

DARCI TOO: A COMPUTER INPUT DEVICE FOR PEOPLE WITH DISABILITIES

Many people with physical handicaps find it difficult or impossible to use the keyboard on a standard computer. Their problems have been compounded by the introduction of mouse control in most of the newer software programs. People with physical disabilities often find a mouse more difficult to use than a keyboard. This article describes the development of DARCI TOO, a universal computer control device for people with physical deficits. The failures experienced during the early stages of development are also discussed, and some recommendations are offered in conclusion for developing products for people with disabilities.

INTRODUCTION

When our granddaughter Darci was born without limbs, we knew that many accommodations would be necessary if she were to lead as full a life as possible. One of our top priorities was providing her with a means of using a computer. Since none of the existing computer access products met Darci's needs, we decided to build a custom computer input device.

Our company specializes in building computer-controlled products for the aerospace industry, so building a computer access device was well within our capabilities. Because Darci has about a third of an arm to work with, we decided that a joystick would provide the easiest way for her to control a computer. She was already using a joystick to operate her wheelchair, and such an interface would therefore be readily accepted. Since we wanted Darci to be able to use a computer in the same way as other children, we designed a device that would replace a computer's keyboard. The need for special software could be avoided in this way, and Darci could then learn to use computers in the same classes as the other students. (This compatibility of an interface with all hardware and software is called transparent access, but we did not know that at the time.)

A larger engineering effort than we had anticipated was required, but the device finally worked, and Darci could use a computer. She operates it by moving the joystick in a series of predefined patterns. Each pattern is assigned a keyboard character. When the microprocessor inside the unit senses that the joystick has been moved through one of the patterns, it sends the scan codes for the corresponding keyboard character to the computer.

We were pleased with the device and decided that it should be made available to other people with disabilities. We developed a commercial version of the unit and named it the Dynamic Asynchronous Remote Computer Interface (DARCI). Although DARCI worked well for some people, we soon found it was not appropriate for all types of handicaps. For example, many people with cerebral palsy do not possess the fine motor skills needed to

operate DARCI. This experience is a classic example of developing an engineering solution for a problem without fully understanding the problem.

DARCI TOO

At this point, we decided that if DARCI was going to be a useful device, it would have to be redesigned. To gain insight into people's needs, we asked several rehabilitation agencies to evaluate DARCI. The people at the Trace Center at the University of Wisconsin and the Center for Applied Technology at Rancho Los Amigos Medical Center were especially generous with their time. Their advice and suggestions were used to develop the design goals for a new device that we called DARCI TOO (Fig. 1).

The goals called for the development of a universal device usable by almost anyone irrespective of disability. The specific design goals for DARCI TOO were as follows:

1. Creation of one device that would interface with all of the most popular personal computers (Apple, Macintosh, IBM-PC, IBM-PS/2, etc.).



Figure 1. DARCI TOO: an alternative computer input device for disabled people.

2. Compatibility with all software and hardware (transparent access).

3. Provision of both keyboard and mouse functions to enable all computer inputs to be supplied by one device.

4. Enclosure of the unit in a sturdy metal case to ensure shock resistance and compliance with Federal Communications Commission (FCC) standards for electromagnetic interference.

5. Controllability through a variety of input devices so that the user could select a device that matches his or her capabilities. These devices include proportional joysticks; single, double, and triple switches; matrix keyboards (Unicorn Board, etc.); video game controllers; and RS-232 serial data (communication aids).

6. Automatic calibration capability for proportional joysticks to eliminate mechanical adjustments that are beyond the abilities of many handicapped people.

7. Availability of various input modes for entering data so that the user could select the mode that matches his or her capabilities. The possible modes are as follows:

- DARCI code (joystick code used on original DARCI)
- Morse code
- Character scanning (using a built-in display panel)
- Matrix keyboard
- Serial input (communication aids)

8. Built-in setup capability so that the user could select the input device and the desired input mode and then set the timing parameters to match his or her abilities.

9. Built-in 80-character display panel that shows keyboard status (shift, caps lock, etc.), setup instructions, scan displays, and the data being entered. Such a display eliminates using the computer's monitor and guarantees transparent access.

10. Internal provision of all capabilities and control software so that outside software setup routines would not be needed.

11. Reprogrammable memory (E²PROM) so that the unit would retain setup information (mode, input device, timing, etc.) on removal of power.

12. Inclusion of a word mode with a vocabulary that could be changed by the user. This vocabulary would be stored in the reprogrammable memory (E²PROM), which

will retain that vocabulary when power is removed.

13. Capability of replacing the keypad on IBM's Screen Reader program to provide the multihandicapped blind with computer access.

Progress was excellent, and all design goals were met. The DARCI TOO device was tested for compliance with Part 15 of the FCC rules for electromagnetic interference and was made available to the public in February of 1992. Since the DARCI TOO's introduction, we have continued to add new features. One of the latest additions is an audio feedback capability. Like most of the DARCI TOO's important features, this addition was suggested by a user. Figure 2 is a block diagram of the device.

DARCI TOO'S DESIGN

The DARCI TOO is controlled by a Z80 microprocessor and stores all control software in read-only memory (ROM) and all user timing parameters and vocabulary data in electrically erasable programmable read-only memory (E²PROM). Power control is provided by a push-button switch (so that a mouth stick can be used). Setup routines are accessed by a second push-button switch. The unit has also been provided with a 2 × 40 character liquid crystal display with backlighting for status, scan mode, and setup displays.

The DARCI TOO's input connectors have been configured in accordance with the Trace Center's standard for input devices. The serial port has been programmed in accordance with the Trace Center's General Input Device Emulating Interface (GIDEI) standard. The device has been packaged in a metal case that can be placed under a computer's monitor, thus making the display panel easy to see. Since the case has also been provided with tilt-up feet, DARCI TOO can be placed on any convenient surface. Interface cables have been designed so that the unit can interface directly with both the keyboard and the mouse connectors on IBM-PC, IBM-PS/2, Apple, and Macintosh computers.

CONCLUSIONS AND LESSONS LEARNED

Our experience with DARCI and DARCI TOO has taught us two lessons that we feel should be applied in the development of any device for people with disabilities.

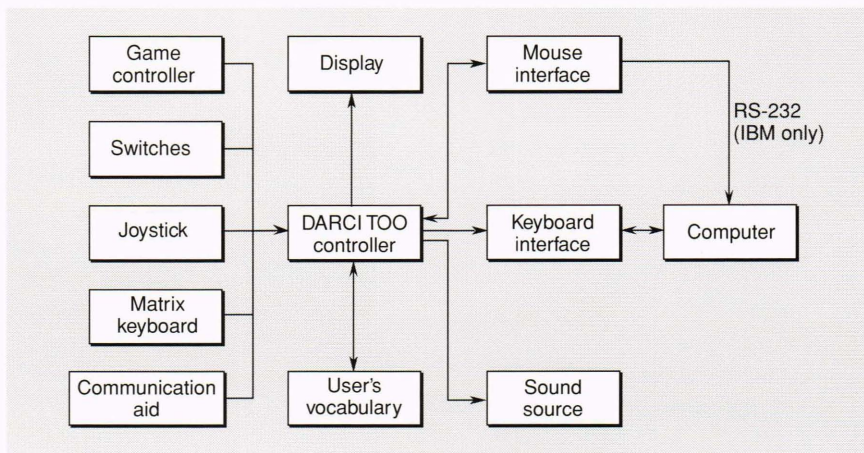
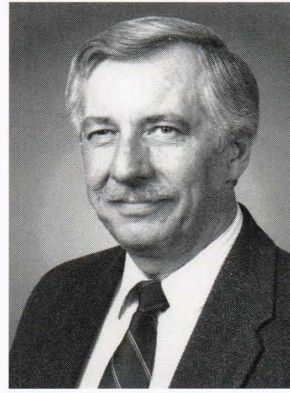


Figure 2. Block diagram of DARCI TOO.

The first lesson is that people with disabilities must be involved in the design effort. Our original device, DARCI, did not meet the needs of enough people with disabilities to be a commercially viable product. This deficiency was discovered only after the unit was placed in the hands of therapists and people with disabilities. Early involvement of rehabilitation specialists and people with disabilities is an absolute necessity in any development effort. The second lesson is that products for people with disabilities must have enough built-in flexibility to allow the device to be customized to fit the user's needs. Each person with a disability is unique, and if the way a device functions cannot be changed to meet the specific needs of each user, it will be a technical failure.

THE AUTHOR



JAMES S. LYNDS is President and Director of Operations at WesTest Engineering. He attended Rutgers University and then served a tour of duty in the United States Air Force (1956-1960). Mr. Lynds then began a career in test engineering. He has worked in a production engineering environment, taught programming and test system design, directed several development programs, and has served as a consultant for numerous development projects. As one of the founders of WesTest Engineering, he has managed most of the larger programs undertaken by the company.

Mr. Lynds' interest in people with disabilities began ten years ago when his first grandchild was born with a severe disability. Since then, he has devoted much of his time and resources to disability issues.