay)
- Touch control smooth-top stoves: to interrupt start-up, keep pressed for more than one second

DISHWASHERS:

- Improve explanation of eco program (users believe there is a breakdown due to the long duration of the program)
- Explain half load
- Explain Aquastop
- Offer guidance on washing times (featured in the salt booklet, and not read by the user)

COLD STORAGE:

- Explain "winter switch" (switch heats at half capacity) to avoid thawing due to lower outside temperatures

- Same display for refrigerator and freezer? Confusion
- Temperature on display: selected or actual? Confusion (excessive variation in No Frost)
- If placed horizontally during transport, indicate that it must be left to stand vertically for at least 6 hours so that oil settles back in place
- Cold storage booklet: displays / LEDs to indicate whether temperature is actual or selected and explain flickering light

2. Assistance and Maintenance

It should be convenient to have a maintenance service via telematics, mainly using telephone lines.

The telephone number for assistance to the user should be more clearly indicated on these appliances, since the CAU (User Assistance Center) must be the only contact point for information on the product, repair calls, telephone assistance, etc (for all ranges)

It would be recommendable for these appliances to be sold with a 5-year guarantee, or it should be included in the retail price, or the manufacturer should cover the cost

Possibility of defining and designing "adaptation kits" for appliances that would make it possible to adapt the product without any added technical complexity; a logical analysis of the economical feasibility of these actions__should be performed, as well as the cost that should be reflected in the retail price

3. General Features of Interacting Elements

In this section some generic issues targeted by users are presented. Besides these considerations, ISO/IEC Guide 71 and ISO/TC 159 N 525 also provide useful guidelines for standards developers to address the needs of older persons and persons with disabilities.

Buttons must be:

- Large (difficult for people with motor limitations in hands, easy location and access)
- Bold embossment (easier to detect by touching)
- Generalized codes for the entire range of appliances (feedback)

Other controls must be:

- Easy to handle
- Audio signal for selecting. Feedback
- Maximum for each point of chosen option

Visual indicators must have:

- On/off light systems (red and green).
- Information in large letters
- Differing geometric shapes depending on function configuration (touch)
- Generalized sound effect for the entire range (Hearing)

2.3.7 Conclusions of the surveys

Important conclusion is that the survey becomes long, not much clear or appealing, with too many white goods.

Another important issue raised from the people in charge of day centers and by the users themselves, is that microwave should be included because they are much more used than ovens.

In the next table we resume the main issues previously detailed.

Cold storage	Washing	Dishwashers	Cooking
<ul style="list-style-type: none"> ▪ Identification of expiration date and condition of food items ▪ Identifying location of products ▪ Easing opening (suction) with lever ▪ Recognizing products ▪ Access to controls (difficult access) ▪ Difficulty in recognizing product/container ▪ When door is left open, call of alert is heard ▪ Identify convenient areas for each item of food and drink (colors could be used). ▪ Avoid formation of ice, Make noise-free and mark in Braille the place where each food item should be found, especially in the freezer drawers ▪ The freezer could warn of expiration dates ▪ Ease access to upper trays 	<ul style="list-style-type: none"> ▪ Avoid bending or squatting, difficulty for manipulating objects lower than knees ▪ Hard understanding of menus and programs, difficulty of perception ▪ Easy identification of end of program to avoid forgettings ▪ Door closing safety ▪ Ease communication of functions ▪ Knowing how much washing time is left ▪ Place touch indicators ▪ 1 function → 1 button ▪ End of washing signal ▪ Different shapes for buttons to ease identification ▪ Single options for color clothes and whites ▪ Reassurance that it works 	<ul style="list-style-type: none"> ▪ Strength: difficulty for moving large containers ▪ Strength: difficulty for moving dishes ▪ Discomfort of having to squat frequently and bend for every dish ▪ Total inaccessibility with vertical opening doors for people on wheelchairs ▪ Improved access to salt deposit ▪ Lower basket is difficult to reach from a wheelchair ▪ If dishes and other elements were set in smaller, easily removable baskets (as, for example, the usual baskets for cutlery) they would be easier to store in place 	<ul style="list-style-type: none"> ▪ Difficulty in identifying cooking stages ▪ Burns when checking if food is cooked ▪ Difficulty with controls, not easy enough to handle ▪ Safety of placing cooking vessels properly ▪ Opening. Oven lever too hard to pull ▪ Difficulty to see properly inside the oven without opening it ▪ Unclear menu ▪ Difficulty with controls, not easy enough to handle ▪ Embossed buttons ▪ Placing safety ▪ Non-digital controls ▪ Emboss edges to aid proper placing ▪ Retractable trolley ▪ Touch ring to check burner area ▪ Added mobility for grill ▪ Beep in case pot or pan is not in proper place

3. FUNCTIONALITIES REQUIRED AND POTENTIAL BENEFIT FOR THE TARGET GROUP

From the DoW, the project foresees to integrate RFID, Neuronal Networks and HMI technologies to build a system that collects data of the home environment and controls any “white good” at home via wireless communication or main connections (EMS, PLC). The users could actuate by themselves any “white good” at home or could let the “e-servant” do the actuation. The “e-servant” will be a White Good control system based on the sensor information and the habits of the users that can program any application without/or with user cooperation. The “e-servant” will also be a “learning system” that detects the loss of abilities of the user and try to compensate them. Main functionalities so far envisioned for the white goods have been:

- REFRIGERATOR
 - o Refrigerator will comment on what goes in and out
 - o Refrigerator will comment on expired goods
 - o Refrigerator will advise on goods where cooling has been interrupted (thermal TR)
- OVEN-MICROWAVES
 - o Development of intelligent systems which aid in the programming of the appliance
 - o Reading the information of the food about to be cooked
 - o Inform the user about the configuration needed to cook food
- WASHING MACHINE
 - o Investigate current industrial laundry solution for domestic applications, i.e. sorting aids to see if modification is appropriate.
 - o Development of intelligent systems which aid in the loading of washing machines
 - o Development of intelligent systems which aid in the programming of the appliance

- STAND-ALONE RFID READER
 - o Identify tagged products that will come into the kitchen after shopping
 - o Identify the packs in the garbage when dropping it.

After the work done in WP1 (analysis of the results in the surveys, the analysis of the European statistics and common work with experts in disability) and considering the technological boundaries in the frame of the project, following we describe the specific prototype functionalities.

E-servant is the central part of the new system enhancing the intelligence of the white goods and providing new functions:

a) Facilitate the use of the household appliances adapting to the disabilities or preferences of the user and using adapted interfaces. Thanks to the multidisciplinary design of the system with social and health workers, we decided not to automatically change the system's functioning to avoid user disorientation. Specifically the functions provided are the following:

- FRIGDE / FREEZER
 - i. Display status:
 1. On / Off / Problem / Disconnected
 2. Temperature (°C)
 3. Door open / closed
 4. Contents
 - ii. Configure:
 1. Target temperature (°C)
- WASHING MACHINE
 - i. Display status:
 1. On / Off / Problem / Disconnected
 2. Time to finish (mins)
 3. Door open / closed
 4. Contents
 - ii. Configure:

-
1. Switch On / Off
 2. Set washing program
- HOB
 - i. Display status:
 1. On / Off / Problem / Disconnected
 - ii. Configure:
 1. Switch Off
 - OVEN
 - i. Display status:
 1. On / Off / Problem / Disconnected
 2. Temperature (°C)
 3. Time to finish (mins)
 - ii. Configure:
 1. Switch On / Off
 2. Set target temperature (°C)
 3. Set cooking starting time
 4. Set duration (in minutes)
- b) Provide useful information and warnings about the use of the household appliances. Specifically the following:
- FRIGDE / FREEZER
 - i. Advise if the door is left open
 - ii. Advise if food is past its use-by date
 - iii. Advise if food is approaching its use-by date
 - iv. Warning about fridge/freezer breakdown
 - WASHING MACHINE
 - i. Advise of wrong mix of clothes (e.g. white and coloureds)
 - ii. Advise of unsuitable fabrics (e.g. dry clean only)
 - iii. Advise if machine loaded but not yet on
 - iv. Advise if cycle interrupted
 - v. Advise if unload incomplete
 - vi. Advise when machine is on final spin

- vii. Advise when cycle finished
 - viii. Warning about washing machine breakdown
 - HOB
 - i. Advise if hob is left on with no pan
 - ii. Warning about hob breakdown
 - OVEN
 - i. Advise when food is ready
 - ii. Warning about oven breakdown
 - STAND-ALONE READER
 - i. When reading a piece of clothing, inform about how to wash it, colour, etc
 - ii. When reading food item, inform how to cook it, expiration date, etc.
- c) Detect emergency situation and automatically take some actions: warn the user, switch off some appliances (e.g. the hob and oven in case of fire or the washing machine if water detected).
- Advise "Fire detected" emergency
 - Advise "Smoke detected" emergency
 - Advise "Flood detected" emergency

The following table lists the expected level of benefits of the determined prototype functionalities for the elderly people in consideration of the main types of their disabilities. This table is created from the results of the surveys and the common work with experts in disability.

Advanced functionalities of prototypes	Expected benefit ²		
	Physical impaired	Sensory impaired	Mild-cognitive impaired
Facilitate the use of the household appliances adapting to the disabilities or preferences of the user and using adapted interfaces.			
Indication of fridge/freezer status: On/Off/Problem/Disconnected, door open or closed, current temperature	High	Medium	High
Display of fridge/freezer contents	High	Medium	Medium
Support for configuration of fridge/freezer settings: Set target temperature	High	High	Medium
Indication of washing machine status: On/Off/Problem/Disconnected, door open or closed, time to finish	High	Medium	High
Display of washing machine contents	High	Medium	Medium
Support for configuration of washing machine settings: Set washing program, switch on/off	High	High	Medium
Indication of hob status: On/Off/Problem/Disconnected	High	Medium	High
Support for configuration of hob settings: Switch off	High	High	Medium

² The level of benefit highly depends on the individual condition of the elderly people and may change in process of time. For instance the practical benefit of notifications or reminders is only important as long as physical impaired persons are able to react on the corresponding situation. As a sad consequence, a diminishing condition of the concerned persons can decrease the level of benefit dramatically.

Indication of oven status: On/Off/Problem/Disconnected, time to finish, temperature	High	Medium	High
Support for configuration of oven settings: Set target temperature, switch on/off, set starting cooking time, set duration	High	High	Medium
Provide useful information and warnings about the use of the household appliances			
Advise if the fridge/freezer door is left open	High	High	High
Advise if food is past its use-by date	High	High	High
Advise if food is approaching its use-by date	Medium	Medium	High
Warning about fridge/freezer breakdown	High	High	High
Advise of wrong mix of clothes (e.g. mix of white and coloured clothes)	High	High	High
Advise of unsuitable fabrics (e.g. dry clean only)	High	High	High
Advise if machine loaded but not yet on	High	High	High
Advise if cycle interrupted	High	High	High
Advise if unload incomplete	High	High	High
Advise when machine is on final spin	High	High	High
Advise when cycle finished	High	High	High
Warning about washing machine breakdown	High	High	High
Advise if hob is left on with no pan	High	High	High
Warning about hob breakdown	High	High	High
Advise when food in the oven is ready	High	High	High
Warning about oven breakdown	High	High	High
Inform how a cloth should be washed, its colour, etc.	Medium	Medium	High

Inform how food should be cooked, its expiration date, etc.	Medium	Medium	High
Detect emergency situation and automatically take some actions			
Advise "Fire detected" emergency	High	High	High
Advise "Smoke detected" emergency	High	High	High
Advise "Water detected" emergency	High	High	High

It is evident that all mentioned safety-related functionalities are generally important for all elderly people and therefore high rated.

Most of the other functions of the prototypes imply easier to operate appliances for the major part of elderly people with physical, sensory or mild-cognitive problems. For this reason they are assigned to ensure a high or medium benefit for the concerned type of disability.

Only some of the functionalities provide a lower extended benefit for the corresponding disabilities but nevertheless they increase the ease of use of the appliances.

Besides this functionalities directly derived from the utilization of the system by the user, an additional functionality for the carer has been identified. By analyzing all the data gathered it would be useful to extract the relevant information in order to evaluate the person's quality of life. Thus, it has been found interesting for user's carer and/or relatives to detect behaviour changes, loss of abilities (memory problems, oblivions, etc.) of the user. For example, it seems clear that changes in HMI's navigation skill, opening the fridge too many times (without picking anything) or loss of skill of programming the washing machine might have relationship with cognitive capacity or disorientation.

4. DEFINITION OF THE TECHNOLOGICAL DEVELOPMENTS OF THE PROJECT

The application of society information to home environments is characterized by the integration of networked computational devices into the physical context. This trend, associated with ubiquitous computing, is evolving toward systems with intelligent and context-sensitive behaviour: a vision of future technological development in Ambient Intelligence (Aml) [2].

Ambient intelligence is characterized by ubiquitous computing, ubiquitous communications and intelligent user's interfaces. Aml systems have to be adaptive, personalized, unobtrusive and anticipatory [3, 4].

As system development trend, universal access to Aml environments brings about the accessibility and usability by user with different characteristics and needs [10]. It is widely know that Aml and ubiquitous computing can cope with elderly and people with disability problems in their everyday life [5, 6, 7]. Regarding home environment systems, a remarkable feature is to support daily routines, such as preparing food or operating household appliances. In order to give access to Aml systems for people with special needs, a multidisciplinary approach (health, social workers and engineers) has to be done. As said earlier, an Aml system has to be adaptive -its behaviour can change in response to a person's actions and environment- and personalized -its behaviour can be tailored to the user's needs-. According to these features, Aml systems for elderly and people with disabilities have to adapt not only to user's actions and environment, but also to the behaviour and frame of mind. A context-sensitive Aml system should reconfigure dynamically to accommodate the needs of users, taking into account a wide range of users and context or behaviour situations.

It is necessary to enlarge the technological approach to Aml: *designed mainly by engineers*. The inclusion of health and social science's knowledge is an essential issue that will enable Aml systems to evolve in order to better cope with elderly and disabled people singularities. It has been demonstrated that it exists a relationship between psychological health and functional activities of daily living [8]. Therefore, supporting daily tasks with the help of Aml systems can improve the quality of life.

4.1 Engineering approach

Previous to the development of an Aml system, context and context-awareness concepts should be properly understood [9]. An understanding of how context can be used will help technological designers to determine which devices and information are necessary in their application. The goal of context-aware computing is to make them interact easier with computers. A context-aware application should collect contextual information through automated means and use this information to execute actions or warnings, present information or modify the environment. To sum up, context-aware applications use context to provide task-relevant information and/or services to a user.

The ambient intelligence environment is composed of processing units distributed over the physical context, as well as wearable devices. Ubiquitous computing enables these objects to communicate with each other and the user. There is a wide range of devices that can be used in Aml systems (screens, displays, cameras, location systems and a variety of sensors), whose function is to collect contextual information. Prior to the design of an Aml system, technologists (electronics, human-computer interaction, computer science) have to decide which features is expected the system to have. Afterwards, designers should choose which contextual information is needed to be able to perform the system's features. Once the necessary contextual information is chosen, devices capable of collecting this information have to be selected, bearing in mind whether the devices are embedded or wearable.

The human-computer interface (HCI) enables the user to control and interact with the environment in a natural and personalized way. Traditional HCI requires an active bi-directional communication between the user and the computer. As the Aml systems increase their complexity and computational power, a paradigm of implicit human-computer interface (iHCI) appears [10]. The basic idea of implicit interface is that the system perceives the users interaction with the contextual information rather than user's explicit actions.

An example of a traditional Aml system architecture is shown in Figure 16. Once the contextual information is collected, there is a data fusion process, which output will be evaluated. This processed information will be used as input of the

decision process, applying action rules previously set. As a result of the last process, a variety of actions will be performed. For example, “smart” appliances can learn user’s habits, keep track of planned activities and assist in their execution [6].

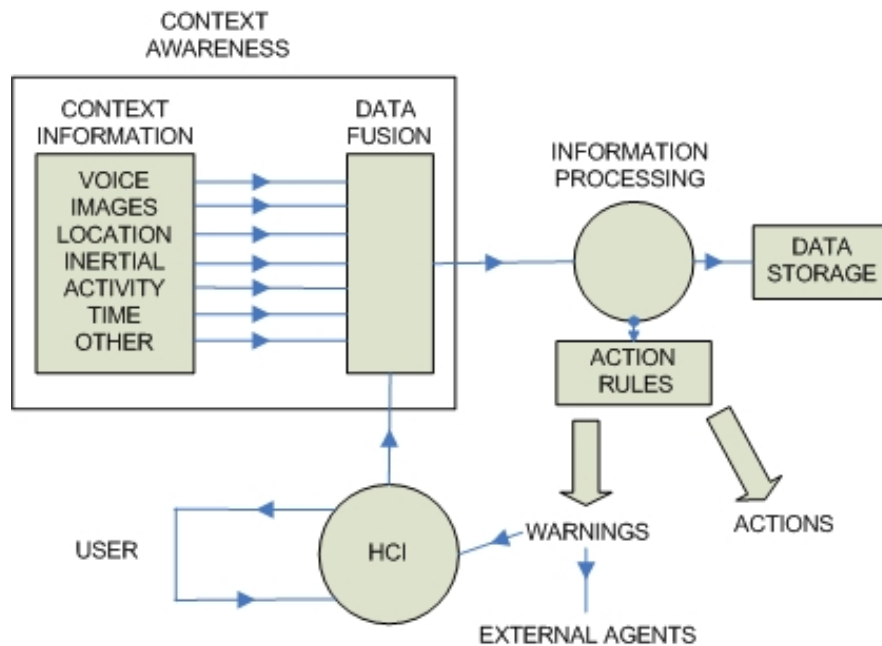


Figure 16. Example of traditional Aml architecture

4.2 Health and social sciences contribution

As previously stated, universal access is a development trend of Aml systems. We must ensure that systems are designed bearing in mind the abilities and limitations of all possible users. To sort out this issue, engineers have to work together with health and social workers (occupational therapist, physiotherapist and psychologist) to include factors not considered for ordinary people. This work might mean the inclusion of new or modified devices, the necessity of new contextual information or the modification of system’s services or action rules. It is recognized that every individual has unique needs, and would be cost-prohibitive to tailor a solution for each individual [3, 4]. Nevertheless, should be taken into account the development of adaptive applications to cover a wide range of possible users.

The human-computer interface is an important factor in the development of application designed for elderly and disabled people. As stated in the previous section, iHCI might bring about context-sensitive interfaces. Moreover, a proper design of user interface might counteract disable people limitations, such as motor, sensory, cognitive and memory handicaps. For example, disabled users could delegate tasks execution to computing units embedded in the physical context.

Adaptability should be one of the main requirements of an Aml system. Considering people with cognitive disabilities, designers have to bear in mind the possibility to reconfigure the action rules profile. For example, short-time memory and attention disabilities will imply remainders to the user. Health and social workers have to use their knowledge to help technologists to know how often and in which situations are remainders needed. In case the user has comprehension disability, the system's HCI output will adapt to user's needs. For people with visual comprehension disability, a moving, talking person in a video may be easier to identify and mentally process than a static image of a person in a photograph. Video and multimedia, accompanied with narration, may be the best way to communicate to these individuals.

In Figure 17 we show how health and social sciences may contribute in the design of an Aml system. Usually systems adapt to context changes and user actions, preferences and –in case of special needs- to his/her permanent disabilities. Furthermore, designers have to bear in mind the possible changes in user's frame of mind (that may be not noticed by the user). Thus, deep knowledge about the disability and social context of the user is essential. In these cases, the way HCI interact with the user has to adapt to confusion, attention loss, hyperactivity or hypoactivity states.

For example, an old person has an intelligent system that guides him/her in their daily activities in the kitchen. When doing the washing up, the system asks the user to select the type of clothes and washing temperature, to add the detergent and softener, to select the appropriate program, etc. This will be the normal procedure considering the user's abilities; nevertheless, if the user gets confused or reflects hypoactivity patterns, the system can automatically do the washing

just asking the user to introduce the clothes and close the washing machine's door.

The processed information obtained from an Aml system can be stored and analyzed a posteriori. Continuous monitoring of body signals and behaviour could lead to much tighter bounds on health variations, and techniques from knowledge discovery and data mining could be used to identify and adapt to causes of cognitive disorders and problematic patterns of behaviour [5].

Furthermore, we can see in Figure 17 how stored data can be used to evaluate objectively the user's quality of life. This is a long term evaluation that should be done by health and social workers. This information can be a valuable feedback to the Aml system which could greatly help in early detection of important health problems that a person may have: depression, dementia, anxiety, etc. [11].

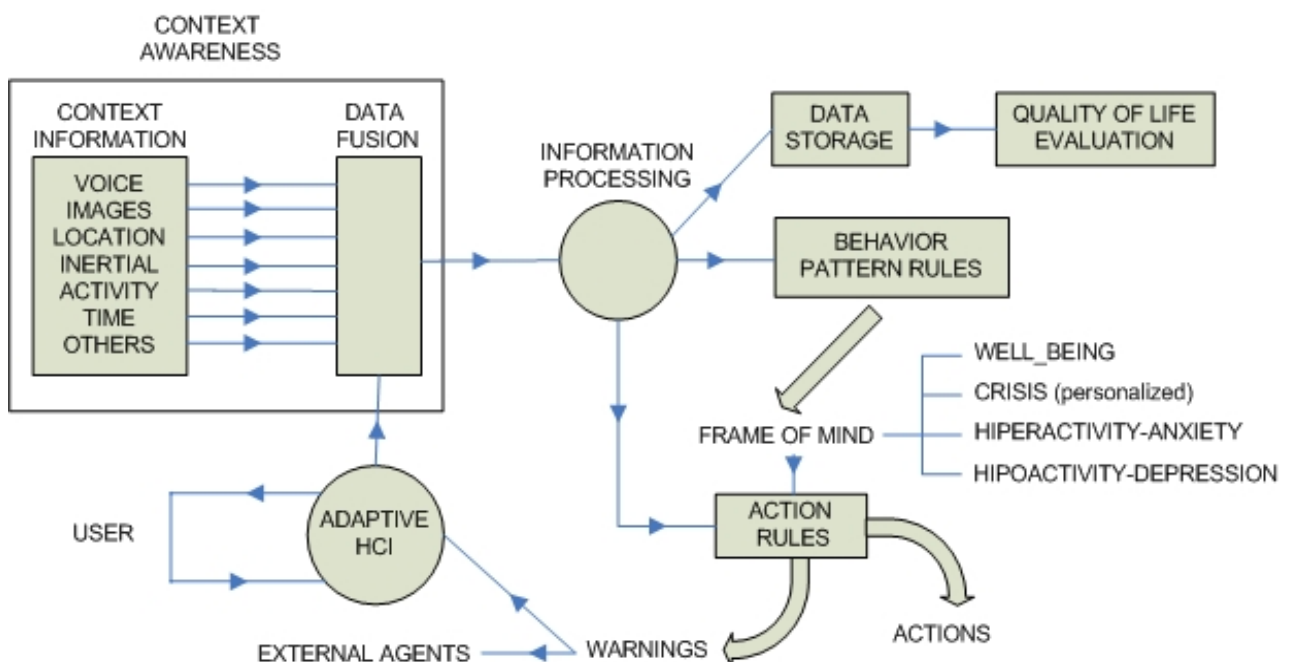


Figure 17. Integration of health and social sciences to a traditional Aml architecture

4.3 Aml kitchen concept

Elderly people suffer some disabilities that get worst with the years. These disabilities will difficult the tasks carried out in a normal independent life. It is a reality that the main disabilities prevent from carrying out home tasks and that about a fourth part of the household accidents take place in the kitchen, where the appliances are key elements.

In this section we apply the concepts so far presented and the requirements stated in previous sections to define the specific implementation of an Aml application for the kitchen specially aimed for the elderly. **Main objective of the Aml kitchen is to increase the elderly and people with disability autonomy in their everyday activities allowing them to carry out an independent live for a longer period of time.**

As we are talking about the kitchen, of course, appliances are the most important elements no matter if they are intelligent or not. It is evident that new "intelligence" and interfaces have to be introduced in the whole system; nevertheless, this doesn't mean that white goods have to be more intelligent or incorporate new adapted interfaces. This would increase their unitary price, harden their installation (adapt the functioning to the user particular case requires configuration) and consequently hinder the market penetration. Thus, instead of having new smart appliances with accessible interfaces, we envision a central intelligence aware of the status of all the white goods, able to control them and also able to interact with the user. That is to say, we just add the appliances the capacity to communicate. This, besides lowering the price of the appliances, also eases their development and perdurability; appliances don't change their current way of functioning, just add a new feature: manage communication hardware to inform about their status and execute actions.

In Figure 18 we can see the blocks diagram including all the technology involved in the Aml kitchen concept.

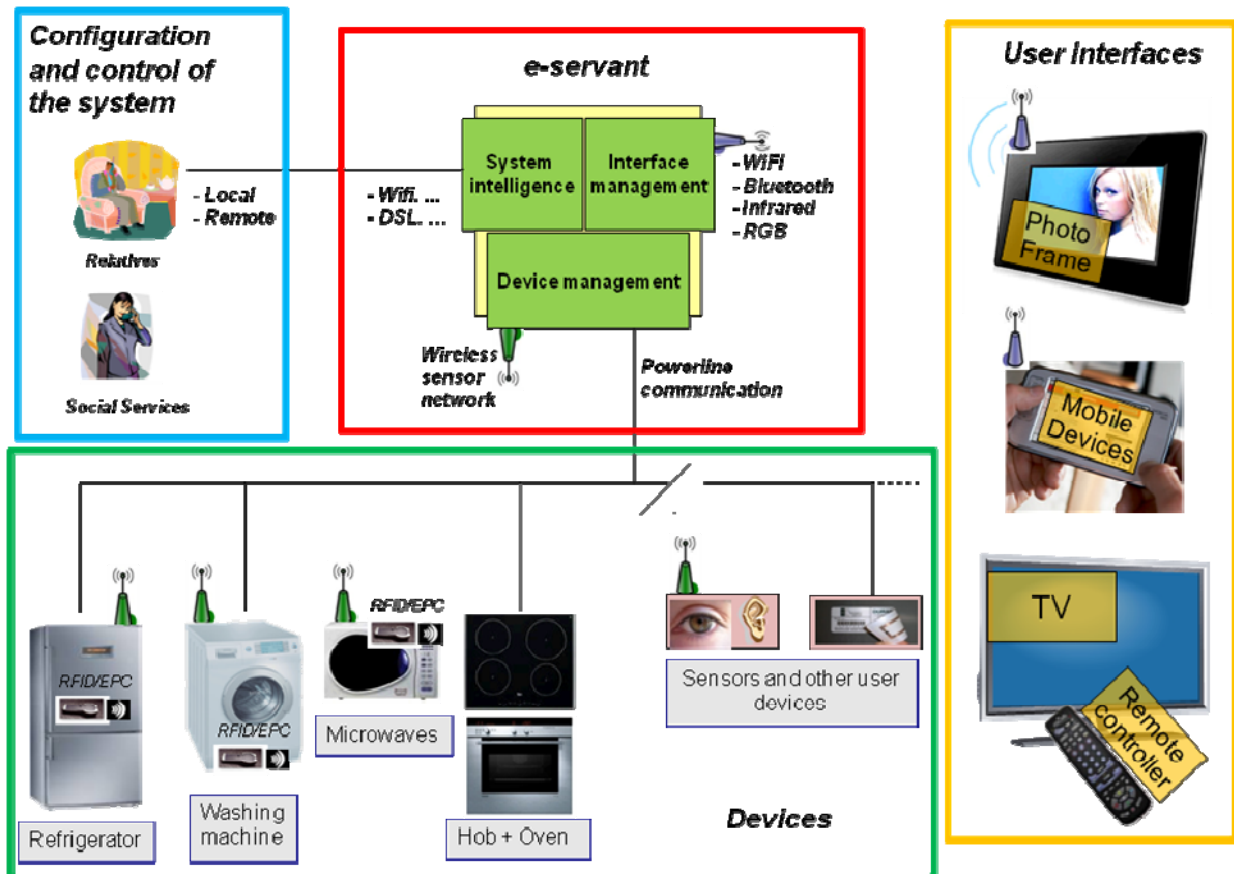


Figure 18. Aml Kitchen

There is a clear correspondence between the system proposed and the integration of health and social sciences shown in Figure 18. All the devices within the green frame would be the **physical context**.

- Obviously the appliances form one basic block in the kitchen; their contribution to the context will be informing about their status (for example, temperature in the case of the fridge, washing program in the washing machine, etc.) and execute actions (for example, change temperature reference, stop operation, etc.).
- Diverse sensors are usually used for context awareness tasks; specific selection depends on the Aml application. We propose some sensors already usual inside the kitchen (temperature, fire, smoke, flooding) and other not so used in this scenario:
 - o door sensors for detecting when the user opens/closes a cupboard or drawer
 - o illumination sensor to detect when the user forgets the light on

- presence sensor to detect when the user enters the kitchen
- We have also considered RFID readers for identifying clothes and food. The use of RFID and EPC can provide useful information about what is in the washing machine or fridge, what does the user want to eat or have just bought, etc. Food information is useful to inform the user about the food that is missing, which food is going to go out of date, which food the user may eat, etc. Cloth information is helpful to determine which washing programme fits best with clothes the user has introduced in the washing machine. An RFID reader in the microwaves oven is also of interest to advice the user the program needed to cook the food about to be introduced.

Food is not only stored in the fridge, for that reason we found useful to have a stand-alone reader able to detect all the items in a bag. This way when the user enters the kitchen after doing the shopping, the system can register the items bought; check if those than need refrigeration are promptly introduced in the fridge. And the same could be done with the garbage bags.

- It's important to highlight that the context architecture proposed is not restricted to the devices so far presented. Any other sensor or appliance could be added to the system in order to enhance its capabilities.

All this information harvested from the context, besides being used to help the user managing the kitchen, is of valuable help for determining his/her quality of life level. For example if the person is losing cooking, washing or shopping abilities, or if he/she is getting more frequently disoriented, etc.

The yellow frame is the human-machine interface (HMI) that manages **user interaction**. HMI devices must be easy of use and must be available for any kind of user, having the capability of change the interface according with the user profiles. They must have good communications interface, but they do not need a powerful processing neither storage capacity.

There are many different types of clients that can be used to managing the system: the mobile devices (PDAs, smart phones, wearable devices, ultra-mobile PCs, touch screens, etc.) which means the user can carry them around the house and be able to monitor the house appliances wherever he or she is; the fixed devices (computer or digital TV) will be used as a centralized control and finally

the embedded devices which can be control panels implanted in each of the actual appliances. After a study of the state-of-art in the actual market about the technical specifications of potential clients, it was decided that suitable user controls for the system will be:

- Digital TV plus remote controller (elderly people accept it and know how to use basic functions). Central intelligence could send "HMI output" through a S-video or digital signal and receive "User information" through an infrared remote control.
- As a portable device, there are many devices of this type but thinking in low cost and enough process and storage capacities, the best option could be a touch screen device with a dock, middle way between a tablet PC and a PDA; something similar to Nokia N800.
- Digital photo frames are also considered because they are having a big market penetration, and because besides pictures they can reproduce audio and video, even some models have wireless communication (Bluetooth or WiFi) and they are simple and cheap. These issues make them a good choice to show information ubiquitously in the home.

Inside the red frame we have the **intelligence** of the system; what is been called e-servant. E-servant is aware of the context and user enhancing the intelligence of the white goods and providing new functions:

- With or without user cooperation, it facilitates the use of the appliances, adapting the systems to the disabilities or preferences of the user.
- It analyzes all the data gathered to extract relevant information that could be useful for user's carer and/or relatives to evaluate the person's quality of life. It is able to detect behaviour changes, loss of abilities (memory problems, oblivions, etc.) of the user. For example, it seems clear that changes in HMI's navigation skill, opening the fridge too many times (without picking anything) or loss of skill of programming the washing machine might have relationship with cognitive capacity or disorientation.
- In the case of conflict or emergency it can send a warning message to a remote care centre that can immediately send a social worker to help "in situ" the users.

Thanks to the multidisciplinary design of the system with social and health workers, we decided not to automatically change the system's functioning to avoid user disorientation.

E-servant will also be the coordinator with whom all the other systems communicate. In order to have an invisible system for the user, different blocks use the most appropriate way of communicating, and e-servant has to implement them all:

- We use power line communication (PLC) over the main wires to get the status of appliances and to control them. PLC is the best option for white goods because all have to be mains powered and there are European standards being promoted on this line. Moreover there is no configuration needed to install a new appliance.
- We use wireless sensor networks to enrol all the sensors in the kitchen and also to get RFID data from the readers. Many protocols exist on these field, so far we are using ZigBee because it is becoming a de-facto standard in home environments.
- Communication with the interfaces is used through standard communication protocols such as Bluetooth or WiFi. The main reason for this is that the communication established can be considered between computers that already include this kind of communication ability.
- Finally, communication with the outside world (information to the social services or families about the user's quality of life, information about possible technical alarms, information about maintenance needed, etc.) is also done using standard protocols such as DSL or WiFi.

There are several possibilities about the hardware where e-servant will run. The most flexible and powerful would be a PC based device: Tablet PC, Mini-ITX (media centres), Ultramobile PC or a traditional PC. The most cost-effective alternative would be an embedded board with the minimum needed processing and communication capabilities. Smart portable devices are also a possibility (PDA, Smart phones, internet tablet) with limited resources and graphical interfaces included.

All the platforms presented have common interfaces: USB, Ethernet and serial. All except those embedded have Bluetooth and WiFi (some embedded in the higher range also include them). None have standard PLC and ZigBee as default interfaces, this implies to use/create gateways (including the drivers inside e-servant) to a standard interface have to be developed. We will use USB because its simplicity and universality (serial is disappearing from many devices).

4.4 Further considerations

The system here presented is the first approximation that will be further refined in each workpackage. As the system created is of big complexity and with big potential, adaptations and changes are being continuously done in corresponding WP:

- WP2: RFID developments
- WP3: software architecture of the system, intelligence, neuronal networks, context awareness, etc.
- WP4: user interaction interfaces
- WP6: architecture of the system, hardware requirements

These changes not only correspond to technical reasons but also to new functionalities and requirements from the users: thanks to the continuous work with end user associations in UNIZAR and NEWI

5. CONCLUSIONS

This deliverable closes WP1 targeting the requirements from end users and technical developments to be done in following WPs.

In section 2 specific needs that the elderly persons have in the use of “white goods” has been surveyed using different and complementary approaches. One approach uses European statistics to create specific Personas to have a clear view of the needs that end users might have. We have also analyzed all the tasks done in the kitchen and their implications regarding the disabilities a user might have according to the WHO’s ICF (International Classification of Functioning) and the household appliances themselves. Resulting from this analysis, specific surveys in Spain were done focusing in the white goods and the activities/abilities related in their handling. In these surveys, people mentioned that they have difficulties even with basic functionalities such as opening the doors of the washing machine. Therefore the user needs have to be prioritized: If the user is not able to open the door all newly developed assistive technology like colour detector... will be useless. Regardless this issue, the concept of the project is demonstrated to be still useful: to develop prototypes of advanced white goods in order to support elderly persons with or without disabilities to carry out a longer independent life in their familiar environments.

From the results of section 2, section 3 clearly maps the exact functionalities that the technological system will provide and the benefits for the elderly people in consideration of the main types of their disabilities.

Finally, section 4 defines the main technological developments in HMI, RFID and neuronal networks to be carried out in later WPs to answer the identified needs of elderly persons in using “white goods”.

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