Pieces of a larger puzzle: a model for understanding a human- computer interaction system for people with special needs

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ABSTRACT

The study of scenarios in which computer based technology and people with special needs play a leading role are confronted, at the very beginning, with the sense that the effort being approached can be called anything but easy. This adjective presents itself, however, as the main force that drives our work when witting this paper. Our intentions when writing this document are centered on the will to help understand what sort of variables may be associated with this' sort of scenarios, their differentiating aspects and some of the existing solutions which may be used in order to optimize them. Our final goal with this paper is to contribute, if even in a symbolic way, to the better comprehension of the pieces, which make up the larger puzzle.

Keywords

Special Needs, Assistive Technology, Human-Computer Interaction

INTRODUCTION

Every single part of a Human – Computer (H-C) interaction system, from high level concerns with the organizational context and system requirements, to semantic, conceptual and syntactic levels included in the interface design, is channeled through input and output activities and devices.

The user, when confronted with technology and when interacting with it, becomes part of a interaction model where user-computer inputs and outputs define the way they relate with each other. This model may include 4 essential components [1]: the directive, the action or input, the input/output (I/O) device and the feedback or output. These components will be explained throughout this paper.

The model's human domain

When first approaching the human domain of this H-C interaction system, our attention must be drawn to the type of relations that it develops with the information it receives and produces. If we analyze these types of relations at a basic level we will be able to see that there are at least 4 different types of actions involved. The user receives the information and responds according to the data obtained through movement and visual, auditory and haptic input and output. This information is stored, according to parameters intimately linked to personal characteristics, in the users sensory, short term and long term memory. In parallel or posterior to this action, the user processes and conveniently applies the information in problem solving, in the acquisition of new skills and error prediction and correction. Although there are some similarities in how each individual performs these activities, the differences, which do exist, are more noticeable when the user has special needs. In order to try and shed some light on this particular piece of our model, the following lines deconstruct some of its building blocks using the Model Human Processor (Card et al83) as a reference guide and linking it with human/information related activities.

The directive

The Model Human Processor maintains, since 1983, a still applicable and up to date context despite its 20 years life span. When subdividing the human side of the H-C interaction system into subsystems, which perceive the information, produce motor responses and act through cognitive procedures as mediators in the whole process, it widely contributed to a better understanding of what happens to information before it steps over the border into the technological domain of the H-C interaction system.

The user interacts with the world through the reception and sending of information, in other words his life depends on the development of activities involving inputs and outputs. When a user interacts with a computer he receives output from it and inputs information into it. The users output is the computers input and vice-versa. The question is when does this cycle begin. Presently the user still has the upper hand in this process and the cycle is only initiated when the user formulates a directive, the information he intends to input.

The directive is generated in the human side of the H-C interaction system and its main responsibility is to initiate the production of inputs intended for the technological side of the system. In order to facilitate a clearer understanding of the sort of relationships maintained in a system such as this one, a visual reference might be useful at this point. Figure 1.1 illustrates the type of H-C interaction system under discussion in this paper and in which the directive piece of the puzzle is shaded. It will also be used as a visual reference for other sections further on.

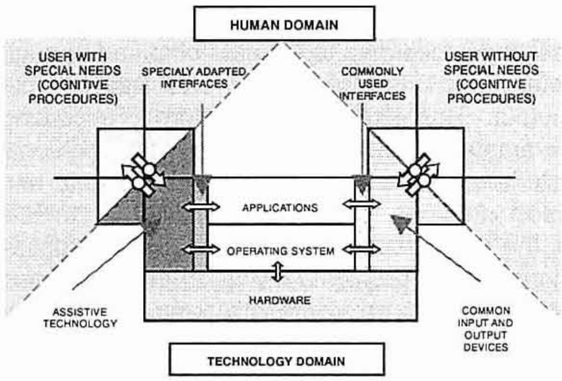

Fig 1 – The Human Domain and the directive in a Human – Computer Interaction System

The users relationship with the surrounding environment has a great influence on the type of directives he or she will elaborate. This involving ambience can be interpreted as the users individual space and can be represented as a group of level rings beginning at a user level evolving outwards to a world level ring. Working closely with practical implications and a strong psychological component, these layers are differentiated according to the following order [2] adding to a total of 7 rings as shown in figure 1.2.

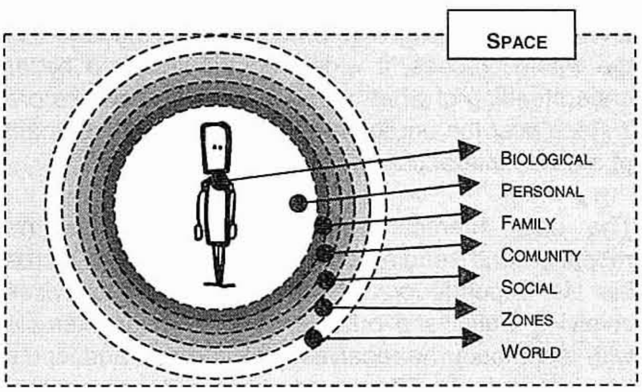

Fig 2 – Man's 7 spheres

- **Biological ring** – The users own body
- **Personal ring** – The users physical capabilities
- **Family ring** – The users home and some of his daily living activities
- **Community ring** – This layer is delimited within by the environments where the user establishes closer relationships outside the family ring (neighbourhood, street, building)
- **Social ring** – The layer where the user develops his normal daily life social activities (town, city, country, social intercourse)
- **Zone ring** – This layer defines the environment in which the user moves around without any important organizational implications (for example the route he takes when going home).
- **World ring** – The outer ring symbolizes the environment in which the user is confronted with long periods of time away from home and that obliges him to develop alternative behaviour habits in order to adapt to new situations (this can happen when taking vacations abroad).

The sensory input from this space involving environment and each of its rings inculcates the user with the need to integrate additional functions Apart from the sensory activities fed by internal and external stimuli, functions at a perception, memory, cognitive and physical level are also preformed. Its is then safe to say that the directive is moulded by the users own goals which are defined according to the users inherent behaviour patterns and in harmony with the context presented.

The action

The user creates system inputs by accessing I/O devices and fulfilling his or her directives. For this process to take place the user needs to conjugate an optimal relation between his or her cognitive procedures and the physical skills involved. This is followed by the assurance that accessibility and usability needs are met according to his or her user profile.

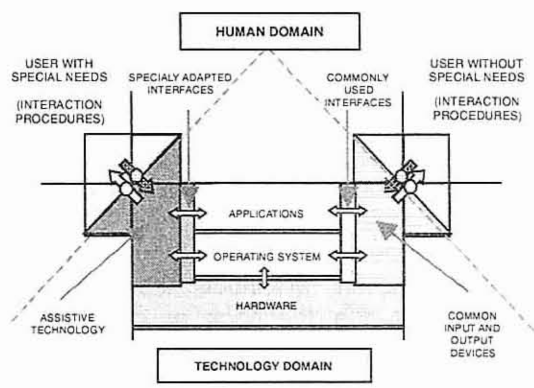

Fig. 3 – The action / input in a Human – Computer Interaction System

The delivery of the directive depends on the users action accomplishment, which involves the production of input through the use of the I/O device included in his computer workstation.

The identification of the optimal body-device access site (BDAS), as referenced in the Life Cycle Assessment tool, used to interact with the I/O device in information input activities may be considered the task able of defining success and failure. The BDAS, such as the mouth, hand, chest or feet, are some of the body parts that can be used to accomplish the action. Every user has a unique individual profile and when choosing the correct BDAS under minding this fact may lead success astray. The common ideas that hands and fingers are first choices as BDAS are not at all applicable in cases where user has special needs. In these cases the options worth studying, depending on the case may include the finger and hand solution but also include the head (forehead, chin, mouth, tongue and eye), the elbow, the arm, the shoulder, the foot and the knee. Some of the issues, which may influence the choice of the best BDAS, are the users comfort, dignity, personal preference and physical endurance.

BDAS demand the user to integrate and use several sensory and physical functions [1] such as: sensory assimilation, physical planning, movement control and performance.

In cases where users have certain physical handicaps, computer based assistive technology provision teams must try to identify what is causing the movement impairment, the sensory and physical function involved, and must work towards the design of a solution capable of compensating identifiable deficits.

Achieving success when performing the action is also closely related with the quality of activation and interaction with the I/O device included in the computer based assistive technology (AT). If the activation is accomplished through user movements, some variables such as resolution, range of movement, strength of movement and versatility of the movement, must be taken into consideration and analysed individually.

Resolution

Resolution is the degree of fine control of the movement. In its essence it represents the quality of movement achieved by the user when interacting with the I/O device.

Range of movement

Range of movement is the maximum extent of movement available. A qualified professional should be responsible for the assessment of this variable due to the fact that any incorrect action may result in strain and possible lesions. The tests usually consist of palpating and stretching the joints in order to determine their range, and boundary limit.

Strenght of the movement

This variable may be understood as the users strength obtained by a single muscle contraction, and his or her endurance, which is the ability to continue repeated contractions before fatiguing.

Versatility of the movement

The ability to vary the quality of the movement and to make fine tune adjustments as needed is what defines the versatility of the movement. Sensory and motor systems work close together on this variable.

The model's technological domain

The Input/Output device

The action as a one time effort or included in a group of activities, when using one or more I/O devices will convey information from the user to the computer. In fig. 3 the action is represented by the input arrow, which passes the border between the human domain and the technology domain, highlighted in fig. 4. These sort of devices are presently available in various "shapes and sizes" and their selection depends a great deal on the users specific profile with all its skills, abilities and needs. In spite of this, there are some cases in which the available solutions do not satisfy the users needs. In these particular cases adapting an already existing solution or designing an individualized one may be the answer.

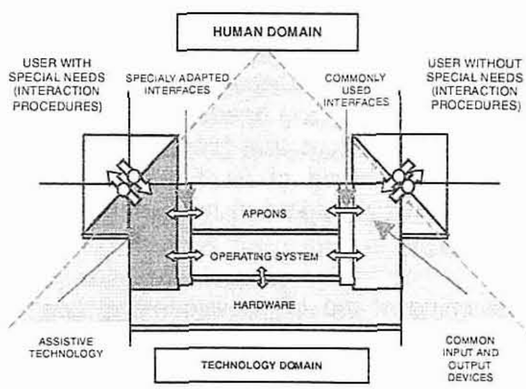

Fig. 4 – The Technology Domain in a Human – Computer Interaction System

Input and Output devices have 4 major characteristics: the selection set, the operational features, the physical features and the feedback methods.
In order to aid the conception of what makes up each of these characteristics, the next subsections of this paper describe them one by one.

The selection set

When we first turn on any regular PC, the Windows operating system takes the stage in its non-personalized state where a group of icons are organized on a desktop theme. Each of these icons may be used as mid stage point to access other groups of selectable items or initiate an application or specific operation. Although the immense number of selection sets available market wise have differences between them, some characteristics such as modality, the number of targets, contact and interaction surfaces and visual contrast, may be tagged as common among some of them.

Operational característics

The I/O device linked to the assistive technology has an inherent group of operational characteristics. The devices purpose of use, in other words what it's for, is probably the most important one. An obvious sign of a failed intervention is the questioning, at the very end of the effort, of what the device does and why the person should use it.

Physical features

Devices of a technological nature have additional features, besides their size and shape that helps to tell them apart. Flexibility and versatility are probably the next most important characteristics attributable to this sort of resources. The first attribute comprehends the number of ways a device may be used in its primitive non-adapted state. The versatility is measured according to the resources capability of adapting itself or being adapted in order to satisfy new interaction scenarios where the user presents a different profile concerning needs, skills and abilities. Input and output devices that fail to present positive configurations in terms of flexibility and versatility evolve more easily into a technologically obsolete solution.

The positioning of the I/O device along side other ergonomic related issues also plays a significant role in the success of the user – computer interaction. Assessment aiming the users profile definition and its results must be used as an immediate reference point when designing the computer workstation. The positioning of the I/O device may be on a table, a wheelchair arm, a headband or even a piece of clothing depending greatly on the body-device access site. No matter where the device is mounted, stability must be always assured as a priority. In order to find the best solution for I/O device positioning several possibilities may be tried out depending on the case at hand. These experiments must, however, avoid rash decisions and irremediable changes in the devices physical structure.

In cases where the AT or I/O device is mounted on a wheelchair (example of Fig. 5), solutions must enable the user to easily remove the device when needed.

Fig. 5 – Stephen Hawkins and his wheelchair mounted Assistive technology solution

The durability of the device must also be accounted for when deciding its correct positioning. This attribute may be understood as the devices ability to withstand repeated use without malfunctioning. It's irrational to suggest the use of a physically fragile device by a user that applies uncontrolled strength in his motor actions. The device will certainly be repeatedly damaged and out of use due to non-compatible interaction. As the user will be unable to use the device, he will become disinterested in the solution and might even abandon its use. We are not trying to imply that all technological solutions must be indestructible; the point is, not all solutions are adequate for all users and that their selection must also be supported by the interaction patterns included in their profile information.

The present trend leads us to buy and to prefer the use of objects that besides being functional are aesthetically appealing. The iMac computer, a Macintosh model is a perfect example. It's still a computer and it still maintains all the functions similar to various other up to date computers. It's also nicer to look at. Assistive technology and I/O devices had to keep up with these trends harmonizing their physical aspect with their functional purpose. An AT solution if seen as ugly by its intended user and by other people, he or she might think twice before using it and looking ridiculous and uncomfortable.

Feedback

The interaction cycle becomes complete with some sort of feedback, also known as output , from the computer. This information will assure the user if his directives are being fulfilled or not. The most common types of feedback are visual, audio and somatosensory. In fig. 6 the action is represented by the output arrow, which passes the border between the technology domain and the human domain.

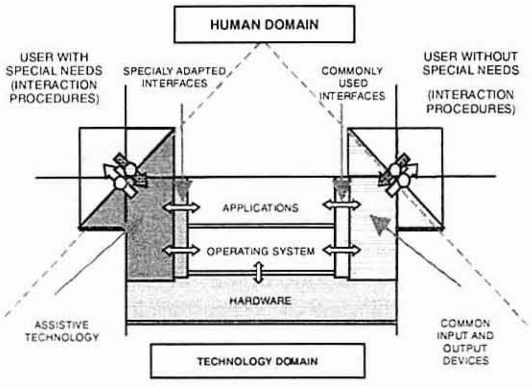

Fig. 6 – The feedback / output in a Human – Computer Interaction System

The level of complexity of the feedback output strongly depends on the users profile and the interaction patterns he or she establishes with the technology. In some cases the feedback can be restricted to a single sound, while in other situations the user might need multiple output information in order to understand what is going on. If someone, in one of these later cases, was using a switch, apart from the switch clicking sound, a small tune and an onscreen visual alert might be necessary to get the message across.

The implementation of a model like this one drives us to the adoption of a methodical procedure plan capable of assuring a successful outcome. This procedure may find some step-by-step support if it is planned according to usual assistive technology provision guidelines.

I/O devices used to access computer based assistive technology

The keyboard, the mouse and the computer screen have already stepped into many of our lives. However it is questionable if these devices present accessibility levels compatible with the ones numerous users with special needs yearn for and deserve. In these cases it is necessary to be aware of the alternatives and complements for such devices.

Blattner in his Interactive Media User Interfaces [3] lists some devices capable of being used as alternatives for the common known input and output technologies. The diversity of input and output devices discussed in his work presents us with the untouchable fact that there are numerous ways of entering and retrieving information from a computer based technology. If we go a step further and analyse the diversity of user and interaction profiles presented by people with special needs, we will certainly be able to add to the list already presented [4].

The accessibility features wanted for these types of technological solutions must be pointed out according to specific intervention areas and in harmony with Human Computer Interaction issues related with computer based technology usage.

In their book "Assistive Technologies: Principles and Practice" Cook and Hussey [5] list I/O devices, selection sets and selection methods, as the elements which most influence the user when interacting with a computer based assistive technology. The problem is that many of these elements are simply not accessible or not usable by people with special needs. The concepts of Universal Design and Universal Usability are often locked up and forgotten when conceptualization and design takes place in these matters.

Michael Chen and Frank Leahy in their "A Design for Supporting New Input Devices" [6] list 4 essential guidelines to be followed when developing computer interfaces. These include concerns related with:

- Alternative ways of performing the same task;
- The inclusion of "Shortcuts" in order to help the performance of a task;
- Extra tools that simplify the performance of a task;
- Tools that combined between them enable or allow a task to be performed.

The alternative ways of performing the same task include alternative access techniques, which according to Janice Herman may be defined as different hardware and software approaches that may be distinguished as direct and indirect selection methods.

In order to develop a more detailed understanding of the existing and market available input and output devices, we now present a list of some of the most common ones.

Input device adaptations and alternatives

As it is plain to see, the variety of profiles possessed by users with and without special needs, presents us with the need to list and lightly describe some of the most common alternative input solutions. These have the ability in many cases to draw users closer to an optimised interaction scenario.

Keyboard adaptations and alternatives

Each key on a keyboard may be considered a switch for its working mechanism is similar to one. This makes it safe to say that a keyboard is nothing more than a collection of switches. The pressing of one of the 100 or more keys included in this input device sends a signal to a decoder that informs the computer which key or keys were struck. The computer then translates the signal into a number, letter, operation or function. The number of responses may increase through the additional use of the Alt, Alt Gr, Ctrl and Shift keys. A group of 100 keys may originate about 256 alphanumeric responses, when the Alt, Alt Gr, Ctrl and Shift keys are also used.

Correct positioning, stabilizing and tilting the keyboard are some of the most common actions used for increasing its accessibility. There are although other ways of improving standard keyboard access.

The following access improvement efforts involve adaptations to the standard keyboard without eradicating it from the computer-based workstation. Size, functionality, key placement and positioning may be altered aiming the satisfaction of specific user needs.

The correct positioning of the keyboard plays an important role in a successful use of computer based assistive technology. When studying the best solution for the keyboard positioning, factors such as user seating or positioning, at his or her workstation, the keyboards size and the users body-device access site, must be taken into consideration.

Key guards can be look upon as a simple but effective add-on for standard keyboards. Users with poor motor coordination may resort to this solution as a way of improving their task performance.

People using touch sticks can achieve access to a standard keyboard as an alternative to non-functional hand interaction patterns. Although it is a lot slower, it may in many cases represent a last chance for computer interaction.

Access and usage of standard keyboards can also be improved with the use of specific customizing software. The fact that this sort of software allows users to make easy changes and then reverse them makes them extremely popular amongst people that share their keyboard with others. The behaviour of the keys can also be modified. Options include the adjustment and the defeat of auto repeat, delay acceptance and the avoidance of accidental keystrokes. Last but not least the pattern of the keys can be re-configured for one-handed users or a customized key arrangement.

Standard keyboard alternatives: Hardware and software

The alternatives for standard keyboards are, in their essence, assistive technologies in hardware and software formats. These devices shoulder the users special needs and present him or her with solutions that are adapted or adapt themselves as close as possible to the person's skills and abilities when interacting with the computer.

Some of these frequently used alternative solutions include alternative keyboards, virtual keyboards, voice recognition systems, alternative input codes and scanning.

Alternative keyboards

Alternative keyboards replace the standard keyboards and have specific features.

Some of the devices included in this group of solutions can be personalized according to the users preferences. These modifications can include, for instance, the changing of the size and function of each of its keys. Depending on their size, alternative keyboards can be classified as expanded or contracted. Expanded keyboards offer a large target surface for people with poor fine motor control, while the contracted version of this input device offers a small target for those who have limited range of motion, pain or some difficulty moving their hands or arms. These types of keyboards also include additional features like for instance, internal functions that avoid user double clicking; vinyl or plastic covers that come in handy when the user salivates excessively; and physical durability that withstands interaction patterns where the BDAS may be the hands, fist, feet or others associated with the use of touch sticks (forehead, mouth, chin).

Virtual keyboards

The expression virtual keyboard is used when a reference is made concerning methods that emulate a keyboard on a computer screen and which are controlled by a cursor [5].

As this sort of keyboard is not a physical input device it is classified as an application or software. Its layout can be changed, resized and moved around the screen. Some special dynamic features can speed up the interaction process with rate enhancers like word prediction and word completion.

Access to virtual keyboards can be achieved through the use of a standard mouse, a trackball or a switch, just to mention a few of the more common associated input devices. In case the user is fortunate enough to have a touch screen, the virtual keyboard can be activated with his hands or with the use of a touch stick (see Fig. 7).

Fig. 7 – A user interacting with his computer with the use of a head pointing device.

Voice recognition systems

Voice recognition systems may represent, depending on the case, a valid alternative to standard keyboard usage. This is an interesting solution for users, which are not capable of achieving satisfactory motor interaction patterns but are able to orally convey their directives.

The system receives the information orally input by the user and then compares it with data it already has.

The computer recognizes sound and not the words or commands entered. It compares the received sound information with other sound files that are already part of its internal data. With the use of predefined metric systems the computer finds compatible data and converts the users information into commands it can understand and follow. The systems lack of accuracy presents the user many times with erroneous functions or a list of possibilities for interpreting the sense of what was said. These flaws, besides the fact that the system is slow, qualify this input device as a last choice solution. As it is transient, it is hard to revise or correct which interferes significantly with other cognitive procedures [7].

Alternative input codes

In some cases the use of an alternative keyboard is done with the aid of a combination of alternative input codes and input devices such as switches.

Morse Code is and example of an input code used in interaction scenarios that include alternative keyboards. With the use of one or more switches combined, the user uses this specific code to input information into the system. The system then decodes the Morse formatted information and translates is into data that is compatible with the functions or alphanumeric keys identifiable in any standard keyboard.

Scanning

Scanning is an indirect access method that requires the user to wait while the device steps through the various choices, which are displayed in a matrix of selections. This type of solution uses switches as input devices to select an item from a selection set visible on the computer screen or on alternative visual output devices.

Scanning methods include:

- Automatic scanning in which the system automatically starts the scanning and maintains it while the scanning program is being used.
- Inverse scanning in which the user must activate a switch to maintain movement of the scanner rather that the scanner moving automatically through the choices;
- And stepped scanning in which the user activates the switch each time he or she wants the scanner to move to the next selection.

These solutions sometimes revert to audio feedback. The user is made aware of what item is now ready for selection by a verbal notice or a sound effect.

Standard mouse harware and sofware adaptations

The standard mouse is always present when there is a PC or Macintosh in site (except for cases where the computer is a notebook or a palmtop). With the evolution of the market and the technologies, the mouse has changed in shape, size and flexibility.

In some cases the adaptation of a standard mouse without withdrawing it from the interaction scenario can be achieved in order to satisfy somebody's special needs.

Once again positioning is referenced as a modification capable of improving the users access the computer based assistive technology. It must be guided by the idea that the final result must generate a minimum strain on the users muscles, tendons and joints.

The mouse cursors onscreen behaviour is something that can also be moulded. Accessing the Control Panel, selecting the mouse icon and changing the pre-established setting on order to suit the users needs may alter its features.

Standard mouse alternatives

The usage of a simple standard mouse is not an accomplishable task by every user. Reasons for not being able to use a mouse may derive from physical, motor, psychological or cognitive disabilities and when such a situation is identified alternative solutions must be listed and tried. The main goal, as in any I/O device, is the improvement of the users access to the computer based assistive technology in order to help him or her to improve their interaction with the system.

When the standard mouse is set aside for not being accessible enough, solutions such as:

- the trackball;
- the touch pad;
- the touch screen;
- switches activated by touch, pressure, breath, infrared light, sound, ultrasound, static electricity, heat and moisture;
- eye tracking systems;
- voice controlled mouse;
- scanning;
- Morse code;

As it is clear to see, some of these alternative solutions to the standard mouse have already been discussed in this paper. It is important to emphasize the idea that if a particular assistive technology isn't suitable for our case then we have to analyse every other solution until we find the right one.

Some extra solutions that may help the users task performance

This last input device related item centres its last thoughts on any other technological solution that can help the user improve his or her access to the computer based assistive technology.

In tasks, which involve the use of text, the user may find a word prediction solution to be the answer for his needs. This rate enhancement software can improve speed of text input and thus enhance the effectiveness of slow input devices. Word prediction allows the computer or communication device to attempt to guess what word the user is attempting to type. A list of possibilities is then presented giving the user the chance to save keystrokes and get on with his work in a more rapid manner.

Output devices

After listing and discussing some of the better known input devices used in scenarios where the user has special needs, it is now time to take a look at some of the solutions used by the technological domain of the H-C system for output information.

The order in which they are presented is strongly related to a certain hierarchy based on the use of our human senses. We obtain about 70% of our sensory input through vision leaving 30% to be shared by the rest of our senses [8].

The examples given here are ordered according to this sensory fact.

The computer screen

The first output device described has to be the one most known, the computer screen. Besides being the most known it is also the one that is most used and that is most accessible by the majority of users no matter how different their profile is.

The only types of users, which have a problem with computer screens, are the ones with visual disabilities. In these cases software add-ons may be used to improve the quality and quantity of information received by the user. Applications such as screen readers work as an audio aid capable of reading out what is on the screen. However, accessible design guidelines are not often followed and many screen readers end up reading incomplete, mixed-up and confusing information.

In some cases software that magnifies the information on screen may be used to help people with poor eye sight. Its functionality may be compared to a virtual looking glass.

Virtual reality (RV)

The main objective of virtual reality is to simulate environments in a way that we can understand and interact with synthetic scenarios according to real already learned behaviours [8].

Its publicised main advantages are the sense of being inside de perceived environment and the easiness with which we can learn to live in them.

The truth confronts us with a whole new story while pointing out some of the requirements and flaws detected in the solution.

Some of these requirements and flaws are [8]:

- Resolution
- Optical distortions
- Position tracking
- Simulator sickness

These issues indicate that VR as an output device still needs some work done on it and is not able to meet the users needs for now. It does, however, present itself as a worth full bet for future Computer- Interaction systems.

Haptic output devices

This sort of device works on the basis of computer information, which is translated into forces applied on the users haptic senses. One of the most interesting examples of this sort of technological solution is the Braille translator. The device receives information from the computer and then translates it in real time while the blind person reads it. The device is set up by a system of pins that simulates de haptic stimuli normally read as Braille.

Audio output devices

The usage of this sort of device is usually done in association with another output device like a computer screen. Its main goal is to function as a complement for visual information presented on the screen in a confused and over loaded way. This sort of device outputs verbal and nonverbal information. The verbal information is made up of words and phrases linked according to a linguistic code. The non-verbal information is made out of non-linguistic sounds (music, warning signal), refered in some instances as earcons [9]

I/O Device Selection

As this paper comes closer to its end, the pieces of the H-C interaction model slowly fall into place. The information gathered until this point enables us to grasp the existing I/O devices, some of their properties and how they relate to certain aspects of the users unique profile, the tasks he needs to perform and the context in which he is undertaking all these efforts. Along side the concerns taken into mind when selecting the best I/O device for the case at hand, Rahman e Sprigle [10] point out 13 principles and guidelines to be followed when designing these types of computer based assistive technologies and interfaces optimised for people with special needs.

The selection of an ideal solution can only be done after the various probable solutions have been tried and after comparing the Human-Computer relationship between them. When a choice is made, the computer based AT must be yet again tested even after the training phase of the intervention has been concluded. It's never to late to discover an error or a flaw in our selected device. If there is a slight possibility that the users needs, abilities and skills have changed, for better of for worse, a second look must be taken at the technology being used in his or her case.

Nielsen's "List of 10 Heuristics for Good Interface Design" [11] may be used as a reference point for many of the work done.

As a final reminder, the user must have time to initiate de usage of the technology in a correct manner. This includes the development of a tolerant attitude when something or other doesn't go quite according to planed. The user must be given the space to gradually auto-adapt himself or herself to this new element that has stepped into his or her life.

Closing Remarks

The closing section of this paper intends to call some attention towards some questions that may serve as food for thought.

What strategies should be followed in order to achieve optimised compatibility between all the pieces presented in fig1.1?

What sort of tests and assessment tools should be used to study computer access profiles of people with and without special needs?

And finally which will be the resulting solutions and H-C interaction scenarios derived from current technological tendencies?

The Internet and the adapting of content for this *technological platform, the transmission of* information and the mediation of computer based activities will no doubt play a important role in answering these questions. Hyprofile [12] is an example of just that. Universal Design and Universal Usability [13] are currently changing the way we create and design and not just at a technological level. Because of all this any final remarks should not be confined within these pages, but must instead lead us to thought on what sort of role should people with special needs play in the effort of understanding and improving information flow in Human-Computer interaction systems.

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