UPGRADE is the European Journal for the Informatics Professional, published bimonthly at <http://www.upgrade-cepis.org/>

Publisher
UPGRADE is published on behalf of CEPIS (Council of European Professional Informatics Societies, <http://www.cepis.org/>) by Novática <http://www.ati.es/novatica/>, journal of the Spanish CEPIS society ATI (*Asociación de Técnicos de Informática*, <http://www.ati.es/>)

UPGRADE monographs are also published in Spanish (full version printed; summary, abstracts and some articles online) by Novática

UPGRADE was created in October 2000 by CEPIS and was first published by Novática and INFORMATIK/INFORMATIQUE, bimonthly journal of SVI/FSI (Swiss Federation of Professional Informatics Societies, <http://www.svifsi.ch/>)

UPGRADE is the anchor point for UPENET (UPGRADE European NETwork), the network of CEPIS member societies' publications, that currently includes the following ones:
- Informatik-Spektrum, journal published by Springer Verlag on behalf of the CEPIS societies GI, Germany, and SI, Switzerland
- ITNOW, magazine published by Oxford University Press on behalf of the British CEPIS society BCS
- Mondo Digitale, digital journal from the Italian CEPIS society AICA
- Novática, journal from the Spanish CEPIS society ATI
- OCG Journal, journal from the Austrian CEPIS society OCG
- Pliroforiki, journal from the Cyprus CEPIS society CCS
- Pro Dialog, journal from the Polish CEPIS society PTI-PIPS

ISSN 1684-5285

Monograph of next issue (June 2007)
"ICT Certifications for Informatics Professionals"
(The full schedule of **UP**GRADE is available at our website)

CEPIS UPGRADE
The European Journal for the Informatics Professional
http://www.upgrade-cepis.org

Vol. VIII, issue No. 2, April 2007

Monograph: Information Technologies for Visually Impaired People (published jointly with Novática*)
Guest Editors: *Josep Lladós-Canet, Jaime López-Krahe, and Dominique Archambault*

* This monograph will be also published in Spanish (full version printed; summary, abstracts, and some articles online) by **Novática**, journal of the Spanish CEPIS society ATI (*Asociación de Técnicos de Informática*) at <http://www.ati.es/novatica/>.

Computing Blind

Carmen Bonet-Borrás

Disabled people should be able to play their part in our information society using new technologies under the same conditions as any other citizen. There are now tools that, to a greater or lesser extent, can alleviate the difficulties arising from visual impairment, and there are also design standards for Web pages that make Internet access possible for the visually impaired who, in turn, should commit to accessibility by using and helping to develop the new solutions.

Keywords: Accessibility, Assistive Technology, Braille, Braille Display, Character Recognition, Design for All, Functional Diversity, Low Vision, Screen Reader, Text Magnifier, Visual Impairment.

Author

Carmen Bonet-Borrás. I was born in Bellreguart (Valencia, Spain) in November 1955 into a family of 4 siblings. Due to my blindness, caused by congenital infantile glaucoma, my early schooling was spent in ONCE centres; four years in Alicante and four in Madrid. I continued my education in a regular school where I studied sciences before changing school to study for my university entrance exams. I studied Mathematics at the *Universidad Complutense de Madrid* and after selling ONCE lottery tickets for 4 years I began my training in IT on a course delivered by IBM where I embarked on my career as a Systems Technician working in Applications Development, Networking, and other fields. I am about to complete my 25th year in this profession. <carmen.bonet@es.ibm.com>.

1 What Is Blind?

If we start by consulting the *Dictionary of the Spanish Royal Academy* (DRAE) we find this definition of "blind": "*Deprived of sight*".

Or in the Seco dictionary [1] "*adj 1 Deprived of the sense of sight. Also, referring to people. DPlaja Literatura 213: 'Each person Lázaro serves is the butt of his mockery: he sees the evil that resides in the blind man.'* ". In spite of being a dictionary of usage, this dictionary, like the DRAE, has very little to say on the subject. Moreover, I think that, given the vast number of references to be found in literature, the one chosen can hardly be said to be the most fortunate example.

Going back in time a little, to the first half of the 20th century, the María Moliner dictionary, also a dictionary of usage, defines blindness as: "*Physiologically incapable of seeing*". This definition is not exactly over-explanatory either, but I prefer it.

Another longer leap backwards in time. The *Diccionario de Autoridades*, the first dictionary produced by the Spanish Royal Academy in the 18th century which backed up its definitions with examples of real usage: "*Deprived of sight, like a man born without it, or who lost it later, through accident or illness: also used for animals. From the Latin 'caecus' with the same meaning*".

And going back a little further in time to the early 17th century and another dictionary, one which nowadays may seem a trifle exotic as it is a compilation of the personal knowledge of just one man. It was the first formal dictionary of Spanish and the criteria used to decide its entries are varied in the extreme. There are a great many personal comments and opinions, it is entirely subjective as we can see by the definition of "blind", and sometimes his definitions are almost encyclopaedic; he tells us everything he knows related to the word in question. I am referring to Sebastián de Covarrubias's *Tesoro de la lengua castellana o española*: "*A man or animal that lacks sight. The man may have been born blind and may never recover [his sight], unless by a miracle; or may have lost his sight due to an accident*".

These last two definitions give us some more information, but let's keep looking. Moving away from the purely academic and returning to more modern times, we find other contributions: *"Blind! Mother of God! the worst thing that could happen to me!*". That's what some passers will invariably say to us when they generously offer us their arm to help us across the street. And then they might add: *"I do so admire you people!*". We hear this kind of intrinsically contradictory comment about our blindness regularly. If blindness makes us admirable, what's all the fuss about?

What is objectively true is that blindness in a person is a condition that's easy to see. As for most generalizations, there are exceptions, but not many. Normally, if you have a visual impairment, sooner or later the people in your circle are going to notice. I am also convinced that blindness is something which very few people view with indifference. The proof of this that there cannot be many people who, at one time or another, have not closed their eyes to try and imagine what it's like to be blind. Do you remember the children's game 'Blind Man's Bluff'? From Homer, epic poet of ancient Greece, of whom it was said he was blind, to the current day, we find references to blindness in literature: *El Lazarillo de Tormes*, *El concierto de San Ovidio*, or *El Túnel* are all important literary works featuring characters who are blind.

For this reason I think now would be a good moment to clarify a number of points before centring in on the topic of this article. From the perspective of my more than fifty years' experience, or perhaps a little less, depending on how you look at it, since while I have been blind since birth, I had no clear awareness of being blind until I reached more or less the "age of reason" (can that be a coincidence?), to this day I still don't know whether blindness makes a *quantitative*

or a qualitative difference. And I'm beginning to suspect that the answer to this dilemma is for ever going to remain in the pending file of my life.

However, what I am in no doubt about, is that blindness is a characteristic that sets us apart, that creates group identity, and causes a major change in the way we relate to our human, social, and physical environment.

Leaving aside any possible value judgements, I will try to limit myself to the more objective aspects. Oh, and by the way; closing your eyes is not much like being blind at all.

The term 'visually impaired' covers a wide range of problems. You may be able to see nothing at all or you may see a little. And if you see a little, what you do see may vary both in quantitative and qualitative terms from person to person. You may see only light and vague shapes, or you may see enough to walk along a street without using a white cane, for example, but only when there's not too much light, or using only the middle part of the eye, as if you were looking down a tube, etc.

The two parameters that are most commonly used to express these differences are visual acuity and visual field. Visual acuity refers to the distance at which a person sees an object clearly. A visual acuity of 1 means normal vision and the figure goes down as the size of the object in question needs to be increased to be seen at the same distance. For example, a person has a visual acuity of 0.5 if he or she needs the size of the object to be doubled or, of course, the distance to be halved. Thus we can speak of:

- Total congenital blindness: does not even know what seeing is, therefore has no notion of light and darkness, or of colour, cannot see black, simply does not see.
- Total acquired blindness: all visual function is lost due to illness or accident, but some memories remain as intellectually manageable concepts.
- Visual impairment: when there is some usable residual vision that can be optimized by using technical aids.

In the first two cases we are talking about the blind, while in the third case we are referring to the visually impaired.

In addition to the visually impaired whose degree of impairment qualifies them as legally blind, there is another group of people who "cannot see properly". These people are said to suffer from "low vision". This is a concept based on functionality and is therefore difficult to define with complete precision. These are people who, after appropriate treatment and standard refractive correction, have in their better eye, a visual acuity of between 0.1 and 0.3, or a visual field whose extent in all directions around the fovea (i.e., around the physiological centre of the visual field) is less than 10 degrees (i.e., a diameter of less than 20 degrees) in the eye with the field of greater central extent, but who uses, or is potentially able to use, vision for various tasks. Obviously, there is no strict dividing line between visual impairment and low vision, regardless of whether the condition falls inside or outside the threshold of legal blindness.

This is a relatively new field of care which is mainly the responsibility of optometrists who attempt to provide more or less effective solutions through the use of optical devices for the conditions that medical science still cannot cure. Low vision occurs more frequently among the elderly, but it can affect any age group, which is why technology is so important as a source of optical aids.

2 Does Being Blind Create a Lot of Complications?

In every facet of life a blind person makes use of a set of capabilities that are different from those enjoyed by the majority of society and, therefore, each facet will be complicated or not depending on whether he or she has the necessary resources with which to act. For example, if it's a matter of reading a book and that book is available in a format that a blind person can handle (braille, sound) there's no problem. The problem only arises when the book is in a format that is inaccessible to a blind person. I would like to underline this difference. This is a true case of functional diversity. Minorities characterized by some kind of functional diversity will find things more or less difficult depending on to what extent society is capable of responding to those functional diversities. I am referring of course to the strictly physical aspects. The emotional side is beyond the bounds of this article.

The visually impaired are a diverse and varied group, depending on the degree of vision they have (if any), the nature of that residual vision, any skills they may have had before they first encountered visual problems, their economic and social status, any rehabilitation they may have received, etc.

So what we need to do is to look for flexible solutions and, depending on how successful we are, we will be able to mitigate the difficulties facing the visual impaired.

3 Market and Technology

In western society, the frame of reference used in this article, the blind and visually impaired represent around 1.5% of the population. In other words, it's a relatively small group of people and, as such, does not carry much weight when it comes to influencing market priorities which tend to be based on profitability criteria and gravitate towards a supply that will reach the highest number of consumers possible.

Meanwhile, technological advantages depend on the interests of the entities that fund research, and once again people with functional diversity are not a priority. In view of this scenario, what tends to happen is that, more often than not, technological advances tend to exclude these groups, either wholly or partially. However those same technological advances often give rise to opportunities that, when properly realized, can provide interesting solutions capable of addressing some of the difficulties caused by disability

Also, bearing in mind the longer life expectancy of the population, an increasing number of people reach an age at which a variety of functional limitations begin to make an appearance. As this group of people grows, so does their economic importance, and they begin to become more interesting from a business point of view.

4 Active Participation

The visually impaired must not be excluded from the information society and the new technologies. That would

only add to their functional differences by making tools used by the sighted majority inaccessible to them.

I therefore believe that it is our responsibility as a group to get involved and participate, claiming our rights as users but also contributing with our collaboration in all processes where it may be of use: from the prototype design phase to the market launch of the finished product. With an open mind and an active will we need to find the way to become directly involved in the processes of research, manufacture, and design so that our problem is taken into consideration from the very moment an idea is first conceived. In that way the idea can be developed and brought to fruition as a product that meets "design for all" or "universal design" criteria.

Modifying something already on the market so as to make it usable by a blind person requires much more work and added expense than if those modifications had already been included in its conception, design, and manufacture stages. Also, when something is designed using design for all principles, it invariably ends up benefiting all users, whether disabled or not.

5 Technology and Visual Impairment

In my opinion it is a legitimate aspiration of all the various groups of people with functional diversity to enjoy the benefits provided by technology. To achieve this we need to ensure that technological advances incorporate features that enable them to be used by the blind or visually impaired, and use such advances to address the problems inherent to their visual impairment. We will use this new technology both to improve available resources and to replace visual information by auditory or tactile information; i.e. to make use of our other senses when there is no residual vision.

Whenever possible we should apply general purpose technological advances to disability related applications. Only when it is strictly necessary should we develop technology for the specific use of people with functional diversity, what is known collectively as assistive technology. The reasons are obvious: general purpose technology will always be more economical and will evolve according to the dictates of the market, while assistive technology will always be more expensive and will evolve less or at a slower pace.

6 Information Technology

Information technology plays an undeniably important role in society. The Internet is a very significant source of information and of business tool. From merely looking up information, to buying tickets, performing bank transactions, etc., it is practically impossible to find a reason for not getting involved in IT. If the visually impaired are to take part in this wonderful world, we need to ensure that both hardware and software are accessible to them while guaranteeing the accessibility of Web pages.

One of the most fundamental aspects of this area of work is that of standardization, or the definition of standards to help facilitate communication between all the various elements, both hardware and software. The closer any element of hardware or software comes to conforming to the applicable standard, the more useful and interesting it will be in terms of accessibility. Among the most important features are: operating system independence, portability (weight and size), versatility of communication, and capability of evolving with the environment.

It is also very important to maintain the functionality of assistive tools. When a new version of a product comes out, it should not lose compatibility with screen readers and other assistive technology tools, something which unfortunately happens all too often (if it happens once that is one time too often). What tends to happen is that when a new version of a product comes out, technical aids lose some of their functionalities while others are improved. Of course, tools need to evolve, but if they evolve on the assumption that the latest version of the product is already in common use, these tools will always arrive late, badly, or never to the consequent detriment of users.

Price is nearly always a sticking point when marketing new assistive technology. To overcome it we need to try and join forces and avoid competing in a market that is already too small. We also need to try and get state authorities involved to help with funding and in particular to promote the culture that products should be accessible from conception.

Among the technology currently available on the market there are a number of solutions that are already up and running. The first problem we need to overcome in order to make use of them is how to handle the mouse and the screen reader.

6.1 Mouse Handling

Not being able to see where the mouse is pointing makes handling the mouse an impractical proposition. The solution is to use the keyboard, a skill which is not particularly difficult for a blind person to learn. However, if this is to be viable, the operating system and the application to be used should be designed for that purpose. If this possibility is not provided for internally, the application will be inaccessible. For every function a mouse can perform there should be a sequence of keystrokes equivalent to the corresponding mouse clicks.

6.2 Screen Magnifiers

For people with a considerable degree of residual vision, the ideal solution is to provide them with the possibility of magnifying the image and altering the colours so as to adapt the presentation to their visual capability. These features are available in software that normally goes by the name of "screen magnifier".

6.3 Screen Readers

For blind people we need to resort to voice and/or braille. Nowadays there a excellent sound card based speech synthesizers which form the basis for what are known as "screen readers", programs that read out load whatever is on the screen, provided that the operating system considers it as text. A screen reader is normally built around a basic module which interacts with the operating system and a number of profiles that act as links for the various applications. They

are designed to be able to tailor the function of reading to each user's needs, always by using the keyboard. A user might require the program to repeat a phrase, spell out a word, say the colour of a character, change the speed of reading or the tone of voice, etc. They are highly versatile programs which provide user-friendly management of the contents of the screen .

However, there are times when a user may wish to read content that the operating system does not identify as text, but rather as a graphic. In this case, screen readers are incapable of capturing or interpreting that information. A graphic is always a graphic. Whether it is a photo of someone or somewhere, or the page of a book, it will always be an image that the screen reader cannot interpret.

6.4 OCR

A type of software known as OCR (*Optical Character Recognition*) has been developed based on a general purpose tool, the scanner, the purpose of which is to scan the graphics on a page and convert them into text. Naturally, if the scanned page contains no characters, there will be nothing to convert. Generally speaking excellent results can be obtained with a minimal error rate, although much depends on the print quality of the graphic to be scanned. Nowadays there are even OCR programs capable of working directly with PDF files.

There are also scanners that come equipped with their own OCR and operate as an independent device with a voice output and their own storage capacity. Or programs that are compatible with certain scanners, but work through a PC. These resources are an enormous help when it comes to accessing the printed word, which has always been one of biggest obstacles facing the blind or the visually impaired.

6.5 Talking Browser

A screen reader will invariably have a profile enabling it to be used with one of the standard Internet browsers. However, there is also the possibility of an Internet browser that can be operated using a keyboard and with a voice output. However, there is a substantial price difference between a voice browser and a screen reader, which is much more expensive due to its greater functionality.

Other software tools have been brought out that enable users to alter the "aspect" of a standard browser by changing sizes and colours. These tools are available through links to the supplier on the page that the end user wishes to visit, thereby providing added value for that page.

6.6 Braille Display

This is a hardware device used for converting the content on a screen into braille. At present these devices usually run under screen reader software, although they have a degree of functionality that enables the user to read "according to taste", to change line, to use a 6 or 8 dot braille, etc., using its own keyboard. They may vary greatly in size depending on the number of characters they can display, from 20 to a maximum of 80, among other factors. There are also significant differences in the way they connect with the computer. Today some devices connect via Bluetooth; they are very compact displays and convenient to carry around.

The price still needs to come down as they are very expensive devices, partly due to the cost of some of the materials used in refreshable braille displays, and partly because of the fact that this is assistive technology for an especially small market. However, it is a vitally important device – braille is, after all, the blind person's reading and writing system - and we therefore need to promote and facilitate its use [2].

6.7 Braille Printer

These are used for printing in braille. They are normally used for text, but there are some printers that enable simple graphics to be printed.

6.8 Personal Notetaker

For a number of years now, it has been possible to acquire notetakers that can be used as standalone devices for word processing, storing a certain amount of data, as calculators, etc. and they have enjoyed great success among blind users. They are easier to use than a computer, their size and compactness makes them ideal to carry around anywhere and, in short, they are a highly useful tool. If they can also be used for exchanging information with a computer, then we are talking about a truly valuable resource. Input to nearly all models is provided by a braille keyboard while output is by voice, although there are devices with a braille output that are less widely used, perhaps due to their considerable extra cost.

6.9 Web Pages

In order to browse the Internet, it is not enough to have tools enabling a blind person to handle a computer. If a Web page has not been designed in accordance with the WAI (*Web Accessibility Interface*) standards recommended by the W3C (*World Wide Web Consortium*), the page is likely to be totally inaccessible. Pages designed with plenty of graphics, movement and so on with the idea of appealing to visitors, are often also very tedious and deficient on certain browsers, types of terminal etc., and tend to be a headache for screen readers. Ideally designers should meet WAI standards from the initial design stage, but that doesn't mean they have to abandon their aesthetic aspirations; an accessible page does not have to be an unsightly page. And forget any ideas of providing a "text-only version" as a solution. Firstly, because there is no reason why a text version should necessarily be any more accessible than the page it replaces, and even if it were, it means twice the work to produce a page that may well be obsolete within the month, making it a complete waste of time.

At this point it should be made clear that when we speak of accessible Web page design we are talking about accessibility in terms of the principle of design for all, not just for the blind or visually impaired which, while being particularly sensitive to this problem, are not the only people with functional diversity that need to be considered.

In fact nowadays we should also be speaking of routine accessibility practices. Web pages should be designed to be

accessible, but we should also be applying usability and accessibility principles in our day-to-day work. By way of an example, think of the way the changes made to a document which several different people are working on are marked with different colours. The use of different colours to indicate changes is fine, but it's no help to blind people. Let's add, say, a double asterisk, and, hey presto, problem solved.

Leaving aside commercial considerations, governments should strive to ensure that, on the one hand, its Web pages are usable by *all* its citizens and, on the other, that the society being built is an inclusive one. Governments thus bear a heavy burden of responsibility when it comes to enacting laws to promote universal accessibility.

7 Other Areas of Technological Action

7.1 Medical Science

Technological advances play an important role in medical science. Major advances in surgery have been made while neurological research is entering territory that some years ago would have been thought of as science fiction. Any battles that medical science can win in the fight against visual impairment, from curing diseases to the neurological emulation of the visual function of the brain, a field in which interesting progress is being made, will very more than welcome. The role of stem cells also appears to be promising.

7.2 Optical Science

The field of optical science has a great deal to offer. From the simplest magnifying glass to the most sophisticated video magnifier that allows you to adjust the magnification, colour contrast, reflections, etc., there is a wide range of products on the market today.

7.3 Digital Books

The new technologies have brought about a radical change in the matter of accessibility to books. While it is true that braille is the reading and writing system of the blind, for various reasons some form of voice technology has very often been used for the purpose of reading. In the past there were cassette recordings of books, recorded by real people. Playback was necessarily sequential and there were scant opportunities to "play" with the content of a book. This situation has changed dramatically.

Firstly, there is a great deal of literature in directly digitized formats that can be handled by a blind person with the tools currently available. The book can be "opened" and the reader can move around inside it with ease. It will be read either by speech synthesis or braille, depending on the user's hardware and software environment. Reading by speech synthesizer through a screen reader is a little shocking at first - the voice sounds a little metallic and robotic - but with practice and with the optimal quality that these media can now achieve, the reading standard is now more than acceptable. It may not be the best way to read Antonio Machado or Pablo Neruda, but it is at least possible. In any event, if you have a braille display or a braille printer you can read in the more literal sense of the word.

The other method is to listen to recordings made in a digital format on a CD. Books recorded in this way will preserve all the advantages of the human voice but will also allow you to access the book via software capable of searching the book by chapter, pages, etc. Add to this the ease and low cost of making copies, which allows users to have their own copy (the traditional method involved borrowing from libraries), we can now justify the use of the term bibliography in the broadest sense of the word.

7.4 Solid Braille

This is the name given to the use of raised dots to form braille letters which are produced by means of a series of droplets deposited on the surface on which we wish to write, which then adhere to it before finally solidifying to form an integral part of that surface. This system has been used in trials for visiting cards, for example. It can be a magnificent solution for labelling consumables, pharmaceuticals, clothing, etc. This is no simple task; you need a material that is of sufficient consistency, clean, and tough, and a mechanism capable of performing this kind of precision writing at a reasonable cost. What I am trying to say here is that the problem of labelling is no trivial matter. Every day we come across packaged products - food, cleaning, leisure products, etc. – which need to be easily and clearly identifiable if the blind are to enjoy autonomy and quality in their day-to-day life.

7.5 GPS

This is a relatively new resource which is very appealing to blind people. The possibility of knowing exactly where you are while walking around places you are unfamiliar with is really very interesting indeed. If it also provides details of the location of specific buildings, shops for example, it will solve one of the most common problems facing the blind. To date, all I know is that there is a GPS service that can be used via a mobile phone, a device which, by the way, will need to be equipped with its own screen reader.

8 Conclusion

While we are waiting for that miracle to which our 17th century dictionary compiler, Sebastián Covarrubias, referred, that we will get our sight back (and it is highly unlikely that we will), let us try to make use of the aids that technology affords us and help improve the quality of life as far as is humanly possible. We cannot afford to miss this boat, as there won't be another one. Let's get down to work do what we can to help.

*Translation by **Steve Turpin***

References

[1] Manuel Seco, Olimpia Andrés, Gabino Ramos. *Diccionario del español actual*. Aguilar, 1999.

[2] Carmen Bonet Borrás. *El braille y el placer de la lectura: los ciegos queremos seguir leyendo con los dedos*. Novática, No. 169, July-August 2004, pp. 67-72. <http://www.ati.es/novatica/2004/169/nv169sum.html>.

