CRT received a referral from the Shepherd Spinal Center to evaluate a DRS client who suffered a brain-stem injury during a head-on automobile collision. The injury left him a quadriplegic with a speech impairment and even after being at Shepherd for ten months, there was little hope for improvement. When the client left Shepherd, he was only able to move his eyes, but after intensive therapy the client has regained some gross arm, finger, and head movement, with little grasping or vocal cord activity. He can type with one finger, read with glasses, speak in a whisper, and feed himself most of the time.

CRT staff members visited the client for the first time in December, 1987 to perform the preliminary evaluation of his workstation needs. The project was funded by DRS in May and in June it was determined that the client needed an extensive workstation, many components of which had no precedent.

The client's goal was to return ultimately to the working world as a productive member of a construction company. He felt that his mechanical engineering degree and experience as a structural engineer for thirteen years, combined with additional course work in construction management could prepare him for a position in the firm that employed him before his accident.

The project, therefore, was divided into two phases. Phase One would provide enough equipment for the client to manage his schoolwork, i.e., access to books, files, mail, drinks, and a computer. The workstation recently delivered to the client represents Phase One. At a later date, Phase Two would provide additional equipment or adjustments to existing equipment when it was established what the accessibility problems in the working environment would be.

Phase One was completed and installed in early November, 1988, although since that time it has required significant adjustments to continue working properly. The project involved several innovative designs to allow accessibility to those with limited movement/dexterity in opening mail and retrieving/viewing files. The following paragraphs summarize the various components of this new workstation.

1. The **Mail Station** incorporates several commercially available components into a single station where mail can be stacked, sorted, discarded, or opened, then stapled or three-hole punched as necessary. All activities are triggered automatically with the exception of tilting a tray to discard trash and pressing a button to activate the three-hole punch.

2. The **Drink Station** is a converted six-pack cooler designed to be plugged into a cigarette lighter. It is mounted in a table top and uses 110 volts power to keep nearly a gallon of beverage cold or hot indefinitely.

3. The **Computer Station** holds two color monitors and the CPU, while an adjustable platform supports a keyboard and a trackball. A panel of switches controls the book elevator (located adjacent to this station), a light over the File Carousel, and the master switch for the entire workstation.
4. Opposite the Book Elevator is the **Printer Stand** which supports the printer at an angle where the printed material can be read as it comes off the printer. Also, computer paper is stored in a bin behind the printer. It self-feeds into the printer and the paper automatically fan-folds into a bin below the printer. On a shelf beneath the printer is a separate floppy disk drive which pulls out like a drawer for easy access.

5. Several previous versions of the **Book Elevator** are on other CRT workstations. This particular one is different in that it has a chain drive system and an enclosed carriage holding books on drawer-like shelves. Separate buttons raise and lower the carriage to the desired shelf and draw them out for viewing the books.

6. The **File Carousel** is the major innovation of this project. Without the use of a robot, the user can (with only two buttons): select a file from the carousel, draw it out of storage, open it for use, and then close and return the file to storage. Up to 30 one-inch thick files can be stored on the present model, and it occupies only a little more space than the original CRT File Carousel.

At this stage, the client's use of the workstation has been somewhat limited. He has been attending classes at Georgia Tech for only several weeks since the initial installation and the file carousel and book elevator, not to mention the computer, have all presented bugs. The book elevator seems to be working fine now, and CRT has installed a repaired drive shaft. The computer vendors have solved the problems with the computer and the client should be able to make full use of the workstation.

It is assumed that CRT will again be designing modules or making changes to this workstation under a new subcontract with DRS when our client has finished his coursework at Georgia Tech and resumed working.

Staff members involved in the design, development, construction, and installation of the workstation were the Project Director, Cabell Heyward, Riley Hawkins, Jeff Stearns, Arthur Schoenfeld, and Chris Ketchum. CRT feels that many worthwhile designs came from this project and due to their applicability to others with similar disabilities, they merit further development. It is believed that the automatic file carousel and mail station could become valuable additions to the CRT workstation system.
October 28, 1988

MEMORANDUM

TO: Brian Lindberg, OCA/PAD

FROM: Janet Myrick, Administrative Secretary

SUBJECT: Final Report for K-10-850

Please find enclosed the original and one copy of the above-referenced final report. If you have any questions, please do not hesitate to contact Carol Whitescarver, x4-4960.

/jm

Enclosures (2)
This project was initiated to address the independent feeding difficulties experienced by a 19 year-old female with cerebral palsy. The goal of the project was to develop a means of independent feeding for periods up to eight hours. The product which resulted from this project was a rotating plate/feeder which functioned without the use of standard eating utensils.

The problem was identified at the Roosevelt Warm Springs Institute for Rehabilitation and referred to CRT engineers who developed and completed the project. Approved in January, 1988, the solution was supplied in March; after evaluation and minor alterations, the project was completed in June, 1988 with a final budget of $5925.

RATIONALE: In the past, the individual with cerebral palsy has accomplished the problematic task of feeding in one of two ways. Either an attendant fed the individual by hand, or the individual fed himself using a special device designed for independent feeding. One such device, a mechanical feeder, requires the user to exercise gross upper extremity motion to push and pull large knobs controlling food delivery. When manipulated, the knobs cause a spoon to drop into a plate, scoop up food, and raise it for the user to take. Another knob rotates the plate, and the spoon cycle is repeated. A similar device, the electro-mechanical CP feeder, uses a switch in lieu of knobs. When the switch is activated, the spoon cycle begins.

Although independent feeders have been used with some success, it was observed that the client for this project reverted to dependent feeding because the drawbacks of her mechanical and electro-mechanical feeders outweighed their advantages. For example, the client's mechanical feeders required her to use gross movements in an upright position in order to operate the spoon. These movements triggered tremors which made it difficult for the client to manipulate knobs and switches, and the raised spoon became a hazard. In addition, the various components of the client's mechanical and electro-mechanical feeders frequently worked against each other rather than in concert. The feeder's spoon often found an empty spot on the plate, and when it did pick up food, it was not unusual for the spoon to drop it before the food could be eaten. Consequently, during informal eating sessions, the client avoided these frustrations by eating directly from the plate without using utensils. The most significant advantage of this method is that the client was required to bend forward toward the plate; this action, known as flexion, caused her tremors to cease, and allowed her to eat in a more stabilized condition. Although this method has been discouraged by therapists, many clients continue to show that feeding without utensils can be a productive solution to the feeding problem.

Recognizing that clients have found eating directly from a plate easier and more practical than using mechanical feeders, CRT's engineers developed a new independent feeding device that functions without standard utensils.
SOLUTION: The design for the new independent feeding device featured three elements (see FIGURE 1): the base, the rotating plate, and the accessory modules.

The base, made of quarter-inch-thick CORIAN, served as a place mat and provided a flat bearing surface that could be easily cleaned.

Attached to the CORIAN base was a rotating plate sectioned into three food areas, two for dry and one for wet foods. The sections were equally spaced around a central indentation, or nose hole, designed to isolate the nose from food areas while eating from the plate. Food sections were separated by sloping partitions to keep food from sliding into other sections of the plate. Likewise, the sloping sides were designed to concentrate food in the center of each section for easy access. To use the plate, the client followed a simple sequence of steps: food was 1) maneuvered up the slope with the tongue and lips, 2) pressed against a vertical surface at the apex of the slope, and 3) taken into the mouth. Chin slots, a series of indentations on the outer edge of the plate, allowed the client to reach other sections of the plate by placing her chin in one of the slots and rotating the plate to the desired food area (see FIGURE 2).

Three interchangeable accessory modules were designed to be snapped into the base on either side of the plate: a napkin holder, a fruit holder, and a beverage holder. The napkin holder was fabricated from a mushroom-shaped piece of plastic mounted on a spring and covered with a cloth napkin held in place by a common rubber band. The fruit holder was devised by mounting a metal skewer across the open end of a polycarbonate spring clip (see FIGURE 3). The device was designed to support the fruit and allow it to rotate for easy access. A second polycarbonate spring clip served as a beverage holder for a soda can or a glass.

EVALUATION: The product was delivered to the client in June, 1988. User acceptance has been high, and the client has tried many types of foods using the system. Her family has expressed such a high degree of confidence in the client's feeding independence that her mother has now returned to work—a major goal of the project.

The client's mother has reported the feeding system is both functional and practical. She considers the design pleasing enough aesthetically to belong on the dining room table. She has also noted that the feeder has begun to serve functions beyond those originally planned. For example, she now leaves the client's medication in the corners of the food sections to be taken at the required time. She has also observed that the fruit module works equally well as a holder for firm vegetables, snacks, and breads.

Favorable evaluations have also come from outside parties including the clinical staff at the Roosevelt Warm Springs Institute for Rehabilitation. At a recent summer camp in Alabama for persons with cerebral palsy, the independent feeder was used by other clients; staff members reported success with these clients as well.

It was determined that a good companion to the feeding system would be a device that could keep food hot or cold for long periods of time. This would allow the user to carry his food along on day-trips to work or school. This idea was pursued in the form of a prototype hot-cold tray. The tray consisted of feeding areas
FIGURE 1. Jennifer Elias Feeding System Consisting of Base, Plate, and Interchangeable Modules
FIGURE 2.
aligned linearly rather than radially. The sections were made of small aluminum pans with washable plastic inserts. Thermoelectric coolers were placed beneath the pans. (Thermoelectric coolers are electric chips that heat on one side and cool on the other. By reversing polarity, the hot side cools off and the cold side warms up. This is in contrast to typical resistive element warming trays that allow only heating.) The device proved feasible and along with the rotating plate/feeder is being reviewed by CRT, Inc. for possible product development.