User Needs and Usages of Assistive Technologies

J. REERINK[1], M. MOKHTARI[1,2], N. BIARD[3]

[1]*Handicom Lab. GET/INT, Evry, France*
[2]*INSERM-U483, Université Pierre & Marie Curie, Paris, France*
[3]*PFNT, Hôpital Universitaire Raymond Poincaré (UVSQ), Garches, France*

Abstract - This paper deals with the problem of selecting the services emerging in the field of the domestic environment (indoor and outdoor). Our research activity aims at studying both the concept of acceptability as well as usability, dedicated to assistive technologies and related to the needs of autonomy. We focus mainly on the usages of existing and emerging technologies and confront them with the specified needs of people having severe disabilities in safety/assistance term outside their homes, or in a matter of living environment accessibility.
This paper describes our research methodology and preliminary results of usages of assistive technologies obtained with the participation of the end-users. Our methods, based on usability engineering and rehabilitation ergonomics and their processes, are actually validated in "real live" conditions involving users in different living conditions. We target mainly the people with severe motor disabilities. We will also propose services specialised on the Smart Home project, which has been funded by the GET and the industrial foundation Louis Leprince Ringuet.

Keywords. Usages, smart homes, motor disability, human-machine interface, users needs evaluation

Introduction

The strategic orientations of telecommunication operators attempt to describe and analyze new contexts of usages of technologies in order to compete in the field of service innovation towards future users. These challenges are quite heavy since it is a matter of fighting in order to win new markets. Actually, these stakes mean to identify and anticipate various practices of telecommunication, either to accompany a latent or already expressed request, or to counter an announced competitor's offer [1]. Today, we can note that studies of usage are a whole field of expertise. Their ambition focus on understanding and specifying the relationship between individual(s) and object(s) in a society by taking account of specificities of each one of these three centres of attention: individual, object, society [2].

The approach consisting in individualizing the technical and functional performances of a product in order to infer the possible usages of the system is no longer sufficient and adapted to meet user needs. Today, for telecommunication operators, the question is to evaluate the acceptability, usefulness and usability of the services as well as the nature of the usages. Whereas the generalization of this approach remains still sporadic in France, a recent interest for simplicity of usage in the economic sector combines disability contexts and product confrontation.

Our intention is to apply this approach to home automation. Since the smart house concept does not only imply material architecture but also technical systems, we should develop a brand new interpretative framework. From the dependence point of view, these systems exist and are available at a certain cost but they are not designed, nor adapted and usable to people with specific disabilities [3]. Usages of those systems must then be spread out and should not be limited by their lack of adaptation.

Our strategy consists in testing, experiencing, experimenting, validating and qualifying the uses of new services by targeting people with disabilities and by using existing technologies designed for the general public [4]. This use of technical assistances will not be limited to the residence, but adapted to environmental various situations, inside (the residence, hospital or workplace) and outside (neighbourhood, station, shopping centre). Usages of existing assistive technologies must be qualified.

Thus, this article restores the preliminary results (diagnoses and tests of usage) of a Tablet PC as a technological and assistive support of house automation for people with motor disabilities.

1. User needs analyses

1.1. Target

We studied, between October and December 2004, five users having severe spinal cord injuries at the rehabilitation hospital of Garches and three young adult suffering from Duchene's muscular dystrophy. None of them had cognitive problems (Table1).

Table1. Users' diagnosis

User Code	User Age	Type of disability
GCH01	32	Spinal Cord Injury C5-C6
GCH02	35	Spinal Cord Injury C5
ADP01	26	Duchene muscular dystrophy
ADP02	23	Duchene muscular dystrophy
GCH03	21	Spinal Cord Injury C7
AFM01	33	Duchene muscular dystrophy
GCH04	34	Spinal Cord Injury C4-C5
GCH05	28	Spinal Cord Injury C6-C7

The last three users were not hospitalized but do live either in specialized residential house or at their parent's place. The average age among the user population we studied is 29 years old.

Muscular dystrophies users are extremely physically dependant; they use electrical wheelchair for their daily moves. All of them are tracheotomised and breathe with mechanical ventilation.

Spinal cord injuries subjects had motor and sensitive attacks of upper and lower limbs resulting from cervical level lesions.

The tests were explored in three different contexts:

- On the New Technologies Platform of the Raymond Poincaré Hospital of Garches (GCH) for tetraplegic users.
- In individual residence (ADP) with respiratory facilities for two of the muscular dystrophy users (A.D.E.P. in Evry :Aid to Disabled and Polios Association)
- And finally on the DRAC (Communications Activities Research Department) of the French Muscular Dystrophies Association (AFM).

1.2. Method Evaluation

We built up evaluations in three different parts:

1.2.1. Previous questionnaire

A closed ended questionnaire made it possible to introduce the user with the test and to collect basic information relating to health, experience in using computer, input devices habits, and so on.

1.2.2. Usages & Usability Testing

These elements were emphasized thanks to the realization of virtual house automation control tasks scenarios

Test 1: Functional use of input devices dedicated to computer access/environmental control system

We started with a functional evaluation of the input device in order to get information related to the approach and the grip of the devices. Then we qualified the operations which can be processed by the device (moving of the cursor, simple clicking) [5], [6] and described the manual procedure chosen when using the touch screen.

Test 2: Procedures observation during a virtual house automation control scenario.

In addition to the observations, we recorded the comments of subjects while dealing with difficulties during the realisation of the task scenario.

Test 3: Usability of input devices.

We interviewed users using this usability scale: "*not at all*", "*rather*", "*enough*" and '*very*". This scale is related to satisfaction, comfort and ease of use shades of opinions.

Test 4: Attitudes and opinions toward HMI (Human Machine Interface)

Attitudes and subjective judgements of the users were requested in order to qualify graphics, icons, buttons and Human Machine Interface design.

Test 5: Usage diagnoses.

We set up an analysis of service functionalities, conditions of use, particular waiting of the users. We also qualified the comfort felt while using a product with a more specific disability point of view (dimension of the material, stigmatization of the handicap …).

1.2.3. Post-questionnaire

It was designed to collect general data on impressions users felt using the technology. It was also meant to give users the possibility to react more freely about their waiting rather than answering close ended questions.

2. Preliminary results

2.1. Accessibility of input devices and usages

2.1.1. Approach and grip

Seven subjects out of eight were able to approach and use the tablet PC through the tough screen modality. When we tested the Tablet PC through environmental conditions and filtered it through disability point of view, we realised that its initial attractiveness gives way to usability criteria that have been insufficiently taken into account. The best usability indicators were: satisfaction of use and comfort for the joystick; ease of use for standard mouse compared to usability investigation upon Track Ball device and Tablet PC device (tactile modality).

Even though this material can be control through other devices, workplace is a real problem when this material is fixed to the wheelchair. We also realised that when we placed this material, the HMI graphic presentation happened to be difficult to see while performing the task. The expectations of people with disabilities on this topic (integration of technical aids) specify that a smaller device would be more fitted but it also means less visibility.

A further evaluation based on Tablet vs PDA comparison could give us more information about the correct size of the material needed for home environment control.

2.2.2. Functional use of input devices

Due to their physical limitations, only three subjects out of seven were capable of using the touch screen modality of the Tablet PC as an ordinary device. However, if the tactile modality (Tablet PC) could not be usable for some, all could effectively use another device to control the interface. In a more specific way, the first results indicate that the mouse and the joystick obtained more positive usability results than the Tablet PC (movement of the cursor and left click).

Furthermore, on seven subjects who were able to use the tactile modality, we obtained a “less adequate than expected” indicator for after scenario questionnaire for user interface satisfaction. Other attributes of usability, like comfort of use and ease of use, obtained indicators that globally assess a “more adequate than expected” user interface.

Overall, it appears that the compared scores for each device and indicator of usability, allows the classification hereafter: joystick 82.22% of usability, mouse 55.55% of usability, Track Ball 51.10% of usability and Tablet PC 50.79% of usability. On eight subjects, three of them could not obtain a functional installation of the Tablet PC on their wheelchair. For the other five subjects, they indicate being "less satisfied than expected" with the dimension of this material.

2.2. Classification of services

It seems that if subjects tend less favourably to project themselves onto an “outdoor” usage of the Tablet PC, this lack of confidence might be related to : aspects of security and protection outside (robbery for instance), stigmatization of dependence, workplace, aestheticism and size of the product. On the other hand, if subjects seem to be more attracted to the use of Tablet PC in an indoor environment, this relationship can be enlighten thanks to different goals subject tend to favour: house automation control (autonomy saving), possible bedridden usage, socialising issues (communicating, working), memorization and learnability procedures (ordinary usage computer for environmental control systems).

Thus, according to the services which were evoked at the time of investigations, we chose the ones they perceived like the most important by people in situation of

dependence. Confronted with professionals of medical sector, families and doctors, we obtained a four themes categorisation depending on the task to perform:

- Inside home tasks applied to indoor environment: Environmental control systems
- Inside home tasks applied to outdoor environment: Communication and e-Services
- Outside home tasks applied to indoor environment: Tele-control and tele-assistance
- Outside home tasks applied to outdoor environment: Worldwide nomadic services

In the table below (Figure 1), we provide a list of potential services most expected by the users. Services are qualified regarded to the indoor and outdoor environment. We sought to identify the usages of technologies, which could meet the needs stated during our Smart Home project:

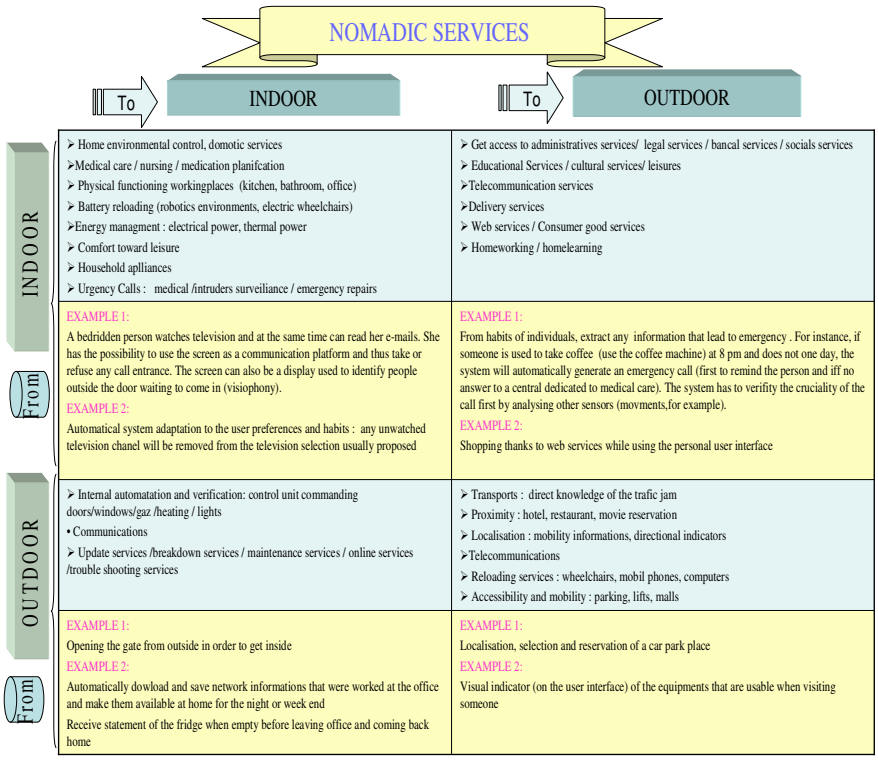

Figure 1. Indoor/Outdoor environment: toward continuity of services

3. Conclusion

As Smart Homes context is not only limited to home environment, but to any living environment, such as the hospital, school, garden, it is necessary to identify the usage of assistive technologies based on the users needs.

When we ask users to virtually achieve specific goals in domestic environment as well as in outdoor environment with a specific material, we can expect them to provide two kinds of subjective data: usages that might not have been focused on yet and usages of daily life. Both aspects might lead us to design new services close to the real needs of people. This aspect of our work is critical to our laboratory because it forces us to follow and focus on the very needs of the people we are working with and also fit the results with the emergent technologies.

To elaborate and test those new services, we use platforms as a real environment filter. Platforms enable us to get access to services testing *in situ*, meaning with certain conditions that determine a possible situation of life. It may then lead us to the prior difficulties that can not be imagined in laboratory. In fact, ecological evaluation is an essential step during engineering life cycle of a product; it brings the possibility to get usage diagnoses before and during the prototyping phase [7]. Thanks to scenarios we validate, or not, hypothetical services: concepts, functionalities, contents must pass the reality test.

In prospect, deployment of technological platforms as architecture demonstrator will be the ground on which we will design services. Testing will take place on different residences depending on the aspect of disability we want to enlighten:

- ADEP household in Evry (Aid to Disabled and Polios association) in collaboration with the Garches Institute Hospital for domestic aspects and rehabilitation
- « Bastidon de Lucie » association in collaboration with EDF (French Energy provider) as leisure centre.

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