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## Equity of Access: Adaptive Technology

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## Equity of Access: Adaptive Technology\*

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**Keywords:** ethics, disabilities, adaptive technology, adaptive tools

**ABSTRACT:** *In this age of information technology, it is morally imperative that equal access to information via computer systems be afforded to people with disabilities. This paper addresses the problems that computer technology poses for students with disabilities and discusses what is needed to ensure equity of access, particularly in a university environment.*

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### INTRODUCTION

English language dictionaries define *accessible* as easy to approach, enter, speak with, or use.<sup>1</sup> For the forty million Americans with disabilities,<sup>2</sup> and those who will develop disabilities as they age, access takes on a special meaning. It is the key to an independent and "normal" lifestyle. Since 1973, laws have been enacted in the United States to facilitate accessibility for persons with disabilities. Section 504 of the Rehabilitation Act mandated that all federally funded agencies meet certain physically accessible standards in general and that they provide "reasonable accommodation" for employees with disabilities, including work-site modification, job modification, or other action to overcome physical or other disability-related barriers in the workplace. Section 508 addresses the appropriate accommodation in terms of technology. It requires that all federally funded agencies and their contractors provide access to computers for all employees with disabilities who need it, and specifies the types of access needed.<sup>3</sup>

In 1975, the Federal Individuals with Disabilities in Education Act guaranteed children with disabilities the right to free and appropriate education in the least restrictive environment.<sup>4</sup> The Americans with Disabilities Act of 1990, which

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addressed employment, transportation, public accommodation (e.g., theaters and rest rooms), and telecommunications, removed physical barriers to accessibility.<sup>5</sup> In the United States, therefore, people with disabilities can now be hired for jobs for which they are qualified, travel by public transportation, and enter buildings to work. Because we are in the information age, however, a person's livelihood often depends on familiarity with and ability to use a computer.

Philip Brey, in his article entitled "The Politics of Computer Systems and the Ethics of Design,"<sup>6</sup> asks: "What are the new issues concerning social morality posed by Information Technology?" One of those issues is that of equal access to computing systems. Although we have lowered street curbs, put in ramps, and made public transportation accessible to people with disabilities, we have lagged behind in adaptive accommodations for computer systems. Why? I think that the swiftness of the computer revolution and the impact that it has had on society were unanticipated. Designers of computer systems were so eager to move into the mainstream, where the return on investment was obvious, that they ignored a segment of prospective users: those with disabilities. For example, at a recent Association for Computing Machinery (ACM) exhibition, only two of approximately one hundred exhibits presented devices for persons with disabilities. When questioned about the lack of adaptive interfaces for certain software products, the vendors usually replied that no one had even considered this group of users. Ellen Barton, in her article "Interpreting the Discourse of Technology," affirms that "integration of technology most often functions to maintain existing levels of power and authority."<sup>7</sup> It is a serious moral problem when computer technology developers ignore the very group who can be empowered most by such technology.

According to the theory of justice of John Rawls, the notion of justice is usually understood as implying that individuals should not be advantaged or disadvantaged unfairly or undeservedly. This implies, among other things, that society should not promote the unfair distribution of "primary goods," that is, those that are prerequisite to carrying out life's plan.<sup>6</sup> I agree with Brey's assessment that, in this age of information technology, access to information via computer systems is quickly achieving the status of a primary good. Brey argues, therefore, that it is morally imperative that both computer systems and their surrounding social structures should be arranged to facilitate equal access.<sup>6</sup>

Because universities in the United States receive federal funding, they are obligated by law not to discriminate against people with disabilities. "Reasonable accommodation" in computer training that occurs at the university, unfortunately, often is interpreted to mean assisted learning, not adaptive technology. I would argue that, at present, students who are physically challenged and those with learning disabilities are not being afforded an equal education if they are not given access to computers which meet their needs, namely, those that use the latest adaptive technology. Such technology, which permits equity of access, has helped to reassure people with disabilities that they can attempt a university education with minimal accommodation

in most major courses of image and quality of life age of information technology," asserts: "empowerment so they can rest of society on a more of access to computer extension a university, to have such access.<sup>6</sup> This for students with disabilities particularly in a university

## THE PROBLEMS

Many parents of children with disabilities across the United States are concerned about their children. The problem is not only in special schools or are in mainstream schools. Tamar Lewin indicates "Classes":

Many educators and parents are concerned, both educationally and financially, about the development of both children and communities.<sup>9</sup>

Although education is not new, it is becoming more and more so. We tend to grow into more and more of a still debated by special families who had to move in order to find a school classroom.<sup>9</sup> Whether it is access to computer technology

By the time a student enters university, there is a challenge and normal college experience. Colleges have handicapped accommodations for students with disabilities. For example, students who have motor impairments

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(e.g., theaters and restaurants) accessibility.<sup>5</sup> In the United States, people are hired for jobs for which they are not qualified. Because access to technology often depends on

computer systems and the digital divide, the social morality posed by unequal access to computing resources, and made public policy issues. Locked behind in adaptive technology, the swiftness of the changes were unanticipated. In the mainstream, where the needs of prospective users: for Computing Machinery, the habits presented devices of adaptive interfaces for which one had even considered limiting the Discourse of functions to maintain the problem when computer technology is empowered most by such

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lateral funding, they are disabilities. "Reasonable accommodations," unfortunately, often fail. I would argue that, at the time learning disabilities are access to computers which adaptive technology. Such technology can reassure people with minimal accommodation

in most major courses of study. It can empower such students and improve their self-image and quality of life by preparing them to take their place in the work force in the age of information technology. As Norman Coombs, in his article "Liberation Technology," asserts: "Today more and more of the disadvantaged are asking for empowerment so they can help themselves. They want freedom to compete with the rest of society on a more nearly even playing field."<sup>8</sup> Given the growing importance of access to computer systems, there is a moral imperative for a society, and by extension a university, to ensure that all of its citizens are given the opportunity to have such access.<sup>6</sup> This paper addresses the problems that computer technology poses for students with disabilities and discusses what is needed to ensure equity of access, particularly in a university environment.

### THE PROBLEMS

Many parents of children with disabilities have been struggling with educational systems across the United States to obtain equitable educational services for their children. The problem is that in many states, children with disabilities either go to special schools or are segregated into "special education" classrooms. However, as Tamar Lewin indicates in her article "Disabled Students Gain Access to Regular Classes":

Many educators and parents believe that segregating children with disabilities is bad, both educationally and morally. They say that such a policy undermines the development of both disabled children, by failing to give them a choice to develop the skills and relationships that they will need as adults, and other children, by preventing beneficial contact with the full range of people in their communities.<sup>9</sup>

Although education is academic, it is also social. Students without disabilities who are accustomed to the full inclusion of students with special needs in their classrooms tend to grow into more accepting adults. Yet full inclusion is far from the norm and is still debated by special education experts and parents. Lewin cites the case of one family who had to move the disabled child 230 miles from home, dividing the family, in order to find a school system that would not segregate the child into a separate classroom.<sup>9</sup> Whether included or segregated, disabled students are not guaranteed access to computer technology.

By the time a student has reached the end of high school and is looking for a university, there is a choice as to where to apply. Parents want the most independent and normal college experience possible for their children with disabilities. While most colleges have handicapped access to buildings and dormitories, there are few accommodations for students with disabilities that encourage an independent learning experience. For example, even when note-takers and readers are provided for those who have motor impairment, and students with learning disabilities have tutors who

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balanced against increased revenue from tuition, the cost of software and hardware to make computers useful to students with disabilities is minimal. And the number of students with disabilities who are studying or want to study at universities is increasing. At Sacred Heart, for example, with a population of approximately 1,800 full-time undergraduates, in two years the number of documented students with disabilities who need adaptive technology services more than doubled from 45 to 105; and many more students began to use the university learning center (ULC) on a regular basis. It is difficult to gather precise statistics on the number of students with disabilities, because it is against the law to seek out such students for identification purposes. They must identify themselves to university officials.

### ONE SOLUTION: AN ADAPTIVE TECHNOLOGY LABORATORY

At Sacred Heart University, the solution to the problem of how to fully include people with disabilities in all aspects of campus life, including computer use, was to create an adaptive technology laboratory (ATL) equipped with specialized hardware and software tools to advance the computing skills of students with disabilities. The laboratory was networked with the campus-wide computing system, affording student access to all software used on campus. The software interfaced with the adaptive tools providing accessibility. The ATL was particularly important to students with disabilities who wanted to study computer science. It afforded them full access to computing resources. The lab was physically located within the ULC, where tutors could evaluate the needs of students and guide them toward the most appropriate adaptive tools.

Funding the adaptive technology laboratory was a challenge. For three years, I wrote to foundations, state granting agencies, and national education granting agencies. Most of these potential sources stated that it was the responsibility of the university, according to law, to accommodate its students with disabilities. Unfortunately, such accommodations normally did not extend to computer technology. Finally, the possibility of creating an adaptive technology laboratory materialized when the university agreed to match a grant that I wanted to submit to the National Science Foundation for instructional laboratory improvement. The grant proposal argued that computer technology is necessary for university students if they are to complete their major courses of study, because more and more of the courses are dependent upon computing tools. It reasoned that providing adaptive tools to students with disabilities would empower and prepare them to work with the latest technology when they graduated.

Although the grant application was successful, it provided only for equipment. There was no provision for training staff or students to use the adaptive tools once they were installed on the computers. With the support of an associate vice-president of academic affairs, several ULC staff members, tutors, and faculty members were able to attend a four-hour workshop to learn what adaptive technology can do for students

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with disabilities. This core group then offered workshops to other faculty and staff at the university, both to demonstrate the tools and to train faculty to identify students and refer them to the ATL. In addition, a computer science senior, who was severely dyslexic, became very interested in adaptive tools and so became the technical support person in the laboratory. Finally, the university recognized the need to help the growing number of students with disabilities and created the position of director of students with special needs. Once the adaptive technology laboratory was created, a benefactor, impressed with the university's commitment to its students with disabilities, provided substantial monetary support for the laboratory.

### NEW CONCERNS

During the first two years of the ATL, several new concerns arose. Although an adaptive technology laboratory may be a partial solution to the question of how to effectively serve students with disabilities, more and more universities are demanding laptop computers for all incoming freshmen, and so the issue arises of adaptive technology for the laptops for incoming students with disabilities. Will the university buy site licenses to allow adaptive software to be loaded onto such machines? How will the problem of alternative input devices be resolved when laptop computers, configured and supported by the university, are mandated for all first-year students? Providing a laptop without adaptive software for students with learning disabilities, or without alternative input devices for students who are physically challenged, would be useless.

For example, a first-year student at Sacred Heart University who had significant learning disabilities rarely used his computer. He had a very difficult time with the keyboard and was distracted by the scrolling screen. Consequently, his papers were poorly written. He failed three of the five courses that required papers during his first semester. When he was evaluated in the ATL, it was observed that because of his lack of keyboard fluency, he used very small words and simple sentences, and he could not cut and paste easily. After experimenting with several software applications, he learned to use an abbreviation-expansion program that allowed him to retrieve words by typing in abbreviations. He was also introduced to word-prediction programs that allowed him to choose words by typing in a letter or a number. He spent many hours learning how these tools worked and how they could interface with his word processor. By the second semester, there were no longer technological barriers to writing papers, and he passed all of his courses.<sup>10</sup>

While this student could successfully complete his work at the ATL, he was still unable to use his laptop. He needed to have the appropriate adaptive software installed on his laptop for it to be useful to him. Barton states that

scholarship provides evidence in support of the leading ideas of the dominant discourse—namely, that the use of technology can expand pedagogy and expand literacy; it also buttresses the major ideas of the antidominant

discourse—namely, that of unequal relations (

We are currently working on these issues.

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The first-year writing illustration of the result program developed at classroom discussions, laboratory, and students other's work. Although technological challenge with cerebral palsy, for because his restricted his words in real time. And the screen and was the students paid for the cost the work! Networks, with equality, were useless in their access.

Ellen Barton affirms unquestioned assumptions the very people it strikes classroom often follow: is subject to the existing incoming students with relevant laboratories can thereby saving the state technology that was, if University who have used as their right to equal university in other com

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discourse—namely, that the use of technology can contribute to the maintenance of unequal relations of power and authority.<sup>7</sup>

We are currently working with the computer center staff to sensitize them to these issues.

Although the adaptive technology laboratory has been a tremendous resource for individual out-of-class assignments, it did not address the problem of in-class computing. Several of our classes, from English to computer science, are taught in a laboratory setting. Our university has six computer laboratories and several networked classrooms for general university use. Unfortunately, the present platforms are not equipped with adaptive devices, even though these labs have handicapped access. It is ironic that handicapped access means one can get a wheelchair through the door, but it does not mean that one can fit it underneath the worktable! In addition, students who are visually impaired cannot read the screens for in-class work. There are no screen enlargers, nor is there voice output.

The first-year writing program at Sacred Heart University offers an instructive illustration of the resulting problems. Electron Networks for Interaction (ENFI) is a program developed at Gallaudet University to enable deaf students to interact in classroom discussions. Using ENFI, English composition is taught in a closed laboratory, and students use the computer to collaborate, brainstorm, and critique each other's work. Although this works very well for our able-bodied students, it creates a technological challenge and frustration for those with certain impairments. One student with cerebral palsy, for example, could not easily respond to his classmates' queries because his restricted hand movements made it impossible to type anything but short words in real time. Another student, with a severe visual impairment, could not read the screen and was therefore eliminated from any in-class exchanges. Both of these students paid for the course, were allowed to register for it, and were expected to do the work! Networks, which *in theory* democratize participation by creating a level of equality, were useless because the students in question had physical impediments to their access.

Ellen Barton affirms that the dominant discourse in technology—based upon an unquestioned assumption that technology benefits society—sometimes marginalizes the very people it strives to empower. The way technology is integrated into the classroom often follows "an institutional imperative, in which the making of meaning is subject to the existing lines of authority in a particular context."<sup>7</sup> Had the needs of incoming students with disabilities been assessed before the semester began, the relevant laboratories could have been equipped with appropriate adaptive devices, thereby saving the students embarrassment and frustration from working with technology that was, for them, inappropriate.<sup>10</sup> Recently, students at Sacred Heart University who have used adaptive devices in the laboratory have begun to advocate, as their right to equal access in the classroom, that such tools be provided by the university in other computer settings.

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## EXAMPLES OF ADAPTIVE TECHNOLOGY

A variety of hardware and software tools can provide access to information technology for persons with disabilities. To date, these have generally been designed by vendors who specialize in adaptive devices. Currently, however, we are seeing some movement by large computer companies toward creating products with accessibility for the disabled. Billie J. Wahlstrom, in her article "Communication and Technology: Defining a Feminist Presence in Research and Practice," poses an interesting question:

Despite the success of such programs (adaptive technologies), we should ask why adaptive software that allows for a variety of learning styles and disabilities has to be added to our systems. Why is it not simply developed from the start?<sup>11</sup>

We are beginning to see some movement in that direction.

### Adaptive Software

It is encouraging that many of the large computer manufacturers have recognized the need to address the issue of accessibility. Several have combined their efforts with manufacturers of adaptive devices to provide compatible interfaces. Microsoft, Apple, IBM, and Sun all have web sites, which offer resources for accessibility (see Resources). The World Wide Web Consortium, an organization that sets technical standards for the World Wide Web, has just released preliminary guidelines designed to help keep people with disabilities from being shut out of cyberspace.<sup>12</sup>

Sun's web page on technology and research contains an article by Bergman and Johnson titled "Designing for Accessibility."<sup>2</sup> In this article the authors state:

not only is providing access the right thing to do, but it is also a requirement in all current federal contracts as required by section 508 of the Federal Rehabilitation Act. In the commercial sector, The Americans with Disabilities Act calls for similar considerations when reasonably accommodating current and prospective employees.

Information technology companies who want federal contracts need to have adaptive interfaces for their disabled employees. Therefore, it is beneficial for software developers to provide interfaces to adaptive devices so that companies who are awarded federal contracts will use their software.

Sun recognizes that disabilities cross all sectors of the population and that the computer is a great equalizer. Bergman and Johnson write: "Like all computer users, users with disabilities vary in age, computer experience, interests and education. When barriers are removed, the computer gives them a tool to compete with all other users on an equal basis."<sup>2</sup> Professor Norman Coombs's personal experience confirms that assertion. Coombs states:

When I began utilizing the computer to communicate with my students, I had no idea of its potential to change my life and my teaching. First, it began by

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liberating me, a blind teacher, from my dependence on other people . . . [and] . . . only when a deaf student joined the class did I come to realize its potential. This young deaf woman said that this was the first time in her life that she had conversed with one of her teachers without using an interpreter intermediary.<sup>8</sup>

Sun is building disability access into the Java platform. Support is forthcoming in four areas: Java accessibility API, Java accessibility utility classes, Java accessibility bridge to native code, and the pluggable look and feel of the Java foundation classes.<sup>13</sup> An exciting aspect of Sun's effort is that

on a component-by-component basis, the presentation is programmatically determined, and can be chosen by the user. Instead of a visual presentation, a user could instead choose an audio presentation, or a tactile (e.g. Braille) presentation, or a combination of the two. This is one step toward equal accessibility for the blind, for example, who still have major problems because graphical user interfaces are not translated well by screen readers. With this support, a user wouldn't need a separate Assistive Technology product interpreting the visual presentation of the program on the screen, but would instead have direct access to that program because it would interact with the user in his/her desired modality.<sup>13</sup>

**Ergonomics**

Ergonomics concerns the relationship of person to machine. The prevalence of computing in the work environment has put anyone who uses a computer for more than two to four hours a day at risk for repetitive strain injury (RSI).<sup>14</sup> RSI is an umbrella term for cumulative trauma disorders produced by prolonged, repetitive, forceful, or awkward movements, particularly of the arm and hand.<sup>14</sup> Carpal tunnel syndrome, tendonitis, and other ailments of the fingers, arms, shoulders, and back are examples of RSI, and they can severely limit computer access. RSI is easy to prevent if people are educated about the correct use and positioning of keyboard and mouse. Yet cases of RSI are increasing and it is estimated that disabilities caused by it will limit computer access for many people.

To accommodate those with carpal tunnel syndrome or various arthritic conditions, there are several adjustable keyboards, including the *Lexmark Select-ease Keyboard*, which splits in the middle and can be angled into various positions. In addition, there are adjustable-height worktables that can accommodate wheelchairs, and there are a variety of chairs that have adjustable arms and backs for users who need extra support or have back problems.

**Alternative Input Features and Devices**

Physical disabilities can severely restrict the use of a mouse and limit keyboard access. As a result, many manufacturers have begun to build alternative input features into their products. For example, Sun Microsystems has built access features into the X

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Windows server. Server features, known as AccessX, provide basic workstation accessibility, and they are typically used by people with mobility impairments. These features include "sticky keys", which allow single-finger operation; "repeat keys", which delay the onset of repeating characters for users with poor coordination; "slow keys", which require that a key be held down for a given period of time before it is accepted to prevent accidental key-press events; "mouse keys", which provide keyboard control of all mouse events; "toggle keys", which indicate the state of a locking key with a tone; and "bounce keys", which require a delay between keystrokes before accepting the next key press to prevent accidental key presses by persons with tremors.

The *Advanced Magic Wand Keyboard* for PC computers is a miniature electronic keyboard for people with a limited range of motion. Users hold a stylus and point at letters on this special keyboard. *Stingray* is a small track ball with programmable acceleration, click-lock ability, and two large buttons. It works on a Mac. *My-T-Mouse* is a mouse-controlled on-screen keyboard for the PC. There are both Windows and DOS versions. *Head Mouse and Tracker* are head-pointing devices for alternative input. They allow the users to manipulate the keyboard with slight head movements. These work in conjunction with *Magic Cursor*, *On-Screen Keyboard*, and *Telepathy* (word-prediction software), which together are known as *Doors2*. Programs that use eye movements to move the mouse are currently being developed. *WiVik Onscreen Keyboard* is a movable on-screen keyboard for the PC which enables the user to enter text into Windows applications using any pointing devices, including mice, track balls, joysticks, touch screens, pens, and head-pointing devices. *WREP* provides word-prediction and abbreviation-expansion powers.

For persons with disabilities who require voice input, *Power Secretary* provides speech input to the Mac. Recently, two new products have appeared on the market: *Via Voice*, which provides voice input and voice output, and *Naturally Speaking*, which replaced *Dragon Dictate* for voice input. In both, the user can speak naturally rather than in discrete sounds.

*Click It* on the Mac provides easy access to menus, dialogue boxes, windows, and scroll bars without using a mouse. It also provides speech output of text and menus. *Intellikeys* is an input device and membrane keyboard that works on both the PC and the Mac (different cables). It includes six overlays which enable the keyboard to be set up in different ways that accommodate the specific disability of the student—for example, keys arrayed in alphabetical order. This is especially good for students with physical dysfunctions. In addition, computer conferencing can be used for students whose physical mobility is limited and for the hearing impaired.

### Adaptations for the Visually Impaired

In order to read full text, users with visual disabilities should have a 17-to-21-inch monitor. In addition, adaptive devices are able to adjust font, size, and color, which

otherwise can be barriers. *Zoom* is a screen enlarger program that will enlarge text twelve times and is adjustable for voice input devices (see *Zoom*). *Video Magnifier* that allows users to view graphics that he or she is viewing. *Bookwise Scanner* by *Bookwise* computer with voice output to the user. *ZoomCaps Key* is a white on black and black on white keyboard.

### Devices for Students with Disabilities

Students with cognitive disabilities served by computer software. Students are also greatly helped by prediction software, which tries to identify the word being typed. It offers word suggestions. This is particularly helpful for students who have had injuries, as well as those who are blind. *Word* for students who have had injuries that creates a split screen. *Word* from Northern Ireland and *Word* as homophones. For example, *Word* exciting dimension of text into voice.

LD students often find it difficult for the Mac and PC is difficult to diagram, and write. Students can switch easily between graphical charts and notes. Visual diagramming helps with diagrams, concept mapping, and diagramming into an outline. *Day to Day* software, such as the *Bookshelf*, can facilitate seven resources on one screen. *Book of Quotations, Co.*

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otherwise can be barriers for users with visual impairments. *Magic Deluxe* is a screen enlarger program that works on the PC. It can magnify text two, four, six, eight, and twelve times and is adjustable. Students with visual disabilities can also be served by voice input devices (see previous section). In addition, the *Spectrum Jr.* is a full-color video magnifier that allows the user to adjust the magnification and color of text or graphics that he or she is reading. It is a free-standing scanner. *Reading Edge* and the *Bookwise Scanner* by Xerox allow books to be scanned onto tape and into the computer with voice output. Several voices and speeds can be chosen to accommodate the user. *ZoomCaps Key Labels* are enlarged keyboard character labels that come in white on black and black on white. They help with the visibility of characters on the keyboard.

### Devices for Students with Learning Disabilities

Students with cognitive processing difficulties or learning disabilities (LD) can be served by computer software that generates vocabulary and creates outlines. Such students are also greatly aided by online dictionary and reference software. Word-prediction software, which includes *HandiWord for Windows*, *Doors2*, and *Co-Writer*, tries to identify the word that a student is searching for based on the student's own past usage. It offers word suggestions that the student can access by number, thus limiting typing. This is particularly helpful for students with aphasia and traumatic brain injuries, as well as those with coordination problems. *Co-Writer* also has voice output for students who have trouble reading the screen. It incorporates a keyboard emulator that creates a split screen: one half is the keyboard, which is accessed through a track ball, and the other half is the area for the student's writing. There is a new product from Northern Ireland called *Text Help*, which does powerful word prediction as well as homophones. For example, it will say "they're" and then clarify it as "they are". An exciting dimension of this product is that it can grab text off the Internet and translate it into voice.

LD students often have a lot of trouble with the organization of ideas. *Inspiration* for the Mac and PC is a graphical outlining tool that enables students to brainstorm, diagram, and write. Students can create diagrams, flow charts, and outlines and can switch easily between graphical and text formats. It allows them to add to their graphical charts note reminders which can be used later when writing their papers. Visual diagramming helps students clarify ideas by creating idea maps, cluster diagrams, concept maps, and mind maps. One keystroke then transforms this diagramming into an outline. This tool interfaces nicely with word processor programs. *Day to Day Notepad* on the Mac also is an outlining tool. Reference software, such as the *American Heritage Dictionary*, third edition, and *Microsoft Bookshelf*, can facilitate online reference for the user. *Microsoft Bookshelf* contains seven resources on one CD: *Dictionary*, *Roger's Thesaurus*, *World Almanac*, *Atlas*, *Book of Quotations*, *Columbia Encyclopedia*, and *People's Chronology*.

F. S. Grodzinsky

## IMPACT ON STUDENTS

One of the most frustrating aspects of teaching disabled students is the difficulty of convincing them that adaptive technology is a key to an independent educational experience. Students who have become dependent upon human support services often find independence frightening.<sup>8</sup> For example, a wheelchair-bound student who had cerebral palsy relied upon his mother to type his papers for him. One semester, the faculty was considerate enough to give him examinations with yes/no questions that he could answer with a nod. When he was referred to the adaptive technology laboratory at his school, he did not want to go and had to be forced to go by his mother. The director set him up with an *Intellikeys* keyboard with sensitivity adjustment and large letters and coupled it with *Co-Writer* for word prediction and word processing. He then became so enthusiastic that he went to the ATL regularly of his own accord because he realized that he could function independently in his schoolwork.<sup>15</sup>

Another student with cerebral palsy had to be convinced by his professor that in his computer class, which was 50 percent hands-on, the student should perform the computer work by himself, using the available adaptive devices. The student thought that it would be just as meaningful for him to tell someone which key to push on the keyboard. He never believed that anyone would be interested in fostering his independent learning skills.

In another case, a female student with cerebral palsy had no ability to speak. She had a computer on her wheelchair, but could only be a passive student in class. She had no desire to use a voice synthesizer because the voices were all robotic or male. It was only when female voices were developed that she agreed to use voice output. This enabled her to actively participate in classroom discussions and created an interesting social dynamic for the rest of the class who waited while she typed in her thoughts, which were then translated by her computer as voice. She could also talk to her friends on the telephone, something most people take for granted.<sup>15</sup>

Another case involved a low-vision student who was delighted that suddenly she could read all of her texts using *Spectrum Jr.* and that she could use screen enlargers to interface with her word processing programs. She became totally independent in schoolwork and could do unassisted research.

Two computer science majors with severe learning disabilities used adaptive software to function independently with reading and writing assignments. They felt better about themselves and their ability to compete in the job market. One was employed to maintain the computer system in a prestigious establishment. The other began to teach courses at Sacred Heart University, continuing to use adaptive tools to organize her lectures and structure her courses.

Because adaptive technology is a relatively new field of research and development, the adaptive technology laboratory at Sacred Heart University affords computer science majors an opportunity to develop some research projects. In addition, the impact of the ATL has extended to other programs in the university. For

example, it is used by the teachers in the use of adaptive technology provides opportunities for the adaptive technology laboratory for internship

## CONCLUSION

Accessibility is the key moral responsibility at people with disabilities classroom resonates in the described above support that 19 percent of the adaptive technology, raising people, allowing many significant improvements in the community. From a perspective restores to persons with disabilities. From a *virtue-ethics* perspective reach their full potential argument in favor of Through disease, accident serious disability. Our provide adaptive technology

In the age of information can be the equalizer that compete for jobs. However Norman Coombs warn society, it could benefit the contrary, computer behind.<sup>8</sup> One long-term and empowerment for individuals who will computer hardware and disabilities actively embrace the advent of computing

**Acknowledgment:** The author number 955086, which I thank Sacred Heart University Barbara Heinisch, director University, for her help.

*Science and Engineering Ethics*

*Equity of Access: Adaptive Technology*

example, it is used by the education department to train primary and secondary school teachers in the use of adaptive technology for their students with special needs, and it provides opportunities to graduates for in-service-related careers and an on-site laboratory for internships.

**CONCLUSION**

Accessibility is the key to equity, both at the university and in the workplace. It is our moral responsibility at the university to provide access to computer technology for people with disabilities. As Wahlstrom notes, "what we do with technology in our classroom resonates in the larger context."<sup>11</sup> From an ethical point of view, the cases described above support the following arguments. For *utilitarian* ethics, given the fact that 19 percent of the population have significant disabilities,<sup>16</sup> providing them with adaptive technology, rather than denying it, would bring about more benefit for more people, allowing many more to be creative members of society. There would be a significant improvement in the productivity of the work force and the happiness of the community. From a *deontological* perspective, adaptive technology provides or restores to persons with disabilities their autonomy, their dignity, their self-respect. From a *virtue-ethics* perspective, adaptive technology enables people to flourish and reach their full potential as rational, responsible individuals. There is even an *egoistic* argument in favor of providing adaptive technology to persons with disabilities. Through disease, accident, or old age, every person is potentially someone with a serious disability. Out of self-interest, the egoist would therefore want society to provide adaptive technology to persons with disabilities.

In the age of information technology, a computer equipped with adaptive devices can be the equalizer that allows people with disabilities to participate in society and compete for jobs. However, such technology requires funding and policy changes. Norman Coombs warns that while the computer is seen as a democratizing force in society, it could benefit mainly the middle class. Unless there is a deliberate policy to the contrary, computing technology could leave the economic underclass further behind.<sup>8</sup> One long-term benefit that we can hope to realize from autonomous learning and empowerment for persons with disabilities is the creation of an assertive group of individuals who will lobby for more built-in adaptations in the development of computer hardware and software. It is a benefit to society to have people with disabilities actively employed and enjoying a quality of life heretofore unknown before the advent of computing.

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F. S. Grodzinsky

## RESOURCES

### Project EASI

listserv: easi@educ.com  
 website: <http://www.rit.edu/~easi>  
<http://www.apple.com/disability>  
<http://www.austin.ibm.com/sns/index.html>  
<http://www.microsoft.com/enable>  
<http://pursuit.rehab.uiuc.edu/pursuit/homepage.html>  
<http://www.scsu.ctstateu.edu/scsu/atl/index.html>  
<http://www.sun.com/access>  
<http://java.sun.com/products/java-media/speech/index.html>  
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## Email, Voice What Policy

Marsha Woodbury,

Keywords: privacy, email

**ABSTRACT:** *Business Responsibility (CPSR) is many such requests to could endorse. This pa reaction to them. The p and the means of identif*

## INTRODUCTION

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\* A version of this paper  
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 International University (ifu)  
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