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Assistive Technology: Fixing Humans

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ASSISTIVE TECHNOLOGY: fixing humans

BY PETROS J. KATSIOLOUDIS AND MILLIE JONES

"Mobility-assistive technology can significantly increase the quality of life for those who suffer from limb loss.

As of June 2008, more than 4,600 U.S. service members have died as a result of the U.S. engagements in Afghanistan and Iraq. More than 32,000 troops have been wounded, many sustaining multisystem polytrauma and other types of disabilities (U.S. Department of Defense, 2008). Disability is a public problem (Gusfield, 1981) as well as a deeply personal one; functional loss necessitates the construction of artificial prosthetic devices and related research. According to the National Institute on Disability and Rehabilitation Research, an estimated 8.5 million children 21 years old and younger have a disability (Jans & Stoddard, 1999). The need for assistive technology—technology that assists persons with disabilities—is great. At no time has there been a greater need to provide assistive technologies than to assist the thousands of our military veterans returning home from the Middle East with a range of physical and mental disabilities. Mobility impairment is a significant concern for many returning veterans. Assistive technologies are playing a major role in assisting our war veterans returning with physical limitations through the loss of a limb or, in many cases, several limbs.

HISTORY AND BACKGROUND

The term assistive technology was first recognized and published in 1988 in the Technology-Related Assistance for Individuals with Disabilities Act (i.e., the Tech Act). Amended in 1994, it was repealed and ultimately replaced in 1998 with the Assistive Technology Act of 1998 (AT Act) (University of Washington, 2013). The AT Act of 1998 describes assistive technology as "technology designed to be utilized in an assistive technology device or assistive technology service" (Assistive Technology Act, 1998). Furthermore, an AT device is any "item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Assistive Technology Act, 1998). A technology service is defined through the AT Act as "any service that directly assists an individual with a disability in the selection, acquisition, or use of an assistive technology device (1998).

Addressing these disabilities presents challenges and opportunities to develop new technologies to help those affected readjust to a life of normalcy. A March 2009 report showed that 39,749 troops had been wounded in the Middle East, with 27% having brain injuries and 33% suffering serious mental health problems (Muncert, Bickford, Guzic, Demuth, Bapat & Roberts, 2011). Walter Reed Army Medical Center is 1 of 36 Warrior Transition Units in the United States, treating over 2,000 patients per month, with some rehabilitations lasting up to one year. Most of the injuries consist of post-

traumatic stress disorder (PTSD) as well as amputation and brain injury. (Muncert, et al, 2011).

In 1990, the United States federal government established a program that funds statewide grant programs committed to increasing the awareness and availability of assistive technology. Each of our 50 states has at least two programs committed to this initiative. The program offers information and referrals based on need to anyone with disabilities or special needs. Old Dominion University in Norfolk, VA serves as the Southeast Virginia Region Site (Virginia Assistive Technology System–VATS), offering information, assistance, demonstrations, and training for devices as well as services (www.lions.odu.edu/org/vats/). Some of the technology available includes hardware, software, and peripherals. These devices can aid those with disabilities in accessing computers and other information technology. Special keyboards or a special mouse can be used by someone with limited hand function. For those with sight disabilities, software has been developed that reads text on a computer screen or enlarges the text for easier viewing. Those with speech limitations can use software programs on an iPad that speak out loud as they enter the text.

Photo 1. While assistive technologies may vary significantly in complexity, there are many times when simple technologies can readily solve a disability problem. Shown here is a student with a stylus to press keys on a computer keyboard.

MOBILITY

Mobility assistive technology can mean any device from a prosthesis to transplants. In the past, severity of wounds in war would have meant death; however, today the advancement in technology and science allows for survival rates to be much higher. Many service members are returning with major limb amputations. Mobility assistive technology can significantly increase the quality of life for many who suffer from limb loss (Sprunger, Laferrier, Collins, & Cooper, 2012). A recent Iraqi war veteran lost all four limbs when the vehicle he was riding in hit a roadside bomb. Brendan Marrocco was not expected to live. However, following prosthesis fittings for his legs, things began to look up. In December, 2012 Marrocco received Johns Hopkins Hospital's first successful bilateral arm transplant. The 13-hour surgery was carried out by a team of 16 surgeons who attached the arm transplants and bone marrow transplant from a deceased donor. Requiring the connection of bone, blood vessels, muscles, tendons, nerves, and skin, it is known as "the most extensive and complicated limb transplant procedure to be performed in the U.S." (Lopez & Larotonda, 2013). Mobility does not mean just the loss of a limb; it may also mean special keyboards and a specialized mouse such as shown in Photo 1 for those with hand or wrist disabilities.

COGNITIVE

Cognitive disabilities fall into several categories, including traumatic brain injury, cerebrovascular accident, learning disabilities, multiple sclerosis, intellectual and multiple disability, autism, and some dementia (Sestic, Dobrota, Radovanovic, & Karic, 2012). According to Sestic, et al (2012), problems addressed in cognitive disabilities include limitations in learning, information processing, knowledge retention (memory problems), learning skills, decision making, communication, and behavioral issues as a result of an inability in emotional functioning. People with cognitive disorders have physical and sensory limitations and often have difficulty performing routine daily activities such as dressing, mobility, personal hygiene, preparing food, medical needs such as taking medications routinely, and adapting to routines for functioning at work, school, or the community (Sestic, et al, 2012).

Physical and sensory abilities include:

- Vision
- Hearing
- Tactile sense (i.e., ability to feel and touch buttons)
- Fine motor control and manupulative (i.e., ability to operate small controls, ability to write)
- Ability to speak
- Coordination (i.e., ability to accurately select small buttons).

(LoPresti, Mihailidis & Kirsh, 2004)

One of the most important factors when considering assistive technologies for cognitive limitations is ensuring a user-environment match that is appropriate for the individual (Scherer et al, 2007). “A person’s initial reactions, including perceptions of the device in terms of usability and effect on quality of life, predict the successful adoption of the ATC and determine [success of] long-term use” (Sohlberg, 2011).

Cognitive prosthetics characteristics include:

- Uses computer technology
- Designed specifically for rehabilitation purposes
- Directly assists the individual in performing some of their everyday activities
- Is highly customizable to the needs of the individual

(Cole, 1999)

Table 1.
Sample aids categorized by level of technology and function.

Low-Tech/ Specific Task	Calculator Pill box reminder Phone dialer Alarm clock Oven timer Labeler
Mid-Tech/ Specific Task	Camera
High Tech/ Specific Task	Global positioning system
Low Tech/ Multifunction	Sticky notes Voice mail Watch beeps Checklists Answering machine Appointment calendar
Mid Tech/ Multifunction	Voice recorder Mobile phone Pager Data watches Wrist palm
High Tech/ Multifunction	Smartphone Personal digital assistants

Adopted from Sohlberg, p. 15.

Assistive technologies for cognitive disabilities can be adapted to the individual based on needs; for example, a telephone with speed dialing reduces the need for the memorization of numbers. There are various software applications available that can be customized to fit the needs of the user. Whether for practice activities (color, words, repetition of ideas, etc…) or communication activities, assistive technologies can play an important rehabilitative role for those with brain injuries so they may readjust to a life of normalcy.

COMPUTER-ASSISTIVE TECHNOLOGY

The use of computer-assistive technology can help individuals with different levels of disability, severe or minor. Even persons with severe disabilities can now use computers equipped to follow and interpret commands based on eye movement or breath. Modern “Screen Readers can scan what’s on the computer monitor and convert it to speech or even Braille” (Assisted Disability, 2012, p. 2). Several large corporations like Apple and Microsoft are now creating products that can assist individuals at no extra cost since existing features such as voice-over are now a part of the standard versions. Every Macintosh computer, for example, includes an alternative, simplified user interface. For those who find it difficult to use a mouse, all Macintosh computers include Mouse Keys, Slow Keys, and Sticky Keys, which adapt the computer to the user’s needs and capabilities (Williams, 2012). The Microsoft Windows environment also includes special features such as a screen magnifier, onscreen keyboard, and narration and high-contrast screen settings. It is these kinds of enabling and assistive features and technologies that can have a large impact on how people interact with their environment.

Computers can play a much larger role in assisting people with disabilities or war-related injuries. For example the da Vinci high-resolution desktop video magnifier (Photo 2) uses a closed-circuit television system (CCTV) to magnify printed or other materials and objects for enhanced vision capabilities. The system uses a Sony® HD camera that has the capability to “see far and near” with a high degree of magnification. A wide range of contrast settings are available to match the visual needs of the individual. Additionally, the system has the capability for optical character recognition (OCR) and text-to-speech conversion, thus making it a very versatile assistive technology.

AUGMENTATIVE AND ALTERNATIVE COMMUNICATION DEVICES

Augmentative and alternative communication (AAC) refers to assistive technology for communication problems. Using both technology and strategic approaches, AAC often focuses on the restoration of cognitive-communication and/or physical speech impediments (Wallace & Bradshaw, 2011). One program example demonstrated at the center in Virginia (VATS) shows an iPad with an application that can translate typed words into voice for those with difficulty communicating orally. In addition, software can be adapted for those with communication or mobility problems, where a computer program can not only translate text to voice but voice to text as well using the iPad app mentioned above. These types of AAC are often known as speech-generating devices (SGD). Many everyday devices can be considered SGDs, which can be adapted for addressing needs of those with communication problems including mobile phones, tablets, and other portable communication devices equipped with wireless and Bluetooth capabilities that are easily adaptable to the needs of those with limitations. Audio books are another type of assistive technology as well—all of these proving that assistive technologies are part of our everyday lives.

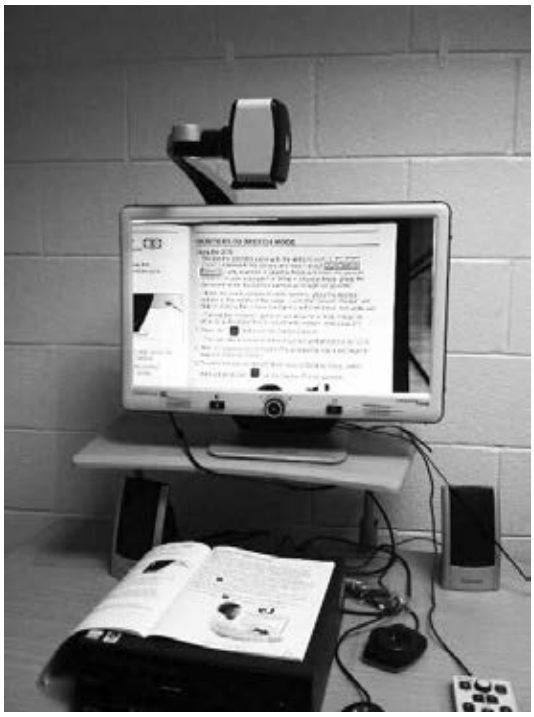

Photo 2. The da Vinci vision system integrates a Sony® HD camera with software applications that enable an individual to magnify and view printed materials in color and varying contrasts with a high degree of clarity. Also, the system has optical character recognition and text-to-speech capabilities.

DESIGN INITIATIVE FOR STUDENTS

As a part of this activity, students will fabricate, fit, maintain, and repair artificial limbs, plastic cosmetic appliances, and other prosthetic devices according to specifications and under guidance of the instructor, who in this case will serve as the patient needing the assistive technology. To be able to complete this activity, students need to be able to read technical specifications to determine the type of prosthesis to be fabricated and materials and tools required in the production of appliances; therefore, a week of research on the related topic is suggested. Starting this activity, students will receive the prescription from the patient explaining the type of disability so they can identify the appropriate prosthetic to be made. As a second step they will lay out and mark the dimensions of parts necessary by using precision measuring instruments and templates. Once templates are made, students will saw, carve, cut, and grind wood, plastic, metals, or fabrics to make the parts, using rotary sawing and cutting machines, and hand cutting tools. Adhesive materials consist of glue, welding, bolts, and sewing to form prostheses. Students will make wax or plastic impressions of the patient's amputated area (given to them from the instructor), prepare a mold from the impression, and pour molten plastic into molds to form the cosmetic appliances, such as artificial ear, leg, or hand. Next, they will assemble layers of padding over the prosthesis to fit and attach the outer covering, which could be leather or

Technology and engineering and career and technical education teachers can use assistive technologies in a variety of ways that can offer pathways to success using computer and information technologies. Examples include:

- Teacher-made accessible web pages that allow students with disabilities to access information, share their work, communicate with peers, teachers, and mentors, and take advantage of online learning options.
- Instructional software with accessibility features (on flash, CDs, or other media) and documentation allow students with disabilities to participate side by side with their peers in computer and technology labs and classrooms, collaborate with each other, create and view presentations, documents, spreadsheets, and actively participate in simulations and all other academic activities.
- Additionally, accessible communication and office equipment can make communication and educational administrative functions readily accessible to school personnel, teachers, parents, and guardians, including people with mobility, visual, and hearing impairments.

(Netherton and Deal, 2006)

Photo 3. Shown is a display of assistive technologies that can be used to solve a wide range of assistive needs. Several examples of the technologies illustrated are digital pocket magnifiers, iPad® with special apps to facilitate vision, adaptive holders for holding containers, flexible keyboards and keyboards with large contrasting (yellow) key caps, and other devices. Each of these devices offers solutions to accessibility issues that individuals and military veterans may have.

fiberglass. When the appliance is ready to be painted, they will mix paints to find the right pigmentation and then polish the finished device, using grinding and buffing wheels. Students will use a number of different instruments and fixtures to test the prosthesis just produced for freedom of movement, alignment of parts, and biomechanical stability. They may attach the prosthesis to the patient's stump, applying their knowledge of functional anatomy, and may even instruct the patient on how to use the

Table 2.
Correlation with *Standards for Technological Literacy*

The Nature of Technology	Technology and Society	Design
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	**Standard 4:** Students will develop an understanding of the cultural, social, economic, and political effects of technology.	**Standard 8:** Students will develop an understanding of the attributes of design.
Standard 2: Students will develop an understanding of the core concepts of technology.	**Standard 5:** Students will develop an understanding of the effects of technology on the environment.	**Standard 9:** Students will develop an understanding of engineering design.
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	**Standard 6:** Students will develop an understanding of the role of society in the development and use of technology.	**Standard 10:** Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
	Standard 7: Students will develop an understanding of the influence of technology on history.	

Note. Adapted from the International Technology Education Association. (2000/2002/2007). *Standards for Technological Literacy: Content for the Study of Technology.* Reston, VA: Author.

prosthesis. Activities such as the one described here are easy to correlate with *Standards for Technological Literacy: Content for the Study of Technology* (*STL*) (ITEA/ITEEA, 2000/2002/2007). See Table 2 for correlations with the *STL* standards.

SUMMARY

As we look at the vast array of new inventions, innovations, and technologies that offer solutions to the assistive needs of individuals, we can see that, through the years, they are becoming more technologically advanced. While many of these technologies may employ specialized digital and electronic systems, others may be simple adaptations of everyday items. For example, an individual who may be challenged with motor skills and dexterity may find an ordinary pencil very difficult to manage and use. A simple solution may be to radically increase the size of the pencil so that it is easy to grasp and manipulate. We see examples such as the da Vinci machine that reads and magnifies text for disabled students. However, the main goal of these devices—to aid individuals with physical and cognitive disabilities—remains the same, and their importance to humanity will remain vital.

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