Towards the Introduction of Accessibility Resources in Public Telecentres

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Summary. In this chapter we tackle the problem of studying the Digital Divide (DD) and we pay a special attention to its relation with disabled people. We emphasise on the importance of the fight against the DD and we report a number of projects that aim to reduce it in Catalonia (Spain).

The main contribution of this work is the study of the DD from the point of view of the relation between Information and Communication Technologies (ICTs) and disabled people. We analyse the problems that disabled people have to face in order to use ICTs. Therefore, we have defined a number of measures to determine the degree of accessibility that a given user has and, we have carried out some experiments to evaluate the proposed measures.

Our work is deeply related with the Òmnia Project and the telecentres network impelled by the Catalan Government. Thus, we must understand our work in the context of these innovative initiatives.

In this chapter we concentrate on the Human-Computer Interaction (HCI) issues related to the DD in order to explain our experience in this field. At the time of writing this text, the experimental part is still in progress, however some previous results are given. Moreover the current work and experiences are also reported.

1 Introduction

Digital Divide (DD) is a term that defines the division between people, communities, states, countries, etc. with respect to the access to the new Information and Communication Technologies (ICTs). Nowadays, it is essential to have technological skills to work in a variety of jobs (*i.e.* administration, education, etc.). Moreover, ICTs have become ubiquitous and they affect almost every aspect of our daily life.

The way in which people face the task of using ICTs varies depending on a plethora of variables. The most analysed ones are the technological literacy and the educational level. These are two very important factors that strongly affect the success of the individuals in accessing ICTs. Unfortunately, these are not the only variables to consider. Some people suffer from mental and physical disabilities that are real impediments to access ICTs, and they must be studied in detail. How can we help disabled people to access ICTs? - Can public telecentres deal with this task? - Can the ICTs be used to improve the accessibility of disabled people? Which projects aim to reduce the digital divide? – Are they addressed to disabled people? These are some of the questions that we will try to answer, at least partially, in this chapter.

We believe that governments must invest to avert the DD, but they are not the only actors involved in this scenario. ICTs themselves should be used to improve the integration of some sections of the population, which have trouble accessing them. Universities and research centres must help in the development of new techniques to make possible the normal and proper access to the ICTs to disabled people.

1.1 Contribution and plan of the chapter

The main contribution of this chapter is the study of the DD that the disabled people suffer. We introduce a number of measurements being the aim to improve the techniques for assessing the accessibility to ICTs and, we test these measurements with real disabled people who frequently visit public telecentres.

The rest of the chapter is organised as follows. In Section 2, we introduce the Òmnia Project and its relation with the Telecentres Network and the NODAT Project. Section 3 gives an overview of the Accessible Computer Project and a set of measures that are specially interesting for being tested on disabled people are proposed. Section 4 is devoted to the explanation of our experience with disabled people in public telecentres. Finally, the chapter concludes in Section 5 with some final comments and future research lines.

2 The telecentres network and the Òmnia Project

In this section we elaborate on the main features of the Òmnia Project and we link it with the telecentres network and the NODAT Project. These Catalan projects have been designed to reduce the DD from a general point of view (*i.e.* they are not only intended for disabled people but for a wider range of sections of the society that have trouble accessing the ICTs).

2.1 The Òmnia Project

Technology already affects us nearly every minute of the day, and as we evolve to a technological society, the need for well-trained people who are technologically literate will exponentially grow. Moreover, technological illiterates will have trouble finding a job or even buying a train ticket. The Òmnia Project (OP) [1] started in 1999 with the aim of overcoming these limitations by providing people with the possibility of integrating them in the new technological age. OP is mainly funded by the Catalan Government and some local organisations.

Òmnia is a Latin noun that means everybody, and in this project it is used as a metaphor for the main goal of OP *i.e.* to guarantee everybody the access to the ICTs and to fight against technological illiteracy. The idea is not new, but it represents a real milestone to minimise the DD in our country.

OP is specially focused on persons and groups with a difficult social situation (*i.e.* ethnic minorities, elderly, etc.). However, a wide variety of people have the risk of becoming technological illiterates.

With a view to getting going on this praiseworthy task, OP defined a network structure, which was made up of Òmnia Access Points (OAP). In 1999 the first 43 OAPs were created, in 2001 68 new OAPs were added to the network and currently there are 112 OAPs working to reduce the DD. OAPs are the building blocks of the OP and they can be defined in terms of physical space, technological equipment and technical support.

- **Physical space**: An OAP is located in a building provided by any of the organisations that take part in the project or by the Catalan Government.
- **Technical equipment**: A basic OAP consists of 9 personal computers with a wide band Internet connection, one scanner, one web-cam, two printers, one CD writer and common software such as a word processor, an e-mail manager, an Internet browser, etc. Some OAPs have increased their technical equipment due to the great welcome given to the project by the citizenship.
- **Technical support**: There is a person in each OAP who is responsible for invigorating the group by exploiting his/her pedagogical capacities; he/she

is called ``*invigorator´´*. The invigorator provides the group with technical support and promotes the socialisation and social integration of the group.

In order to work as a real network, the invigorator has to communicate with other invigorators and share his/her experiences in the OAP. The union of all the OAP forms a network that fights against technological illiteracy by following three main common action lines:

- **Community interaction**: This action line represents the philosophy that founds the project and can be divided in two principles:
    - The access to the OAPs must be free to everybody namely individuals, organisations, groups and associations.
    - Each OAP must be a place for social cohesion, and it must help in promoting the interaction between people and regions.
- **Labour and social insertion**: An OAP provides people with enough knowledge to address some basic tasks such as writing a Curriculum Vitae or sending an e-mail.
- **Education**: This line aims to guarantee a proper technological education to everybody. This education may let the users access to the information society and avoid their exclusion.

If we take a look at numbers in Catalonia in 2004, some results can be emphasised:

- The access to the OAP is perfectly balanced according to the gender. Specifically 49% of the OAP users were women.
- Regarding the age of the participants, 7% were elderly, 24% were children, 30% were young and 39% were adults. The complete distribution of participants is shown in Figure 1.

There is no official information on people with disabilities using the telecentres resources but, to the best of our knowledge[1], few disabled people go to public telecentres. This behaviour is due to the lack of information that the disabled people receive from the public telecentres. In fact, they believe that they will not be properly helped in these environments.

It is clear, that it is necessary to increase the amount of information given to the disabled people in order to make them visit the OAPs.

[1]We have talk to several invigorators.

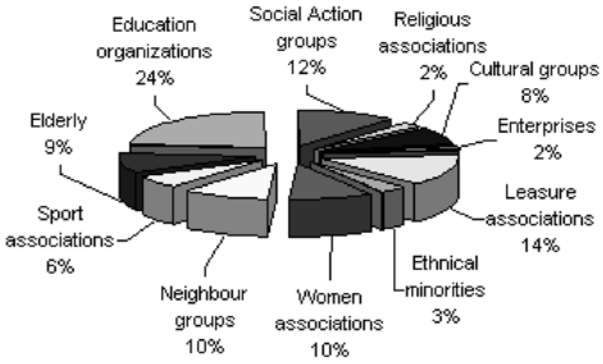


Figure 1: Distribution of the participants in the Òmnia Project

2.2 Telecentres network and the NODAT project

Due to the great success of the OP and the existence of other projects promoting the access to the Internet, such as public Internet access points in libraries, teleworking centres, and Internet public centres amongst others, the Catalan government decided in 2001 to impel a larger project. To do so it merged all these projects. As a result of this merge, the NODAT Project started out with the creation of the telecentres network. The NODAT Project is founded over the next main principles:

- The telecentres must be distributed over the whole country (Catalonia).
- A tele-working community should be created.
- Technological education must be provided and new useful contents should be created.
- The whole network must be audited in order to evaluate the evolution of the information access of the citizenship.

As a result of the NODAT Project, the OAPs were transformed into telecentres and a global and larger telecentres network was created. Currently, the telecentres network is working properly to satisfy the objectives of the project.

3 Accessible telecentres: the accessible computer project

In this section we describe the foundations of our work and, we show the way in which we deal with the problem of providing accessibility to disabled people in public telecentres.

Our study began as a toy-project in the *Ribera d'Ebre* telecentre[2] in Catalonia. A woman with severe mobility problems, lets call her Mary, visited the telecentre. Initially, her husband helped her in tasks like checking the e-mails and typing the answers because Mary was not able to use the standard mouse or the keyboard. We have been talking with the invigorators of the telecentre and we decided to test an alternative input system that could be useful to Mary. So we bought an inexpensive joystick and we installed an open-source joystick-to-mouse emulator and an on-screen keyboard. Since then Mary is able to check her e-mails and answer them without the assistance of her husband.

This experience let us think that it was possible to provide accessibility resources in a cheap and simple manner, so we proposed the idea to the Catalan government. Our proposal was accepted and, after a year, 23 Catalan telecentres were equipped with different assistive technology resources and their invigorators were trained with some basic accessibility courses.

The rest of this section includes a brief review of the state of the art in Spain. Next our philosophy and desiderata are presented while some ideas about accessibility are proposed. Next some assistive technology devices are commented. Finally we present some performance measures, their aim being to help the invigorators in the evaluation of the accessibility.

3.1 Some previous work in Spain

Introducing accessibility resources and assistive technology devices in public telecentres is not new. The Internet Society, in a paper submitted to the UNESCO in 2000, said *"Self Sustaining Internet Training Centres should include some standard assistive technology as part of their access efforts"* [2]. There is a trend to include support for people with disabilities in public telecentres [3, 4]. In Spain the ONCE (Spanish organisation of blind and visually impaired persons[3]) has founded two telecentres in Sevilla and Valladolid equipped with assistive technology resources [5]. There is little information about these projects and we have not found the description of the methodology and resources used. Thus, we believe that a relevant contribution of this chapter is to describe a possible approach to deploy accessibility resources in public telecentres.

3.2 Our Philosophy

Traditionally, accessibility and its related technical support were directly associated to complicated and very specialised devices. Moreover, these devices used to be very expensive. Our main idea is to break this trend (following the

[2] http://www.riberaebre.org/telecentre

[3] http://www.once.es/vocacion/webenglish/default.htm

UNESCO recommendation) by using common hardware[4] controlled by specific software that, in some cases, is open source. The main advantages of using off-the-shelf hardware are: a lower price, higher availability and good quality. Although it is necessary to provide disabled users with some technical support, they are generally able to quickly understand and use the devices.

By following the ideas of the Òmnia Project and the telecentres network, our main goal is to provide a wide variety of disabled users with accessibility at a reasonable price but, we always consider specific problems and/or limitations (in some cases a detailed attention and specific devices are necessary). Thus, the introduction of quantitative interaction performance measures [6] will be crucial to meet our objectives. These measures can help users and invigorators during the assessment process.

3.3 Assistive technology used

Next we describe some of the assistive technology that is commonly used.

- **Keyboard/Mouse extension lead.** It is useful to place keyboards, mice and trackballs where the users can better use them (*e.g.* on the wheelchair's table). Obviously using wireless mice and keyboards is the best approach; but an extension lead is a cheap option to reuse hardware.
- **Operating system technical aids.** Computers are equipped with Linux and Windows operating systems. Both have configuration options for various special needs such as hearing, sight and motion disabilities. For example, it is possible to configure the desktop theme with high contrast colours, large icons and large text fonts.
- **Joystick.** It is a well-known computer peripheral mainly used for gaming, in our scenario it is used for controlling the mouse pointer.
- **Virtual keyboard.** This is an on-screen representation of a standard keyboard. As long as a person can control a mouse, a trackball or another pointing device, he/she can send keystrokes to any application.
- **Web-cam based head pointer.** This system consists on a web-cam and an application (in our case we use *Ratón Facial* [7, 8, 9, 10]) that lets the user control the mouse pointer with slight movements of the head.
- **Screen magnifier.** A screen magnifier is software that shows enlarged screen content. It is suitable for visually impaired people with some functional vision.
- **Text-to-Speech Synthesis (TTS).** TTS systems are able to artificially produce human speech from an ASCII text. In our context this system is used to make easier the readings (*e.g.* from a web page) to visually impaired people with some functional vision.

[4]We understand by "common hardware" the devices that we can find in commercial stores at affordable and standard prices.

3.4 HCI measures

The use of HCI performance measures during the accessibility assessment process is not a new idea[6], but usually the assessment process is only based on qualitative criteria, that is, the invigorator observes the way in which the user interacts and decides which device better fits him/her. Although the qualitative assessment could be useful in some cases, we believe that it is necessary to introduce quantitative criteria (*i.e.* a set of measurements) for determining the quality of the interaction. This is interesting because it establishes an objective and common criterion between professionals. Moreover, some users could use the measures periodically in an autonomous manner, so they can monitor their improvements, and they can decide to test other devices or set-ups.

Although a variety of interaction technologies (*e.g.* switch-based) could be used, we have centred our efforts on the pointer-based interaction. We have developed a tool that implements an interactive task being the aim to analyse the user interaction when using pointing devices. The user should complete the task as fast and as accurate as possible. Performance data are collected in real-time (*i.e.* pointer movements, clicks). When the task is accomplished a summary is presented to the user.

Pointer control performance analysis

The most common assessment measurements for pointer devices are speed and accuracy. The ISO 9241-9 standard defines a single measure *i.e.* the performance. Performance units are bytes per second and it is computed by considering the speed and precision of users. Performance is a good measure, but does not take into account the path followed to finish the task. So we decided to introduce some additional measures [11, 12] that give us some more information.

The procedure is based on the ISO 9241-9 multidirectional ”point and click” task with optional sound reinforcement. A set of targets (*e.g.* circles) arranged in circle is presented to the user (*cf.* Figure 2). Users should click the highlighted target (*e.g.* a red coloured circle). Once the target is clicked the next target is highlighted. The process finishes when users have clicked all targets.

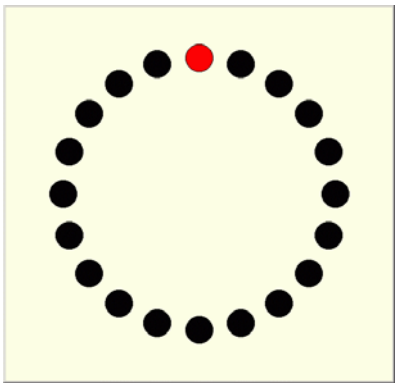


Figure 2: Screen shot of the application used to collect data. The user should click on the coloured circle.

4 Our experience

The invigorator has a key role in training and improving users accessibility. He/she is at the user's disposal and must guide them through the assessment process bearing in mind their disability profiles. To that end, the invigorator must receive a practical instruction at the time of installing the accessibility hardware devices. This instruction is oriented towards the practical needs of the invigorator in terms of the accessibility components utilisation. Moreover, the instruction is inspired in a basic accessibility guide that is also given to the invigorator in order to aid him/her. Furthermore, we are introducing the HCI performance tool that complements the qualitative assessment process described in the guide. Different kind of resources are also available on-line, namely bibliography, forums for discussion and debate, FAQs, etc. Due to the great variability that exists on the disability degrees, the invigorator can be helped by a consultancy consisting of engineers, speech therapists and physiotherapists.

As we have mentioned, one of the main goals of the project is to provide disabled users with accessibility. However, it is also important to teach the users the basic knowledge that let them properly use a computer outside the telecentres (*e.g.* at home). In addition, most of the required hardware is standard and the software is open-source, thus, the user can easily obtain them at reasonable prices. It is planned to receive feedback from the invigorators and users in order to guarantee the improvement of the proposed solution.

4.1 Disability profiles

Two main disability profiles are taken into account in this project: impaired vision and motor problems. People with hearing problems are also taken into account by means of the operating system accessibility options; fortunately hearing problems are not serious barriers to use a computer.

A recommended assistive technology testing path is provided for each profile, going from the most common tools to the most specialised ones. In all cases users, assisted by the invigorator, must choose the most suitable combination of assistive technology.

Impaired vision

We focus on people with impaired vision with moderate sight problems; so the users are able to vaguely see the computer screen. Note that each person is unique and his/her disability varies.

In these cases the testing path includes: using the largest available screen, lowering screen resolution progressively; increasing fonts, mouse pointer and icon sizes; using a high contrast desktop theme, using the screen magnifier and using the text to speech synthesis.

For blind people more specialised resources are needed like Braille output devices or software for screen reading. We are now working in evaluating an affordable screen reader system for such cases.

Motor problems

We are mainly interested in mobility problems related to upper limbs or hands that disturb the normal keyboard and mouse usage. It is clear that, people with disabilities in their legs and wheelchair users must be able to reach the computer and, to that end; all the architectural barriers must be suppressed. Although this is a very interesting subject, it falls out of the scope of this chapter.

We provide different approaches for keyboard and mouse access.

- **Keyboard.** Common keyboard access problems include lack of precision to hit the appropriate key, repetitive hits and the impossibility to hit two or more keys simultaneously [13]. All these problems are addressed though the operating system keyboard accessibility options. When this is not enough, an on-the-screen keyboard may be used if the users are able to control the pointing device or, in the worst case, hit some key (*i.e.* using the scanning mode).
- **Mouse.** The mouse requires better motor skills than the keyboard. First, users must be able to drag and stop the cursor accurately. Second, they must be able to push a button one or two times (double click) without mov-

ing the device. In this case the testing path includes: adjusting the mouse speed and acceleration settings, disabling OS desktop double click option, using the trackball, using the joystick and using the cursor keys emulation. If this is not enough a web-cam-based head pointer (e.g. *Ratón Facial*) can be used in conjunction with the on-screen keyboard to provide a total replacement of the keyboard and mouse devices.

4.2 Preliminary experimental results

In order to test the proposed performance measures with disabled people, we have used the software explained in Section 3 and we have carried out a number of experiments with people suffering from cerebral palsy (*cf.* Table 1). Depending on the abilities of users we can adjust the difficulty of the task (*i.e.* changing the target size and the distance between targets). During the task execution the software collects the reaction time, the execution time, the performance, the trajectory data and the errors.

We have selected a reduced number of users suffering from various degrees of cerebral palsy[5]. Note that it is difficult to work with people suffering from cerebral palsy because they have a serious lack of concentration and attention. Thus, it is difficult to carry out experiments to assess their ability to use a given device. The results that we present here are preliminary results and, they are intended for an illustrative purpose only. They do not pretend to be considered statistically significant but they only give an idea of the first results that we have obtained from our study. The tests were carried out with the most appropriate devices (*i.e.* mouse and cursor keys) for each user. It is clear that controlling the screen cursor is much faster by using a mouse than by using cursor keys, so we selected the first device when possible.

User & device	Reaction Time (ms)	Path Time (ms)	Errors %	Throughput
Cerebral Palsy & Mouse	275.83 ± 253.12	3568.77 ±3054.52	0.24±0.6%	1.44±0.77
Cerebral Palsy & Cursor keys	2406.43 ± 1025.16	18338.85 ± 8088.32	0	0.23±0.1
Normal & Mouse	71.27 ± 32.94	673.96±162	0.02±0.12%	5.33±1

Table 1: Average and standard deviation of the analysed measures

[5]In general, cerebral palsy cannot be classified in different degrees. This is due to the fact, that cerebral palsy is not a simple problem but a complex merger of problems. When we speak about different degrees of cerebral palsy we want to express the fact that each individual suffering from this disease has different mental and physical capabilities to work with a computer.

During our experiments we have collected the next data (*cf.* Table 1):

- **Reaction Time**: It is the time that users need to start moving the pointing device after seeing a new coloured circle.
- **Path Time**: It is the time that users need to move the pointing device from its current location to the new coloured circle.
- **Errors**: An error is considered to occur when users click out of a coloured circle.
- **Throughput**: Combines speed and precision in a single unit whose units are bits per second.

After taking a look at the results in Table 1, we can reach the next conclusions:

- The reaction time of users suffering from cerebral palsy is clearly larger than the one of a non-disabled user. This result is not surprising, but it confirms that these disabled users require special attention. Specifically, it will be necessary to develop adapted graphical interfaces in order to make disabled people able to interact easily. The same conclusion can be reached regarding the path time.
- The path time is enormously shortened when a disabled user utilises a mouse instead of cursor keys. This result is due to two main reasons:
  1. Disabled users, who are able to deal with a mouse, have better movement capabilities[6] than the ones that can only work with cursor keys.
  2. The movement of the pointer is slower when using cursor keys than when using a mouse.
- The error rate obtained by the disabled users utilising cursor keys is 0 (or almost 0) and can be compared to the results of a non-disabled user. This result is really surprising and opens the door to the creation of cursor keys based interfaces[7].
- The throughput obtain by a non-disabled user is far from the ones obtained by users suffering from cerebral palsy. Moreover, due to the fact that the throughput mainly depends on the utilised time, the use of a mouse increases the throughput.

[6]Note that the fact that a disabled user is able to properly manage a mouse does not mean that he/she is free of other mental problems, which make his/her interaction difficult.

[7]All graphical interfaces can be access by using cursor keys. However, most of them are designed to be used with a mouse. Thus, the design of new graphical interfaces oriented to the cursor keys could be a goal.

5 Conclusions

This chapter reports an innovative experience in the framework of the Òmnia Project started up by the Catalan government. This project can be considered as an important step beyond the minimisation of the so-called Digital Divide with disabled people.

Our work highlights the importance of the quantitative assessment and all the related assistive technology that let disabled people keep in touch with technology. We have focused the chapter on explaining our experience and how our quantitative measures can be used.

We have experimented on disabled people suffering from cerebral palsy, being the aim to provide experimental quantitative data extracted from the most used control interaction devices (pointer control and text input). At the moment of writing this chapter our results are still preliminary. It means that we have not enough feedback to be able to enumerate the advantages and disadvantages of the proposed experiments, but we can obtain some insightful ideas.

Currently we are studying some other disabilities in several Òmnia centres. One of these studies is related to the mouse and trackball interaction with motor disabled people. Another study tests the screen magnifier features on users with only 25% of vision. Globally, we are experimenting on fifteen different people.

We believe that sometimes disabled people cannot achieve higher personal autonomy levels because of the high cost of assistive technologies and, we think that the low cost systems that we have presented here can minimise this problem.

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