DIGITAL DISABILITY

An Examination Into The Effectiveness Of Multi-Modael Interfaces for People With Disabilities

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Abstract: The provision of assistive technologies are always deemed to be a worthwhile cause by corporate and government entities. Yet even in today's enlightened society, the provision of accessible e-commerce, e-business and e-learning is generally limited to specialists in accessibility issues. The question as to why disabilities are often considered an afterthought remains one of the most puzzling aspects of current IT policy. This examination of assistive technologies is not only designed to assess the needs of people with disabilities, but to assesses the range of multi-modal human computer interfaces and proposes combinational solutions that are designed to provide accessibility and usability with mainstream computing products and services. Through the comparison of available technology with the technological requirements of people with disabilities, this paper will demonstrate that there is still a need to focus on the issues surrounding digital disability in an increasingly dependant technological society.

Key words: Elearning, vision impaired, digital divide, assistive technology, rehabilitation engineering.

1. INTRODUCTION

In recent years there has a growing awareness in the provision of accessible technologies for people with disabilities. The introduction of Section 508 in the United States and the associated legal action due to the inaccessibility of the 2000 Sydney Olympics web site have highlighted the fact that people with disabilities are not only interested in using technologies such as the Internet but rely on the use of assistive technologies for the completion of everyday tasks.

Due to the increase in accessible resources on the Internet, it would be a common misconception to believe that all areas of government and industry are actively catering for the needs of people with disabilities. Although much progress has been made, the implementation of assistive technologies is generally left to small companies that struggle to produce such products with limited financial resources. Government policy, although constantly under review, is often challenged with the difficult task of providing an intricate legislative framework which needs to support the rapidly changing Information Technology industry and the needs of people with disabilities.

As the development of assistive technology continues to evolve, new e-learning methods are challenging existing thinking through the incorporation of large industry groups with the use of multi-modal interfaces. The ability to move away form the 'one size fits all' approach of assistive technology and embrace a range of options which has led to a successful implementation of industry-bas. ed IT certification program for people who are blind or vision impaired. Furthermore, the practical applications of multi-modal technologies can provide for the development of corporate and e- learning opportunities. The development of such programs demonstrates that lessons have been learnt from the rocky road of past assistive technology implementations.

2. DEVELOPMENT OF ASSISTIVE TECHNOLOGY AND POLICY

Historically the development of assistive technology has been a difficult road for people with disabilities. Though the 1980s, many assistive technology products and services were developed across the numerous computing platforms. This made it difficult to determine which computing system would become the dominant player and meant that business and educational institutions had to make difficult choices as to what would be the preferred computing platform for the development of assistive technology. (Gergen, 1986) Once business began to focus on the use of the Apple Macintosh and the IBM PC platforms, the development of the Graphical User Interface made it difficult for speech synthesizers to extract the textual information from the non-linear, 2-dimensional data environment. Furthermore, early speech synthesizers were unable to tell the difference between operating system information and information required by the user. (Drake, 2003)

As the GUI gained prominence through the 1990s, assistive technology became more adept in interpreting the GUI effectively. Legislation such as the Americans with Disabilities Act of 1990 (ADA) provided an initial framework in which the provision of accessibility in various industries to assist employment in the United States spilled over to Information Technology. (Mondak, 2000)

Although access to the computing technologies and the early use of the Internet improved, difficulties emerged again with the introduction of the graphical web browser into the public domain. Although this greatly increased the uptake of the Internet, people with disabilities were once again faced with accessibility issues. One study revealed that ADA provided a good overall framework for accessibility in relation to employment, it did not effectively cater for technology that was to be such a vital source of information for people with disabilities. Learning, physical and sensorary disability groups all struggled due to the inaccessibility of web pages. (Hinn, 1999)

In response to the increasing inaccessibility of the Internet, the World Wide Web Consortium (W3C) published a series of guidelines to provide web designers with the information required to make web sites compatible with existing assistive technology. (W3C, 1999) Although these guidelines have assisted the provision of accessible Internet usage, a great number of corporate online entities do not use the guidelines due to the perceived restrictive nature of visually impressive web content.

One of the more significant policies in the provision of accessible technology was the introduction of Section 508, a part of the US Rehabilitation Act of 1973 Section 508 states that all workers in the US Federal Government must have their IT needs catered for. (U.S. General Services Administration, 2003) This has certainly improved the acceptance and awareness of assistive technology, yet one of the are concerns that the legislation has no 'teeth'. To date no one has been prosecuted for section 508 non-compliance.

3. ASSISTIVE TECHNOLOGY PRODUCTS FOR PEOPLE WHO ARE BLIND OR VISION IMPAIRED

As the legislative framework and available technology improves, there has been a rapid increase in the number of assistive technology devices available. Given that approximately 1/3 of all assistive devices are discarded due to difficulties such as not achieving independence, lack of training or conflicts with environmental needs, it is clear that choosing an appropriate assistive technology device is an important decision that warrants careful consideration. (Bryant & Bryant, 2003)

When discussing the use of assistive technology in relation to the specific gathering of electronic information, we need to focus on the types of input and output available. Common input devices consist of the keyboard, touch screen, mouse, trackball, joysticks, pointing devices and voice recognition software. Output devices generally consist of screen readers, screen magnifiers and printers.

To examination the nature of choosing assistive technology, it is worthwhile focusing on one specific group. One example that provides an overview of technology are people who are blind or vision impaired. The reason for the selection of this disability group is due to the fact that people who are blind or vision impaired face both a sensorary and mobility impairment. As such, they tend to use a variety of assistive technology devices.

In the case of many disabilities, particular emphasis needs to be place on either the input or the output of information. In the case of blind or vision impaired individuals, it is necessary to focus on both. Many input devices, such a as touch screens, mouse, joysticks and other pointing devices are difficult to use due to the inability to receive accurate feedback of the required selection. As a result, most information is entered via the keyboard or voice communication.

Examples of such specialist screen magnification products include ZoomText and MAGic. Screen readers such as JAWS and Lookout are highly beneficial in conveying electronic information. (Bryant & Bryant, 2003)

Although this is beneficial in the access of generic electronic information, it provides only part of the solution that is required in an eLearning environment.

4. NON-VISUAL HUMAN INTERFACES

4.1 Methods of audio presentation

Although synthesised speech is a common form of conveying electronic information to blind and vision impaired individuals, it is not the only method of computer-generated auditory output. Numerous researchers have investigated the use of non-speech sounds to assist or replace the delivery of electronic information. This would prove advantageous in both the areas of computer output and the human interpretation of auditory data.

While synthesised speech usually takes a considerable amount of time to deliver an interface message, it is unambiguous and requires little interpreation. This is a strong argument for the inclusion of speech synthesis into an audio interface; the speech output can aid new users in their learning of an auditory environment.

Another aspect of the auditory system is that it is very sensitive to changes in status. In particular, a listener can become accustomed to a particular sound and ignore it, yet the sudden removal of such a sound could be classed as a notabl rewster, 1991). This would encourage the use of s ntinuous processes, such as a

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ned as a possible haptically enhanced method of interaction, ranging from a vibrating mouse which reflects sounds in multimedia applications to devices that attempt to represent a screen display in a tactile manner. (

Figure *1*. Logitech Wingman force feedback mouse (left) VTPlayer (right)

) Haptic mice can be divided into two categories: mice with tactile displays mounted on them, and force-feedback mice that simulate objects and textures using forces.

Figure 1. Logitech Wingman force feedback mouse (left) VTPlayer (right)

O'Modhrain and Gillespie (1995) constructed a prototype force-feedback mouse to display the user interface for people who are blind, called the Moose. GUI elements are represented using variable resistance to create

h acteristics that identify the e -drop' can be represented h ier when an item is being dragged. The mouse is perpendicularly connected by flexible spring steel to a workspace tablet. The effective workspace is 3cm square.

The VTP (2003). (

Figure *1.* Logite t) VTPlayer (right)

) has two 16-pin aille display, mounted where the ouse. These form a tactile represe cursor.

4.3 Three-di

The flexibility i devices has proven to be of int devices can present most possibi nvestigation. The Phantom (

Figure *2 The Phantom*

Figure 1) is a commonly-used devices in this category. All three-dimensional haptic devices are expensive and not currently available for mainstream use.

Figure 2 The Phantom

Figure 1: The Phantom

One particular study aimed to make mathematical graphs accessible to blind people. Fritz & Barner,1999, considered one, two and three dimensional data. A detailed description of the mathematical process required to translate an idea into a force profile, suitable for implementation on the Phantom was given.

4.4 Tablets

Tactile graphics tablets have received much attention as the most direct way to represent the information on a visual monitor. They are frequently comprised of a large rectangular set of pins which can be raised and lowered like those in a refreshable braille display. However, other approaches have used vibrating pins or plastic bumps. Shaped memory alloys have also been used in the construction of tactile graphics displays. Two major disadvantages of this approach are that the metal is activated by heat and reacts in a non-linear manner. Howe, Konatarinis & Peine (1995) created a tactile display with a pneumatic cooling system. This allowed the display to be used accurately at 6Hz; their goal (based on research on tactile perception) was 10Hz. They proposed that this could be achieved through liquid cooling and improved control models.

An important benefit of tactile tablets is that they often support multipoint interaction like that in the real world. That is, objects can be felt with all fingers of both hands, rather than with the point of one stylus or by the movement of a mouse. This allows maximum use of the restricted bandwidth available to the sense of touch.

Although this would seem to be a very promising means of tactile display, commercialisation of this type of device has been hindered due to the high cost of the displays.

4.5 Combining into a multi modal user interface (UI)

Both auditory and haptic interfaces have their strengths and shortcomings. Surprisingly, little has been done to combine the strengths of each approach most of which has been limited to providing access to graphs.

Yu & Brewster (2002) found that using multiple modalities to provide access to graphs reduced the importance of a high-quality force feedback device. They compared the Phantom and the Logitech Wingman mouse for use with a multimodal graph and found little difference in users' performance between the two devices. Using each device, audio and haptic combined feedback was easier to comprehend and produced better accuracy than haptic or audio feedback alone. Therefore, the use of multimodal presentation can enable understanding at affordable cost.

5. CISCO ACCESS FOR THE VISION IMPAIRED (CAVI)

As stated earlier, vision is the main sensory modality employed in learning. Teaching materials in the areas of information technology and computer engineering are highly visual in nature. Vision impaired students find it increasingly difficult to access and process these visio-centric learning materials and on-line delivery.

As an environment for testing suitability of multimodal user interfaces this section describes a research project undertaken by Curtin University in conjunction with Cisco Systems and the Association for the Blind WA to identify tools and techniques appropriate for vision-impaired students studying computing at tertiary level. Multimodal is particularly suitable for this course due to the content rich curriculum that encompasses many different facets of assistive technology, specifically related to environmental, computing and learning assistive technologies.

The research will focus on two main areas, firstly the physical access and delivery of materials, and secondly, alternate methods of embodying and presenting the required technical content. The first area will investigate the use of force-feedback (haptic), 3D sound, Braille and speech output as methods to overcome access problems associated with low vision. The second area will study the comprehension of visio-spatial concepts and images by blind students in order to identify not only those modes and representations difficult to comprehend, but also those easily assimilated. The materials posing cognitive assimilation difficulties can then be converted into formats more readily understood by blind students.

The researcher has been involved in the Cisco Networking Academy Program since 2001. This program is an e- learning model that delivers web-based educational content, online testing, student performance tracking, and instructor training and support in addition to hands-on labs. It is the result of an alliance between Cisco Systems, educators, governments, international organizations, leading technology companies and nonprofit organizations to prepare graduates for the demands and opportunities of the new global economy. (Cisco 2004)

The Cisco program is well accepted by industry and educators as an effective and worthwhile certification. However, the curriculum is delivered as media rich web pages. This style of delivery is unsuitable for people with vision impairment. As the curriculum is targeted at the mainstream community, one of the unfortunate aspects of the curriculum is that it relies heavily on visual keys to illustrate learning objectives.

Assistive Technology aids can be split into several different categories. They include positioning, mobility, augmentative, computer access, adaptive toys and games, adaptive environment and instructional aids. When it comes to conveying information technology in a learning environment, simply relying on the input and output requirements will not automatically provide educational equal opportunities to people with disabilities. It is important to take a multi-modal approach through the incorporation of assistive technology devices. Figure 3 illustrates some of the environmental and instructional aids used in the course. The blocks are used to explain the networking OSI model, packet headers and encapsulation. The pegboard conveys instructional information on hexidecimal, binary, decimal conversion and subnetting. The pipecleaners are used to show waveforms. By connecting a signal generator to a speaker, frequency and amplitude information may be relayed to the user in a non visual format.

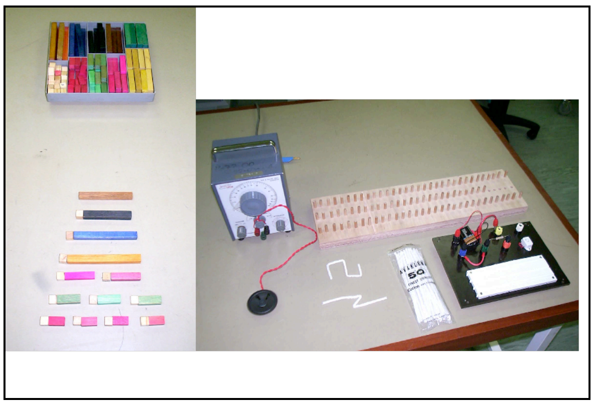

Figure 3. Low tech aids

6. CONCLUSION

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