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Monograph: Information Technologies for Visually Impaired People (published jointly with Novática*)

Guest Editors: *Josep Lladós-Canet, Jaime López-Krahe, and Dominique Archambault*

- 2 Editorial. Our Training as European Professionals
- 5 Presentation. Information Technologies for Visually Impaired People — *Jaime López-Krahe*
- 10 Computing Blind — *Carmen Bonet-Borrás*
- 15 Assistive Technology for the Blind and Visually Impaired — *José Antonio Muñoz-Sevilla*
- 20 An Overview of Handheld Computerized Technologies For People with Visual Disabilities — *Philippe Foucher*
- 29 Access to Scientific Content by Visually Impaired People — *Dominique Archambault, Bernhard Stöger, Donal Fitzpatrick, and Klaus Miesenberger*
- 43 Computer Games and Visually Impaired People — *Dominique Archambault, Roland Ossmann, Thomas Gaudy, and Klaus Miesenberger*
- 54 Computer Vision Tools for Visually Impaired Children Learning — *Gemma Sánchez-Albaladejo, Alicia Fornés-Bisquerra, Joan Mas-Romeu, and Josep Lladós-Canet*
- 62 Technology and Education in the Field of Visual Impairment — *Sílvia Boix-Hernández, M^a Teresa Corbella-Roqueta, and Lucía Melchor-Sánchez*
- 67 SAW: a Set of Integrated Tools for Making the Web Accessible to Visually Impaired Users — *Fernando Sánchez-Figueroa, Adolfo Lozano-Tello, Julia González-Rodríguez, and Mercedes Macías-García*
- 72 Automatic Adaptation to the WAI Standard — *Juan Manuel Fernández-Ramírez, Vicenç Soler-Ruiz, and Jordi Roig de Zárata*
- 79 Helping Authors to Generate Accessible Content: two European Experiences — *Carlos Rebate-Sánchez and Alicia Fernández del Viso-Torre*

UPENET (UPGRADE European NETWORK)

- 84 From **ITNOW** (BCS, United Kingdom) Informatics Profession
Inline or Online? — *Steve Kennedy*

CEPIS NEWS

- 86 CEPIS Projects: Next Milestones and Events

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Assistive Technology for the Blind and Visually Impaired

José Antonio Muñoz-Sevilla

A decade ago, actions aimed at improving the living conditions of disabled and elderly people, including access to culture-related goods and services, were no more than a generous, paternalistic concession. That request, based on "cultural charity", has now become a fundamental demand within the rights of citizens to full integration and access to information. This article analyses how technology is being used by people with visual impairment as a channel to access information, and describes some research lines identified by ONCE (the Spanish National Organization for the Blind) as priority in the field of technical aids.

Keywords: Access to Information and Visual Disabilities, Aids for the Visually Impaired, Assistive Technology for the Blind, Visual Impairment and Technology.

1 Introduction

To say that we live in a highly technological society will surprise no one. However, it may come as a surprise to know that not everyone enjoys the same rights under the law. The right to information is one of the pillars of social development which should apply to everyone but sadly this is not the case. When information is generated, universal design principles are not always applied; therefore, much of the information generated is inaccessible for a number of people due to their lack of knowledge, age, physical characteristics, psychological characteristics, etc. One highly illustrative example is the way content is posted on the Internet. Content is not always accessible by disabled people, even though there are clearly defined standards and principles governing the design of Web pages and content in place to prevent access discrimination (W3C-WAI standards [1]).

The technology used in the field of visual impairment has all too often been developed specifically to address these accessibility problems without actually solving them. We will go on to analyse the role of the principal players involved in this process and look at what is being done to ensure that the visually impaired can access digital information.

2 The User

We must all have come across people with a more or less serious visual impairment. However, probably not very many of us are able to define with any accuracy exactly what blindness is. Functionally speaking we might say that *a person is blind if he/she has perception of light only, without projection, or has no sight whatsoever.*

The World Health Organization [2] defines blindness as "visual acuity of less than 3/60, or corresponding visual field loss to less than 10 degrees, in the better eye with best possible correction" (ICD-10 visual impairment categories 3, 4 and 5) and low vision as "visual acuity of less than 6/18, but equal to or better than 3/60, or corresponding visual field loss to less than 20 degrees, in the better eye with best

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He has collaborated in a number of articles and books on the subject, such as "*Apoyos digitales para repensar la educación especial*" (Digital aids to rethink special education) Editorial Octaedro, 2001; White Book "*I+D+I al servicio de las personas con discapacidad y las personas mayores*" (RD&I in the service of the disabled and the elderly) Instituto de Biomecánica de Valencia, 2003; "*Touch, Blindness, and Neuroscience*" Universidad Nacional de Educación a Distancia (UNED), 2004; "*Tecnología y discapacidad visual*" (Technology and visual impairment) ONCE, 2004. <jmsv@once.es>.

possible correction" (ICD-10 visual impairment categories 1 and 2).

In functional terms, we may consider a person to be visually impaired if he/she has serious vision problems and, in order to function properly in his/her daily life, may require a visual rehabilitation programme and/or optical or electronic aids to mitigate the negative aspects of their disability.

The disabled come from all walks of life but all have one thing in common; to a greater or lesser extent they all need additional guarantees if they are to enjoy their full rights as a citizen or participate in the economic, social, and cultural life of the country on an equal footing with their fellow citizens [3] [4].

On the international scene there is a great awareness and sensitivity regarding equal opportunities issues and non-discrimination on the grounds of any personal or social condition or circumstance. Thus, the United Nations Organization (UN), the European Council, and the European Union, among other international organizations, are currently working on the preparation of policy and legal documents on the protection of the rights of disabled persons.

In Europe, the most interesting developments in the field of accessibility are to be found in the *e-Europe* 2002 action plan [5] (now superseded by *e-Europe* 2005 [6]), which has as one of its primary goals the adoption and recommendation of a number of Web accessibility guidelines in member states.

It was precisely this idea of accessibility that spawned the *Web Accessibility Initiative* or WAI. This is an initiative led by the W3C which aims to improve information access for the disabled by developing accessibility guidelines, improving Web accessibility evaluation and training tools, implementing an educational and awareness-raising programme on the importance of Web page design accessibility, and opening up new research fields in Web accessibility.

We must all be aware of how the development of information and communication technology has brought about a substantial change in the way information is produced, managed, and accessed. Such a change has undoubtedly given rise to a huge increase in the volume of information in circulation, but this does not always mean that that information is accessible.

All too often when information is generated no thought is spared as to whether the format or the medium used to disseminate it is apt for everyone who may want to access it. This is when we run the risk of creating a situation of "digital exclusion", a term that has unfortunately had to be coined to describe a situation in which we are in danger of excluding certain sectors of society from the information society due to disability or even social disadvantages.

Technical aids have had an enormous impact on those suffering from visual impairment. There can be no doubt that, in most cases, such aids are, and will continue to be, the way people with a severe visual impairment can overcome their disability and realize their potential.

3 Technical Aids

Assistive technology for the visually impaired comprises electronic and/or computerized devices and aids that are specifically designed for the blind. They may be highly specialized (requiring a specific training course before they can be used properly) or of a lower level of specialization (simple enough not to require any prior training). These products are intended for the blind and the deaf-blind.

Aids for people with residual functional vision are referred to as low vision products. These are mechanical or electronic optical aids used to correct, improve, or optimize a person's visual acuity.

4 The Services

There are a number of services and resources that can be provided and, when appropriate, acquired to help the visually impaired achieve personal independence:

- Specific devices, aids, and technology.
- Specially adapted material.
- Material in accessible media (braille, recorded material, and information technology).

- Optical aids.
- Non-optical and electronic aids.
- Training and family support.
- Guidance to other institutions to ensure the accessibility and adaptation of physical environments.
- Training and guidance for external professionals, voluntary workers, etc.

For the purpose of this article we will concentrate on the first four aspects and we will analyse how technical and human resources are employed in Spain to ensure that the visually impaired enjoy a good level of personal independence.

Among its main missions, the ONCE (the Spanish National Organization for the Blind) [7] is committed to ensuring that all its members and, in special cases, people who are not members but have needs due to visual impairment, can access, be trained in, and handle information technologies under optimal conditions and with the aid of any technical and human resources that they might require. The resulting independence opens up more and better opportunities in the fields of culture, education, work, leisure, etc.

But, in order for this mission to be achievable, we must deliver the means to constantly upgrade technical aids; that is to say, we must work collectively on the universal design of products and services and, where that is not feasible, we must redouble our research efforts to develop the appropriate technical resources.

With regard to the public sector, those involved in assisting people with visual impairment who are registered with ONCE provide their services under the auspices of that same organization. The goods and services provided by ONCE related to communication and access to information are described below:

■ **Shop-Showroom:** In each city there is a showroom for displaying assistive products and for handling the orders made by ONCE members. These showrooms are run by ONCE's administrative branch offices and departments. They are specialized shops where people with visual impairment go to find the range of assistive products available in Spain.

■ **Professionals:** All activities related to training, guidance, and technical support for products for the blind and deaf-blind are carried out by technicians specializing in devices and aids for the visually impaired. There are 85 such technicians, and they are spread all over Spain so as to be able to provide individual attention to users wherever they may be. These professionals receive basic computing and training skills before going on to learn more specialized techniques and methods through ongoing training and refresher courses organized, coordinated, and delivered by ONCE's research centre, the *Centro de Investigación Desarrollo y Aplicación Tiflotécnica* (ONCE-CIDAT). Later in this article we will be taking a closer look at the workings and structure of this research centre, which is also responsible for the design of the organization's intervention strategy.

- For users with residual functional vision there are

122 technicians throughout Spain working out of 44 centres. These are responsible for training, guidance, and technical support for low vision aids, tools to aid users in their day-to-day lives, and spatial orientation aids .

■ **Assistive technology classrooms:** all of ONCE's regional branch offices, administrative departments, and centres (45 in total) have a training classroom with the infrastructure and the specialized hardware and software required to deliver training and support to the users registered at each centre. These classrooms represent the hub from which the aforementioned 85 professionals pursue their activity and provide the appropriate technical support to regular education establishments, training centres, companies, and basically anywhere where there may be blind users, together with ergonomic and functional studies to adapt work and study places.

5 The Research

Organizationally, the CIDAT research centre [8] comes under ONCE's *Dirección General Adjunta para Servicios Sociales* (General Directorate for Social Services) and works in close coordination with the dependent department of that directorate, the *Dirección de Autonomía Personal y Bienestar Social* (Personal Independence and Social Welfare Department) (see Figure 1).

CIDAT is engaged in research and development, the evaluation, maintenance, and repair of products, the training of trainers, the provision of guidance, the import/export of goods, the production, distribution, and marketing of assistive products, and the provision of a personalized service to users of technical aids for the visually impaired.

The research centre is headed by a general manager and

has five dependent departments (General Resources, Production and Maintenance, Sales and Marketing, User Care, and Research and Development, as well as a consulting service to provide guidance in the use of technical aids for visual impairment). The total headcount of all the departments, including both skilled and unskilled workers, is around 80.

Focusing now on the Research and Development Department, as part of ONCE's ongoing quest for progress in the removal of physical and digital barriers, this department develops many national and European projects, putting into practice its accumulated know-how and experience in the definition of specifications and in the validation of trials and products.

The Research and Development Department's Action Plan calls for collaboration with companies which, generally speaking, act as subsidiaries for the provision of R&D services and the manufacture of products commissioned by, or in support of, ONCE.

With regard to research of a more academic nature, we would highlight the research agreements in place with a number of Spanish universities. This collaboration is formalized through institutional collaboration agreements at various levels: education, work, etc. Thus, for example, in the field of IT engineering, the framework agreement is aimed at collaboration in technological research and innovation through the promotion of technical support, IT development, and the dissemination of IT, to ensure the social integration of the disabled.

6 Plan of Research of ONCE-CIDAT

CIDAT's [9] main lines of research are aimed at developing products and services related to:

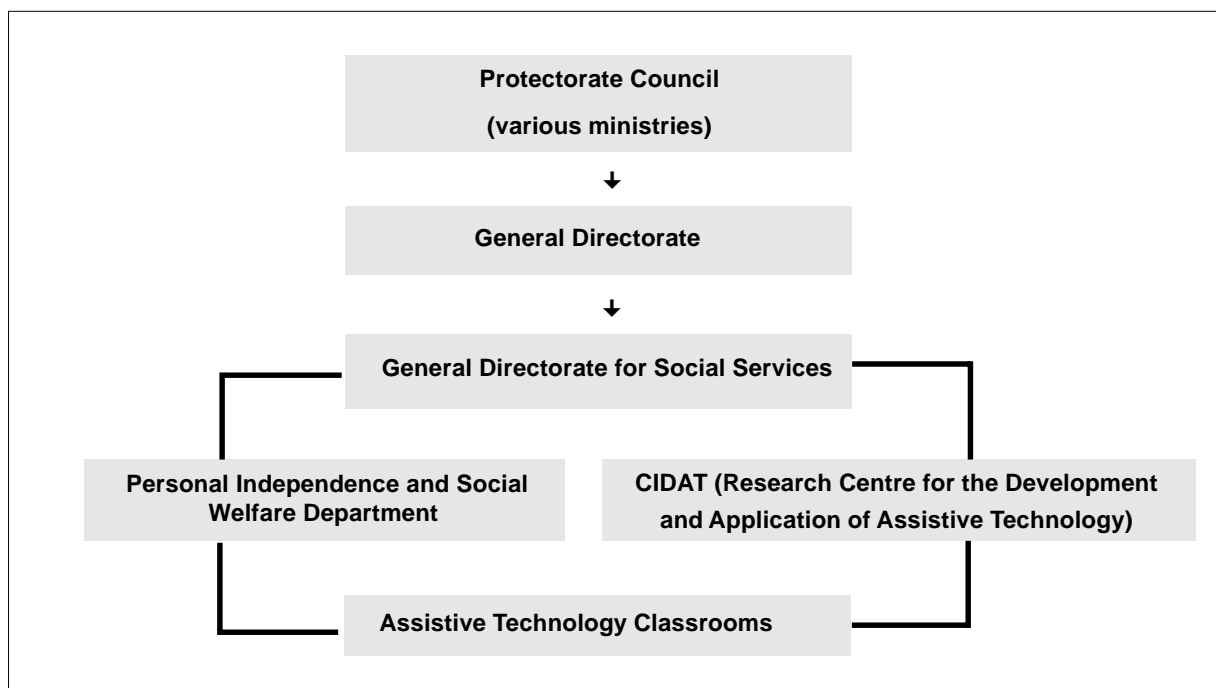


Figure 1: Basic Hierarchy of ONCE-CIDAT.

■ **Resources facilitating access to computer-based information.** This line of research centres on the continuous upgrading of screen magnifiers and readers to enable users to access the most commonly used operating systems and applications. This equipment needs to be accompanied by modern information access devices such as braille displays (cell, line, or full-page) and other tactile representation devices with improved functionality and design. Research is also conducted into the integration of speech synthesizers that improve on current performance in terms of speech quality and range of languages (official languages in Spain), and into speech recognition technologies insofar as they help provide access to information for the blind and the visually impaired (screen readers, magnifiers, braille displays, PAC Mate, Plectalk PTN1, Victor Reader). Meanwhile research is also being conducted in the field of *virtual reality* as a source of tools capable of opening up new channels of access to information (projects such as GRAB[10], INMU, etc.).

■ **Access to paper-based information, and data conversion and processing applications.** In this field, CIDAT works on the ongoing evolution and improvement of optical character recognition, and keeps a watchful eye on the market for any products using this or similar technology that might be useful to ONCE and its members. The centre also researches into systems capable of reading *ID codes on banknotes and products* (barcodes, PDF, magnetic strips, inks, etc.).

In the field of *specific technology for people with residual functional vision* research is conducted into the most advanced optical techniques to develop high performance, portable, and inexpensive enlarging devices.

Meanwhile, for those who may wish to process the information retrieved by the above mentioned technologies, CIDAT is conducting ongoing research into the development of braille conversion systems, musical and mathematical notation, PDF, and the recording and playback of formats such as Daisy, mp3, etc. (symbolic braille, Bluetype keyboard, Lectotext, etc.).

■ **Braille printers and print control software.** In order to continue to exploit the market potential created by ONCE with the manufacture of new printers and the upgrading of existing ones, CIDAT is researching into ways of maintaining ONCE's current competitive level while meeting the needs of its members. This hardware is complemented by print driver, spooler, and adjustment software which is upgraded constantly to meet the requirements of the printers and the demands of the market. (Braille display, Linux printer drivers, Quickbraille).

■ **Educational and recreational software.** As technology is acquiring an increasingly more significant role in the world of education and is also an important tool in the educational development of blind and visually impaired students, researchers at CIDAT believe that it is essential to pay the maximum attention to this line of research. One aspect of this work is to ensure accessibility to the operat-

ing systems, content, and content management systems used by each of the Spanish Autonomous Communities.

CIDAT has also developed other educational applications and devices (dictionaries, encyclopaedias, interactive courses, concept tables, etc.) covering educational needs from infant school right up to university.

Meanwhile the centre continues to develop adapted games, not only for PC environments but also for mobile telephony and even educational board games (Lambda, BME, English course, accessibility to Spanish Royal Academy, bilingual dictionaries, Espasa dictionary, ONCE-Larousse, tutorials...), games ("*Invasión alienígena*" [Alien invasion], stories, "*La pulga Leocadia*" [Leocadia the flea], "*Aventuras en el tiempo*" [Adventures in time]...), etc.

■ **PDA's and mobile telephony.** These two fields, PDA's and mobile telephony, are undergoing a permanent evolution towards convergence in which their separate identities are becoming blurred, therefore for the purpose of research into assistive technology the two are treated as one. CIDAT's research is focused on continuing the progress already made in accessibility to these devices, with the development and/or adaptation of GPS applications, office automation utilities, games, etc., while looking for new ways to provide accessibility to other products via these devices.

At the same time CIDAT is researching into accessibility to new PDA models and into accessibility to third generation telephony (MSP – screen reader for PDA's -, Wayfinder).

■ **Professional tools and occupational training.** In response to the ever-changing market for the tools that drive a company's business activity, researchers at CIDAT study the viability of adapting these tools to the needs of the blind and visually impaired for activities such as remote assistance, accessibility of the equipment used in physiotherapy, distance learning applications and the adaptation of telephone switchboards. At CIDAT we are aware that this is a sector which offers great possibilities in terms of the integration of people with disabilities into the job market.

The continuous advances made in telephony technologies in the service of the workplace makes it necessary to identify and apply solutions that will ensure their integration in the shortest time possible, while optimizing the cost of this type of solutions. For this reason, research efforts are mainly focused on accessibility to computerized switchboards.

■ **Accessibility to home automation and household appliances.** The development of solutions providing accessibility to household appliances is centred on the communication capabilities provided by Bluetooth technology and ONCE's relationship with expert companies in that field and with household appliance manufacturers, mainly using mobile phones or PDA's as access terminals. However the use of other technologies as a means to access such appliances is also under study.

Also, given the continuing development of home automation systems in our society, CIDAT also researches into

technologies to provide accessibility to such systems.

■ **Public transport.** Public transport is one of the main barriers facing the disabled. It is therefore essential that all the players involved in this sector, whether public or private, identify and provide accessibility solutions wherever they are needed. In spite of the fact that the provision of greater accessibility does not strictly depend on technological research, the various technologies used in the field of assistive technology may be of great help in adapting public transport to the requirements of the blind and visually impaired and so give them a greater independence in terms of mobility. For this reason CIDAT works in collaboration with public transport companies, the Public Administration, and the ONCE Foundation, providing guidance and research in systems that improve accessibility to public transport.

■ **Audiovisual media.** The widespread use of audiovisual systems such as DVD, and the high expectations aroused by digital television, make these fields highly interesting from an accessibility point of view, since the development of these media, which were designed under universal accessibility criteria, can open up a world of disabled-friendly information and services. For this reason, CIDAT collaborates with companies and the other areas of ONCE involved in the study of and research into systems which ensure optimal accessibility to these communication media (Digital TV).

■ **Manufacture, prototyping, and adaptation of specialized devices and equipment.** In this field CIDAT is involved in processes of design, prototyping, production, and manufacture of canes, braille writing tools, the mechanical parts of various assistive aids, and special adaptations of other equipment. The centre also researches into the manufacture of new canes that substantially improve the quality of those in current use to meet the highest demands of our members, using state-of-the-art materials to produce solid, stable, and durable canes.

7 Collaboration with Third Parties and Participation in Major Events

Our centre regularly collaborates with and participates in any national and international events that may bring us into contact with new technologies or help disseminate our products and activities.

With regard to international events, in addition to taking part in meetings with the manufacturers of specific solutions, we also participate in international assistive technology trade fairs such as CSUN (*California State University at Northridge*) [11], SightCity (Germany) [12], etc.

Here in Spain, as well as the various exhibitions we attend or organize to make our products known to users, we also collaborate with other enterprises in a wide variety of events of a less specific nature, such as SIMO [13] or the *Semana de la Ciencia* (Science Week) [14].

We also regularly collaborate with companies or public or private organizations in presentations, discussion sessions, workshops, etc.

We attend and often collaborate in the organization of

events for two reasons. Firstly to keep up to date with the new products and solutions that are constantly being released and, secondly, to disseminate our activities and raise society's awareness of the needs of the visually impaired and the solutions that they require when faced with the new technologies.

Translation by Steve Turpin

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