Technology in the Education of Multiply-Handicapped Children

(technical aids, school system)

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The number of technical aids now available has allowed severely multiply-handicapped children to better participate in their education. Project TEACH (Technical-Educational Aids for Children with Handicaps), a 3-year early childhood demonstration project of the Federal Office of Education, provided ten children with seating systems, mobility aids, feeding devices, and augmentative communication aids. The children's performance of academic, motor, daily living, and communication skills as they relate to their educational program is reported as well as the model used to deliver technical services in an educational environment.

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In July 1978, the Office of Education awarded a 5-year early childhood demonstration grant to the Memphis city schools, Division of Special Education. The primary objective of the project was to demonstrate that severely physically handicapped children could participate more meaningfully in their educational programs as a result of assistance from technical aids in the areas of seating, communication, mobility, and personal care. The secondary objective was to evolve service delivery concepts into a model that could be replicated in other educational settings.

The need for this project was manifested by the fact that more than half of the approximately 8 million handicapped children in...
the United States did not have access to quality educational opportunities at the time the grant was written in 1974. The grant permitted the formation of a cooperative agreement between the Rehabilitation Engineering Center (REC) at the University of Tennessee, which has provided the technical consultation, device design, fabrication, and maintenance support, and the Memphis City Schools, Division of Special Education. The cooperative effort was termed Project TEACH—Technical Educational Aids for Children with Handicaps.

The staff of the school system and the REC identified three major areas of need: (a) specialized seating and positioning to prolong attentive upright postures, (b) augmentative communication aids to facilitate communication between teachers and students (both handicapped and non handicapped in the mainstream classrooms), and (c) the expansion of educational goals to include the acquisition of skills of daily living such as toileting, feeding, refined motor skills, and mobility.

Previous experiences of the project staff, as well as those of colleagues working with handicapped children in other areas of the country, led to the subjective observation that technical aids can significantly increase the level of participation of severely handicapped children within educational settings. However, these differences in participation had not been documented by using quantitative measures. This lack of data makes it difficult to justify to third-party payers the expenditures involved in the use of the aids. Objective documentation of the individual student's progress within the three areas of priority listed above was an important aspect of the project.

This report presents a summary of the occupational therapist's involvement was primarily to assess, provide, and train children in motor skills necessary in the use of the technical aids used and described technical aids used and described later. Emphasis in this paper is on aspects of particular concern to occupational therapists: seating, mobility, feeding, and gross motor function. Data on communication skills and academic achievement are reported elsewhere (1).

Project Staffing and Participants. The staff assigned to the project were a speech pathologist (50% time), occupational therapist (75% time), rehabilitation engineer (50% time), engineering technician (50% time), and a project coordinator (100% time).

Ten children with cerebral palsy participated in the project. To meet the guidelines of the Federal Office of Education, Early Childhood Division, all children were less than 8 years of age or below the third grade level at the beginning of the project. There were six boys and four girls; the youngest was 3 years old and the oldest was 13 years old. They were referred by special education personnel from the population of 4,239 children registered with the Division of Special Education, Memphis city schools.

Selection criteria were established by the Project team to determine which of the children could benefit most from the technical aids. The criteria were: the children be non-speaking and severely functionally limited in such skills as trunk and head control, personal care skills, and mobility.

An assessment protocol was developed and used to obtain base line data on existing functional levels and needs for each child. Areas of concern included intelligibility of speech and independence in areas of toileting, feeding, mobility, and upper extremity function. Based on determined needs, the team then sought to provide technical aids to meet these needs.

Results of Four Testing Categories

Measurements were taken in four testing areas over a period of 18 months. The effects of seating and positioning support, mobility devices, ADL devices including feeders, and motor skills were monitored.

The Effects of Seating and Positioning Supports (Figure 1). Eight students required custom-fitted seating systems in order to be positioned therapeutically; two students were ambulatory and therefore were not included in this component of the study. In measuring the effects of therapeutic seating systems, three areas were considered: (a) maintaining head control, (b) maintaining trunk control, and (c) a student's ability to use his or her arms in a gross functional manner. Baseline measurements were taken before seating devices were provided. Other measurements were taken at four intervals 6 months apart within an 18-month period while students performed activities with and without the seating systems.

When the students were pulled from lying supine to sitting, they were able to maintain their heads in alignment with their trunks (head control) for an average of 51.6 sec; they were able to hold their heads in alignment with their trunks when prone on a wedge for 106.09 sec; and when prone standing were able to hold their heads in alignment with their trunks for 19.24 min (1154 sec). However, when in their therapeutic
seating systems, the students' ability to hold their heads in alignment with their trunks increased significantly to at least 7 hours, which was the end of the school day. Most children continued to maintain upright alignment for varying periods during bus transport and also at home. The ability to sit upright in a stable posture is essential in a classroom where students must visually attend to blackboards and TV monitors, be fed or able to feed themselves, and able to participate in group activities.

In measuring trunk control—the ability to maintain the trunk in an upright midline posture—students were seated in four different positions: sitting cross-legged on the floor, sitting on a wedge, sitting on a standard chair, and sitting in a therapeutic seating system. The average time they could maintain trunk control in each position was recorded. The average time sitting cross-legged on the floor was 6.46 min; sitting on a wedge averaged 10.7 min; sitting unsupported on a standard chair averaged 5.96 min. Sitting in their seating system, they were able to maintain the trunks in alignment for an average of at least 7 hours, which marked the end of the measurement period.

Arm control was measured by recording the number of times in 1 minute a student could bat a ball, 20-cm (8-inch) in diameter, suspended from the ceiling with a rope. While in their seating systems students batted the ball an average of 19.3 times in 1 minute. When not in their seats they had insufficient control to bat the ball at all. Further study to compare seating support and changes in fine motor skills is needed.

Mobility (Figure 2). Four of the ten students were selected to receive powered mobility. Reasons for not

![Figure 1](http://ajot.aota.org/)

**Figure 1**
Mean seating times

![Figure 2](http://ajot.aota.org/)

**Figure 2**
Mean mobility measures
providing powered mobility to the six remaining children included age, an unaccessible home environment, and uninterested or irresponsible family.

Baseline performances using manual wheelchairs, or, in one case, ambulation with a walker, were taken prior to the provision of the powered devices. Devices included an A-BEC chair, two Everest & Jennings 3P chairs, and a modified Amigo Cart. Comparative tests were run and measures were taken by recording the time required for the student to traverse a distance of 125 feet (38.1 meters), first using manual propulsion when possible, and then in a powered device. The second series of tests involved the use of a revolution counter added to both the manual and powered chairs to record the total distance covered in a normal 6-hour day averaged during a typical school week. This measurement was considered indicative of the range of experiences a child could and/or would have access to in a day. Also, children who cannot move independently are less likely to be expected to take initiative for their own timetable in the school day.

Three of the four children were unable to complete the manual propulsion speed test within an acceptable time frame because of the extent of their physical disabilities. The fourth child could walk the 125-foot distance with a modified walker in 89 seconds. Using their powered devices, all four children could traverse the test track in less than 1 minute. Individual variations were due to the ability of each child to control the system, and the type of powered device he or she was using.

These findings on the four children led us to believe that children with zero or very limited mobility can be given sufficient control over a powered device to permit them to mobilize themselves safely within a school environment within a practical time frame (i.e., traverse 125 feet in less than 1 minute).

The distance test revealed that the average distance traveled by each of the four children dependent on manual propulsion was 1,184 feet (388.1 meters) during a typical 6-hour period; three of the children relied on random propulsion by others, and the fourth ambulated with the use of a walker. Using powered mobility, the average distance traveled within the 6-hour period was 2,231 feet (680 meters), almost twice as far.

**Personal Care: Feeding.** Feeding was chosen to represent a personal care activity in the project because it has significance for the child and can reduce costs for attendant time within the educational setting. Staff costs money. Barriers to mainstreaming are often represented by need for staff if children are not independent.

Four of the ten students were totally dependent in feeding—three possessed the potential for independence with the assistance of a technical aid, and one, although still dependent, could be fed with greater efficiency using an aid. Each solution provided was individualized as follows:

1. **DD** was provided with a Winsford Feeder (2), a powered device operated by chin control (arms are restrained under the tray).
2. **HR** was provided with a Cerebral Palsy Feeder (3) since she has sufficient gross motor arm placement to hit the levers required to operate this mechanical feeder.
3. **BK** was provided with a swivel plate because he could not reach the food at the far side of his tray and a built-up spoon handle to facilitate grasping of the utensil.
4. **SR**'s tray was modified to restrain her arms, giving her more upper trunk stability during feeding (4).

Feeding skill measurements were taken using the following procedures. The time required for a teacher aide to feed a randomly

<table>
<thead>
<tr>
<th>Student</th>
<th>Without Equipment, Unassisted</th>
<th>Without Equipment, Assisted (fed)</th>
<th>With Equipment, Unassisted</th>
<th>With Equipment, Assisted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(min)</td>
<td>(min)</td>
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<td>(min)</td>
</tr>
<tr>
<td>D.D.</td>
<td>Cannot Eat</td>
<td>20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>H.R.</td>
<td>Cannot Eat</td>
<td>15</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>S.R.</td>
<td>Cannot Eat</td>
<td>25</td>
<td>Cannot Eat</td>
<td>17</td>
</tr>
<tr>
<td>B.K.</td>
<td>Cannot Eat</td>
<td>20</td>
<td>10</td>
<td></td>
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selected school lunch was recorded. Next, the child was given the feeding device as well as indirect training until a proficiency level with the device was obtained. Then the time required for each child to eat independently, or, in one case, to be fed with the arms restrained (SR), was recorded.

As indicated in Table 1, technical aids allowed three of the children to become independent during mealtimes and to accomplish this within a practical time period (30, 25, and 10 minutes, respectively). Although in two cases the feeding time was increased by 10 minutes, it obviated the need for a salaried aide present throughout mealtimes. With arms restrained, SR could be fed in a shorter time (17 vs 25 minutes).

**Motor Skills Training.** Gross motor arm placement was measured on three students. Activities were chosen to duplicate the motor skills required to operate the control switches of powered technical aids, that is, slot control and single switch control. Two devices, the Pick and Push and the Arrow Board, reinforce these skills and were therefore chosen for training purposes.

The Pick and Push was used to train controlled arm placement in five locations. The device is a control panel with five slots; each slot has a paddle mounted over a switch that, when hit, activates a buzzer. It is similar to the slot switches commercially available from Prentke-Romich Company (5). For one complete response a student must correctly select and "buzz" at each of the five locations.

The Arrow Board was used to train sustained motor responses. It consists of an arrow mounted on an arborite sheet that rotates as the student maintains contact on a touch switch that activates the motor. A student must rotate the arrow 360° for one complete response.

Five children were trained on these two devices individually a minimum of three times weekly. All children were placed with one particular teacher who was willing and capable of monitoring the results. Also, these were children whose individualized education program (IEP) stated that acquisition of motor skills was a primary educational goal. The remaining five children either had no possible hand skills (4) or were in educational placements that were not conducive to carrying out the research as defined by the TEACH team.

The children were asked to select and operate specific switches and their skill level was recorded. Measures on both devices were taken three times over an 18-month period. The students' mean response times on each device are illustrated in Figure 3A and B. As indicated, these severely physically handicapped children gained considerable control during this 18-month period. On the average, they became twice as proficient in operating the arrow board, and more than four times quicker in operating the Pick and Push. Since the two training devices resemble commercially available control switches, it can be con-
cluded that, with a structured training program, even severely motor-impaired children can learn to operate the controls of specific technical aids.

The Delivery Model
Since diverse variables affect the successful delivery of technical services in an educational setting, we identified the steps required in our delivery system and illustrate them in a generalized flow chart. Figure 4 presents the flow model developed and refined as a result of the experiences gained throughout the project.

Upon receipt of a referral, a multi-disciplinary team begins a thorough screening and evaluation process. Our experience indicates that an occupational therapist, a speech pathologist, the parent, and an educator should form the nucleus of the team. The teacher’s input and cooperation is essential if, in fact, the children are to use the technical aids in the classroom in order to enhance their educational performance. The occupational therapist brings expertise in education and training for positioning, fine motor skills, and knowledge of the state of the art in technical aids. A speech pathologist is essential in the evaluation and training for augmentative communication systems. The parent’s and student’s interest and cooperation are prerequisites to meaningful involvement in any program. Rehabilitation engineers, social workers, rehabilitation counselors, and others can be called upon depending upon individual student needs.

A vital part of the assessment process is coordinating the child’s ongoing medical and therapy treatment programs to ensure compatibility of management goals and the receipt of the background information necessary for decision making. Communication with the parents and classroom teachers is essential since the ultimate plan must, by law, be incorporated into the child’s individualized education program.

In general, four alternatives are available to the assessment team related to the provision of a technical aid: (a) provide a commercial device, (b) provide a modified commercial device, (c) provide a custom-designed device, and (d) acknowledge that a solution does not exist within the current resources available to the team.

In most cases, providing a commercial device is the most practical approach and, therefore, is the first route investigated. Risk is diminished if access to trial aids is possible so that an evaluation with the proposed aid can be carried out before committing financial resources.

If a commercial aid does not meet the needs of the child, two technical options remain. These options, the modification of a commercial device or the conception and production of a custom-designed device, usually require available technical resources. Modifications involve controls, connections without display modes, and interpretations of technical data from the suppliers. Custom-designed solutions are costly both in money and in time. Once the modification or prototype design has been validated and a device fabricated, it should be subjected to use trials. Failure to meet a child’s needs at this point suggests a reassessment of the problem. In all cases, once a successful device is working under the supervision of the technical resource team, training others associated with the child’s daily environment is the next vital step. Providing detailed instructions and support to educators during the transition phase into the classroom cannot be overstressed. Maintaining and repairing technical aids in a timely manner to minimize “down time” is vital to maintain student motivation and supportive teacher involvement.

Finally, most children’s needs for technical aids change with time. Therefore, periodic re-evaluation and assessment of the needs is necessary to review the continued appropriateness of the aid.

Cost Distribution
The cost of technical support provided to Project TEACH is summarized in Figure 5. Cost of analysis was related to the five component areas of technical support: seating, mobility, communication, aids to daily living, and education and training aids. The cost within each category has been subdivided into three types of aids: commercial, modified commercial, and custom designed.

The number of technical aids available to children from commer-
cial sources expanded rapidly during the course of the 3-year project. Several children in the project received custom-designed equipment that is available now commercially. To provide data more useful for planning and budgeting, the cost distribution has been adjusted to reflect commercial costs of these devices where applicable. Although certain aids are now commercially available, providing aids is normally made through professional consultant channels. In these cases, costs of the aids have been included under the commercial category, whereas the professional time involved in the prescription fitting of such aids has been distributed between the categories—modification of commercial equipment and the custom-designed solution.

The results shown in Figure 5 indicate that average seating costs per child were $620.00, with $330.00 for commercial solutions, an additional $40.00 for modified commercial, and an additional $250.00 for custom-designed solutions distributed between commercial, modified commercial, and custom-designed solutions, respectively. These costs did not include the wheeled base since there are a variety of commercial options and prices for similar bases that vary with individual dealers. Powered mobility costs were the highest, with an average of $2,000.00 per child, and increments of $1,150.00 for commercial, $200.00 for modified commercial, and $650.00 for custom-designed devices. Further analysis of the graph will result in the cost figures for communication aids, ADL devices, and evaluation and training equipment for the ten Project TEACH children.

The cost distribution does not include the routine maintenance and repair of the aids that were provided. Over the course of the 3-year project, it was determined that the cost of maintenance, local repair, and repair of aids by commercial suppliers resulted in additional expenditures of approximately 10 percent above the cost of providing the aids.

Conclusion
The provision of technical aids can have a profound impact on improving the educational achievement experienced by severely physically handicapped children. They can sit longer with positioning equipment, and therefore can pay attention and participate in the classroom. With augmentative devices, they communicate both more rapidly and with a larger vocabulary. Teachers can better assess and remediate specific deficits in their academic records and the students learn to work independently and more rapidly on academic material. With powered mobility they move more easily and can become responsible for their daily routine. Because of their added skills, such as independent feeding, more children can be successfully mainstreamed and will have the opportunity to effectively communicate with those in their community.

Technical aids alone are not a solution. Provided after a thorough evaluation, in conjunction with a full training program, ongoing follow up, and maintenance, technical aids can assist handicapped children to become active participants in their academic programs.

Acknowledgments
The authors acknowledge the support and guidance provided by the Memphis city schools—Special Education staff assigned to Project TEACH under the direction of Harold Perry, and the Rehabilitation Engineering Center staff under the direction of Douglas Hobson. The interest and encouragement of the parents and students were also instrumental to the success of the Project.

A more comprehensive publication, Project TEACH Case Studies Report, is available from the University of Tennessee Center for the Health Sciences—Rehabilitation Engineering Center, 682 Court, Memphis, TN 38163, cost: $9.00. A sound/slide audiovisual production available on loan from the same source provides a general description of the project activities.

Much of our experience as well as the experiences of six other centers in establishing technical resource facilities for providing technical services appears in the report published by the National Association of State Directors of Special Education in 1980 (Assistive Devices for Handicapped Students—A Model and Guide for a Statewide Delivery System: National Association of State Directors of Special Education (NASDE), 1201 Sixteenth Street, N.W., Washington, DC 20036, price: $4.50).

Note: A full report on Project TEACH is available on a limited basis from the authors (price, $5.00).

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5. Prentke-Romich Company, RD 2, Box 191, Shreve, OH 44676