

Computers for communication

New Developments in Handicapped Access

Peter Bates

In Dalton Trumbo's 1970 film "Johnny Got His Gun," a seriously injured World War I vet, paralyzed, blind, and dumb, spends his life shut up in a room so the world can't see him. All attempts to communicate fail because his superiors refuse to take him seriously. The film is tragic, not because of his wounds, but because he is both frozen in his plight and deeply frustrated.

If Johnny were real and living today, he could probably communicate with an Apple IIe personal computer.

"If you can twitch a muscle," says Dr. Howard Shane of Children's Hospital in Boston, "you can probably use a computer." New developments in software, hardware, and access devices make it possible for even pre-school age handicapped children to use computers faster, easier, and yes, cheaper than ever.

Before we talk about some of the new devices on the market, we should mention the access devices, or switches. The most sophisticated communication device incorporating the latest in infrared technology and voice synthesis would be useless if a person with cerebral palsy couldn't access it. To accomplish this goal, computer companies which specialize in products for the handicapped like Zygo and Prenke Romich offer a complete line of switches. The Zygo catalog features no fewer than 25 varieties. They range in complexity from a simple "tread switch" (similar to a sewing machine pedal), to a five-part multi-switch.

A person who can do little more than breathe can operate a computer



Tony Bonfiglio with custom keyboard designed at Boston Children's Hospital.

with a "sip and puff" switch. Blowing activates one function, like scanning a menu; sucking enlists another, like increasing the scanning rate. Others include a "lever switch" for head motion; a flat "leaf switch" to use inside the elbow, under the chin, or in the mouth; and a "brow-wrinkle" switch attached to the head via a sweat band. According to Dr. Bruce Gans of Tufts New England Medical Center, an electro-magnetic switch can detect electrical activity in a twitched muscle and transform it into a switching signal. Gans also considers voice input modules as switches for patients who can make clicking sounds with their tongues.

The key to most computer operations for the disabled is row/column scanning, invented in 1972 by a young Tufts University engineer named Rick Foulds. Called the Tufts Interactive Communicator (TIC), the device uses a double line LED display that scans the alphabet in groups of five letters. When it



The original TIC Tufts Interactive Computer.

passes by the group containing the desired letter, the user presses the switch. The scanning mode then shifts to individual letters within the group. With another touch of the switch the user selects the letter, which then appears on the top line. In this way words are constructed laboriously, like a puzzle, one piece at a time. Commercially, the device never caught on; Tufts distributed only 200. But for someone who couldn't speak, the TIC was a revolutionary advance over eye-gaze boards. These tedious tools require a tutor to monitor which symbols or words the handicapped person is looking at.

Adaptive Firmware Card

Today, the row/column scanner has reached a high level of functional sophistication with the Adaptive Firmware Card from Adaptive Peripherals, of Seattle, Washington, a small company run by Paul Schwade, the inventor of the card.

For \$400, the Adaptive Firmware Card turns an Apple II or IIe into a spe-

cial communication computer that handicapped users can access from any single switch device. According to Schwade, a non-technical person can easily install the flat cable into slot 7 and attach the card itself to the side of the Apple keyboard with velcro.

What can it do? When activated, it is a keyboard emulator, creating letter, numeric, or punctuation displays on line 23 of the monitor. The user can choose the order of the letters (e.g., by frequency of use), the speed of the scan, and which 40 words to store in memory for easy access. There is even a paddle simulation mode for games.

Lee Trocki of Norwell, MA, has Dushane's Muscular Dystrophy, a degenerative condition that leaves him nearly paralyzed. Henry St. James, his rehabilitation counselor, jury-rigged a pad switch for him to use with his Adaptive Firmware Card. Training himself to program, Lee now knows Basic, Fortran, Pascal, Cobol, and assembly language.

When St. James gave him *Multiplan*, he designed a grade-book template for the local school in a few days. Using *Quickfile*, he built an overdue notice database for the local library and printed them out on 3 x 5 cards. With *Applewriter*, he types more than 30 characters a minute and could do more if the screen didn't reform after he typed each character, a peculiar trait of the software. The Florida state school system has even contracted with Lee to adapt the British Acorn Computer for handicapped access. He will convert their brand of Basic to the U.S. operating system.

The Living Center

Apple isn't the only personal computer that can be adapted for handicapped use. Words+, Inc. of Sunnyvale, CA, puts out The Living Center, a system which interfaces with a Radio Shack TRS-80. It first creates a menu of items the user can select, such as letters, words, or sentences for communication; opera-

tions to control the system; graphics and games options; and even operations to run household appliances. The Living Center can be interfaced with off-the-shelf items, like printers and voice synthesizers. Whole families can use it, not just the disabled individual.

Like the Adaptive Firmware Card, the Living Center is also a scanning device. Unlike the card, it has a larger vocabulary. Users can scan and select from 1200 available words or build up to 100 new ones.



Clockwise from top left: Lee Trocki using the adaptive Firmware card for his Apple; A student of Howard Shane on his father's lap using the adaptive Firmware card at Boston Children's Hospital; Jerry, a victim of Reyes Syndrome, accesses CompuServe via a C64 and wrinkle switch; An Epson HX-20 hooked up to a Houston Instrument Digitizing Tablet.

We all know how literal computers are. What happens if the operator wants to enter the word "exercising"? He could create it by selecting the first word "exercise" then the suffix "ing," since the system stores endings in its vocabulary too. It is programmed to drop the final e or, for contractions, add an apostrophe.

The Words+ Living Center can also check spelling, add and delete words, phrases, and sentences permanently or for one-time use, and sound an alarm that shrieks for help should the user press a switch for longer than seven seconds.

The minimum system, consisting of computer, software, switch adapter, and switch costs \$2200. Words+, Inc. states in their brochure that customers can buy the computer separately and obtain the rest of the system from Words+ at a reduced rate.

The Portability Problem

As affordable and versatile as these systems are, they lack one important thing: portability. For a person in a wheelchair who can't talk, a system that could accompany him as he travelled would greatly improve his quality of life. Researchers are working on this problem. So far they have come up with two solutions.

Dr. Shane worked on a project to modify a special wheelchair for Tony Bonfiglio, a 16-year-old with cerebral palsy who cannot speak.

First, he installed an Apple IIe computer behind the wheelchair, beside the three motorcycle batteries that power both wheelchair and computer. Next, he installed a speech synthesizer and mounted a small monitor in front of Tony. The true genius of the system, however, is the custom keyboard and software.

Shane decided that although a single switch/row column scanner would work in Tony's situation, it was too slow. Tony had enough motor control to access a modified keyboard, so designers increased the size of the keys and placed the

important control functions (up arrow, space, control) in the center, his best motor area. So that he would not accidentally erase anything, they put the delete key in a hard-to-reach spot.

In designing the software, engineers incorporated direct selection and a scanning cursor. For example, to find the word Katherine, Tony pushes ESC to enter the phrase file. Many handicapped users move across keyboards and unintentionally activate the wrong keys. To counteract this, the engineers provided a delay function. To access all the K words, Tony touches the key for at least a second. According to his instructor Kathy Dawson of the Boston College Campus School, he has figured out on his own that pressing K then A will list all the Ka words. He can then find Katherine faster.

At this point in his education, Tony

can't read. A Votrax speech synthesizer announces each word as it scans. When asked if he may become too dependent on the synthesizer and never learn to read, Dawson replied that Tony dislikes the sluggishness of voice scanning and has already learned to recognize certain words before they are spoken, and even spell certain small words himself.

As Tony learns, his designers and instructors upgrade his system. Right now they are working on a spring-loading plexiglass rod he can use to place his hands closer to the bottom keys, his most difficult access area. Soon they will turn the delay function down to a half-second.

Demasco is working on the line-of-gaze method, the most exciting development yet in handicapped access.

Rehab engineer Patrick Demasco at Tufts New England Medical Center for Rehabilitation Engineering Center takes a different tack as he adapts lap computers for wheelchair use. Today special computers for the handicapped like the Zygo scanWriter can cost more than \$4000. Demasco and his colleagues would like to bring down the price with portable computers. Also, portables are inherently flexible. While a Zygo has a changeable vocabulary, it has a fixed program. In contrast, it is possible to create custom programs for TRS-80 Model 100 because the system is software based.

Demasco has compiled programs on cassette for the Model 100 and the Epson HX-20 that incorporate row/column techniques. Using a display similar to the Adaptive Firmware Card, Demasco bases his character display on frequency of use rather than alphabetical order. Page commands activate discrete series of seven sentences, which the user can then scan and select with a single switch.

Demasco has hooked the Epson up to a Houston Instrument digitizing tablet that relies on an external cross hairs cursor, sometimes mounted on a head pointer. The patient makes a direct selection, similar to Tony Bonfiglio's setup, but with an important difference. Each of 132 squares has two levels, the initial object word or phrase and another level that may, for example, offer the opposite

of that word or phrase. Call it an electronic Thesaurus if you like, but it is not difficult to learn. The disadvantage: it is not yet portable. The digitizing tablet is still too large for wheelchairs.

Demasco is also working on the line-of-gaze method, the most exciting development yet in handicapped access. Aided by a head motion tracker developed by McDonnell Douglas Electronic Corporation (and popularized in the film "Blue Thunder"), a miniature video camera mounted on a pair of special glasses "looks" at the operator's eye making a selection on the video display screen. By tracking its location relative to the head position, the camera sends the information back to the computer, which presents the selection.

This technology is attractive because it does away with the slower row/column scanning—the eye scans instead. It does, however, require those special glasses. Demasco is currently working on the "corneal reflection pupil center" technique that tracks eye motion without glasses. So far the greatest limitation is random head movement, which can confound the sensitive video camera.

Looking Ahead

More developments are taking place in handicapped access than we have space to mention. Linc Associates, Inc. puts out *The Special/Ware Directory, A Guide to Software Sources for Special Education*. This reference guide includes 61 pages of providers of hardware and software for special education, along with descriptions. Encyclopaedia Britannica Educational Corporation, for example, sells CARIS, an "Animation and Exploration" program for deaf and learning disabled children. *The Special/Ware Directory* is the most comprehensive I have seen. (\$13.95, Linc, 46 Arden Rd., Columbus, OH 43214).

Like most computer fields, handicapped access is growing fast. The opportunities it will open to people like Lee Trocki are limitless. Already handicapped users group abound on databases like Compuserve. At this point it is important to convince government representatives of the necessity for handicapped access. Then the scarce funding will grow.

Today there is more money available for motorized wheelchairs than for special computers. "This is very shortsighted," says Patrick Demasco. "If I were disabled and had a choice, I would prefer communication to mobility." But that choice should not have to be made. ■