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ABSTRACT

This book is based upon group participation and presentations given at three regional workshops on science and technology for the handicapped. The first workshop focused on issues in technology for daily living. Papers presented examined such areas as daily living technology for the disabled, psychological aspects of rehabilitation engineering, technology for recreation, and technology for the living environment. The second workshop addressed issues in technology for education. Papers presented considered such areas as low-budget ideas for the visually impaired in science, modifications of effective teaching of handicapped students, robotic manipulation aids in rehabilitation, computer-assisted lipreading for the deaf, and closed captioning of motion film for use on national television and for delayed broadcast by affiliates. The third workshop explored issues in technology for employment. Papers presented considered such topics as barrier free office design, factors in choosing technology for the job site, access to the total work environment, and innovations in adaptive equipment and job site modifications. A list of participants for the three workshops, workshop goals, and workshop agendas are included. (JN)

Technology for Independent Living II

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Issues in Technology for Daily Living, Education, and Employment

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Issues in Technology for Daily Living, Education, and Employment

Edited by

Martha Ross Redden and Virginia W. Stern

Proceedings of the 1981 Workshops on Science and Technology for the Handicapped

La Jolla • Rochester • Minneapolis

Project on the Handicapped in Science

American Association for the Advancement of Science

This book is based upon group participation and presentations given at three regional workshops on Science and Technology for the Handicapped, convened by AAAS in 1981, and funded by National Science Foundation Grant No. OPA7920290.

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Foreword

This volume of selected papers is the record of a milestone effort in our society to understand the role of engineering science and technology in the world of physically disabled individuals. Beyond data, you will come to see that people are the key element at all stages in the development and delivery of assistive technology. As we begin to acknowledge that disabled people are "expert witnesses" of their own needs, we must also recognize that technology has no value separate from the people who transform theory and practice into utilitarian devices. And, beyond individuals, both the technologist and the disabled person work within a complex web of social/technical institutions that must be coordinated for the effective delivery of rehabilitation technology.

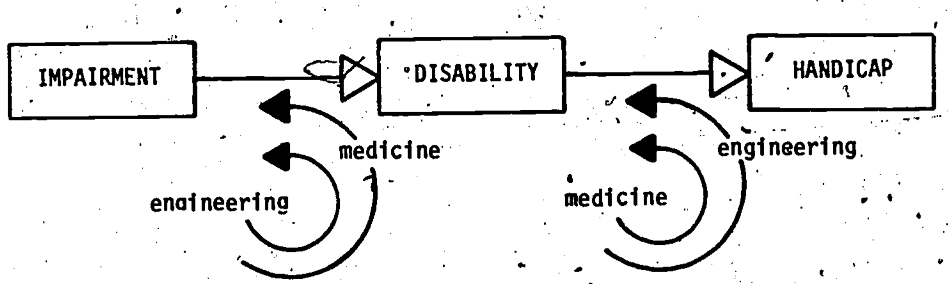
To visualize the interaction between physical impairment, medicine and engineering we may examine The International Classification of Impairments, Disabilities and Handicaps (WHO Chronical, Vol. 34, 1980, pp. 376-380) which defines three key stages in the evolution of a handicap.

Impairment: any loss or abnormality of psychological, physiological, or anatomical structure or function.

Disability: any restriction or lack of ability resulting from an impairment to perform an activity in the manner or within the range considered normal.

Handicap: a disadvantage for a given individual, resulting from an impairment or a disability, that limits or prevents the fulfillment of a role that is normal (depending on age, sex, social and cultural factors) for that individual.

The interaction between these three phases in the development of a physical handicap are traced below. It is the primary role of the health care profession



(with backup from engineering) to minimize the progression from impairment to disability. In a complimentary sense, the engineering science community seeks, with support from the medical profession, to reverse the tendency for a disability to induce a handicap.

When associated with impairment, the contribution of engineering science is often expressed as tools for diagnosis and treatment, "assistive technology." When directly applied to disability, it is expressed as tools for living, "assistive devices." The evolution of humankind can be measured in terms of our mastery of tools. Tools allow us to control our environment in ways quite beyond our native ability. Hand tools have become machine tools and now machine tools have evolved hands. We are building general purpose programmable machines (robots) whose primary function is to manipulate other machines (manually). As machines gain vision and hearing they may serve the disabled as vision and hearing aids, or, they can serve as "seeing-eye-robots" and "hearing-ear-robots." In these and other cases it will be increasingly useful to distinguish between anatomical and functional rehabilitation strategies.

The dominant philosophy in rehabilitation, implicit and explicit, has been to replace lost or damaged anatomy. Functional specifications are too often based on the assumption that missing limbs or sensory organs must be replaced. However, this approach places severe constraints on the control, size, weight, power and geometry of potential solutions. This situation is to be avoided in that there is usually a negative correlation between the degree of anatomical fidelity in an assistive device and the degree to which functional performance criteria can be achieved.

This line of reasoning has clear and appropriate limitations where cosmetic issues are an overriding concern.

As you read through this exceptional collection of papers please look for the union of needs and methodology. As a field, we are still very much in need of basic strategies, principals of operation and theory. We are in need of unity in the face of natural forces in rehabilitation that tend to encourage differentiation by disability.

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Mechanical Engineering
Stanford University
Stanford, California
and Director,
Rehabilitation R&D Center
VA Medical Center
Palo Alto, California

Acknowledgements

The Proceedings published in this volume represent the work of many people. Some presented papers which appear as the printed record of the 1981 workshops. Others contributed leadership in developing discussion themes, participant lists, and in serving as small groups discussion leaders and rapporteurs. We are grateful for their cooperation and enthusiasm. The lively spirit of the workshops would not have been possible without the contributions of all these individuals, who shared their experience from a wide range of disciplines and geographic locations.

Our appreciation goes especially to the co-sponsors of each workshop:

La Jolla: Dr. Harriet Green Kopp
Acting Dean, College of Human Services
San Diego State University
San Diego, California

Rochester: Dr. William E. Castle
Vice-President, Rochester Institute of Technology
and
Director, National Technical Institute for the Deaf
Rochester, New York

Minneapolis: Dr. Nancy Crewe
Associate Professor, Department of Physical Medicine and Rehabilitation
University of Minnesota
Minneapolis, Minnesota

They and their university staff members gave generously of their time and knowledge to assist the AAAS staff in program planning, local connections, and logistics. We are grateful also to the disabled and non-disabled persons from organizations in each community who served on planning committees and arranged for local services.

This volume is the result of the hard work of four people:

Sue Bardellini Forman served as principal copy editor and production coordinator. Mary McCarthy collected and did initial organization and editing of the manuscripts. Jill Groce assisted in summarizing the small group sessions.

Lorraine Stillwell coordinated workshop registration and follow-up activities.

Janette Alsford Owens was responsible for the design of the Proceedings and *Bulletins* and Marjorie Crow typed the Proceedings.

Kathryn Wolff, Joellen Fritsche, and Susannah Borg of the AAAS Meetings and Publications Center supervised the final production.

Shirley Malcom, Head, AAAS Office of Opportunities in Science, offered guidance in all aspects of the project.

James Aller and Lynn Preston of the National Science Foundation gave continuing encouragement, direction, and support.

Design

Background

Since 1975, when the concerns of handicapped individuals in science were brought to the attention of the American Association for the Advancement of Science (AAAS) by a deaf biologist member, the AAAS Project on the Handicapped in Science (PHS) has been a national center of information on handicapped persons in science. The Project on the Handicapped is part of the AAAS Office of Opportunities in Science. A major thrust of the Project since its beginning has been the development of a Resource Group of Disabled Scientists. This group, now numbering over 1,000, consults on matters of handicapped individuals' access to science education, architectural and laboratory accessibility, professional meeting accessibility, aids and equipment, and barriers to employment. All activities of the Project on the Handicapped in Science are directed toward the interrelationship of science and disability.

In 1980, the Project on the Handicapped in Science began a three-year program to increase the interaction between disabled and ablebodied scientists and engineers working on science and technology for the handicapped. A three-year series of regional workshops and *Bulletins* disseminated nationally which contained information from them, were funded by the National Science Foundation (NSF) through its Program of Science and Technology to Aid the Handicapped. The impetus for the workshops was based on a need to expand the findings of an earlier NSF-funded AAAS/PHS project and its resultant publication *A Research Agenda on Science and Technology for the Handicapped*. This agenda identifies priority research needs in science and technology for disabled individuals and suggests the type of exchange between disabled and non-disabled people which would result in effective research and development strategies to meet current pressing needs of handicapped people and to improve their quality of life.

The workshops provided a unique opportunity for disabled and non-disabled scientists and engineers to participate in the process of identifying current research, outlining requirements for innovative development, proposing new programs of research in technological aids, and methods of effectively sharing state-of-the-art information on devices to avoid re-invention of the wheel, and the wheelchair. Joining the scientists and engineers in their discussions were disabled consumers, parents of disabled youth, architects, designers, manufacturers of aids for disabled persons, physicians, nurses, occupational and physical therapists, rehabilitation counselors and administrators, communication specialists, representatives of small business and the insurance industry, and educators at the pre-college and college level. Each workshop had its own particular mix of individuals, reflecting both the institutions of the region, the existing educational, employment, and recreational opportunities, and the networks that had previously developed. One of the major goals of the workshops was to expand these networks, to initiate communication between individuals from institutions that were within "shouting distance" of each other but were separated by traditional historical and attitudinal barriers. The workshops also provided a platform for private individuals who were independently developing aids and devices, with an opportunity for interchange with institutionally-affiliated persons researching in the same area. Notices in *Science* magazine alerted a wide audience of people to inquire about the workshops; many of these people were not part of the formal discipline of rehabilitation engineering and were able to bring experience from a different perspective.

Because the main objective of the workshops was to actively involve disabled persons in research and development of science and technology for the handicapped, a special effort was made to include a significant number of disabled people in each group of participants. Invitations were issued through local disabled consumer groups, parent organizations, disabled student officers on university campuses, and the AAAS Resource Group of Handicapped Scientists. Registration for each workshop was planned to include a wide representation from institutions of the region and also allow for unexpected registrants representing lesser known or newly established groups.

The overall theme for the 1980 workshops was "Independent Living and Its Implications for Science and Technology for the Handicapped." The 1980 Proceedings, which includes the presentations from the workshops in Stanford, CA, Boston, MA, and Houston, TX, were published under the title, *Technology for Independent Living* (Virginia W. Stern and Martha Ross Redden, editors, AAAS Publication No. 82-R-2, 1982).

In the 1981 series, each workshop had a special focus:

Issues in Technology for Daily Living	(La Jolla, CA)
Issues in Technology for Education	(Rochester, NY)
Issues in Technology for Employment	(Minneapolis, MN)

The formal papers and transcripts of some of the panel discussions from the workshops are included in this volume, along with the programs of each workshop, complete lists of participants, and summaries of the small group discussions that took place between formal presentations.

The workshops were designed to be highly participatory. In addition to scheduled small group discussions, coffee breaks and evening social activities offered opportunities for informal exchange of experiences and resources. Everyone had something to contribute--there were no auditors or silent observers.

At the final session of each workshop, all registrants gave oral presentations of their own action plan developed during the course of the meeting. The action plans were not recommendations for a government bureau or outside agency to implement--they were individual practical proposals of activities to be carried out in the near future by the participants themselves in their own environment--university, laboratory, hospital, business, or community-at-large. Participants were encouraged to use the resources of AAAS to carry out their plans and to inform AAAS of their progress by sending notes to the information exchange of the *Bulletins*. Action plans were often made by groups of participants from different institutions in the same geographic area who had discovered at the workshops that they were working on parallel tracks in seeking solutions to problems.

The *Bulletins*, published by AAAS after each workshop, reported on selected speeches and small group discussions from the workshops. In addition, the *Bulletins* contained notices of current and proposed research in technology, announced the most recent NSF grants on science and technology to aid the handicapped, and gave details of new products, other meetings, and available resources. The *Bulletins* expanded the exchange of information from the project headquarters and the workshop groups to a mailing list of 5,000 disabled persons, scientists, engineers, consumer groups, government agencies, universities, laboratories, small businesses, and the Congress. The *Bulletins* have been a vital link in joining the various target groups throughout the country, and allowing for individuals to write in relevant comments and share information about new resources.

At the beginning of the project, an Advisory Committee was selected to plan the workshop sequence and themes, present and participate in the workshops, and give continuing guidance. The whole Committee met at the beginning of the project, and subcommittees met at the time of each workshop. Advisory Committee members, all of whom worked in various areas of disability or who were themselves disabled, were selected to represent the following areas of expertise: *engineering; industrial design; rehabilitation medicine; basic research; economics; psychology; law; teacher training; small business; manufacturing; insurance; consumer organizations; administration and counseling in rehabilitation programs; university teaching and administration.* Advisory Committee members represented or worked in the disability areas of hearing impairment, visual impairment, mobility impairment, and vocal impairment. A listing of Advisory Committee members appears on page 213.

Group Discussions and Action Plans

The 1981 Workshops on Science and Technology for the Handicapped were a forum for the exchange of information and new ideas. Each workshop focused on one major theme: in La Jolla--"Issues in Technology for Daily Living," in Rochester--"Issues in Technology for Education," and in Minneapolis--"Issues in Technology for Employment." Although there was a natural overlapping of discussion from one workshop to another, ideas and action plans suggested by the participants will be listed under these three themes. The action plans are personal goals set by the participants to describe the activities they wished to pursue after the workshop which would lead to the improvement of technology used by disabled people. An integral part of each workshop were the group meetings at which participants identified problems in the theme area and discussed personal strategies for solving those and similar problems. Transcripts of two small group discussions held at the Minneapolis workshop are included as examples of group participation.

Group Discussion I

Following are the members of the group.

- Cathy Redd
  Student Counseling Bureau
  University of Minnesota
  Minneapolis, Minnesota

- George Patterson
  Employment Specialist
  Minnesota Services for the Blind
  St. Paul, Minnesota

- Paul Ashton
  Rehabilitation Psychologist
  3M Center
  St. Paul, Minnesota

- Steve Keppel
  President, United Handicapped Federation
  Minneapolis, Minnesota

- Dennis Maki
  Clinical Microbiologist
  ~~Virginia,~~ Minnesota

- Frank Johnson
  Advisor for the Elderly
  "Caring" Program
  Richfield, Minnesota

- Dick Juergens
  Adaptive Equipment Specialist
  Iowa State Vocational Rehabilitation Facility
  Des Moines, Iowa

- Renee Sandy
  Coordinator of Evaluations and Placements
  Courage Center
  Golden Valley, Minnesota

- Jenene Dillavou
  Counselor/Advisor
  Area 7, M.S. Service League
  Exceptional Persons, Inc.
  Waterloo, Iowa

- Graeme Mitchell Hopple
  Director of Adult Services
  Greene County Board of Mental Retardation/
  Developmental Disabilities
  Greene Inc.
  Xenia, Ohio

- Jim Dall

- Randy Black
  Academic Specialist
  University of Wisconsin
  Madison, Wisconsin

- Jack M. East
  Executive Director
  American Amputee Foundation Inc.
  Arkansas Rehabilitation Institute
  Little Rock, Arkansas

- Steve Wastvedt
  Personnel Administrator Specializing in
  Handicapped Programs for Control Data
  Control Data Corporation
  Minneapolis, Minnesota

JENENE DILLAVOU: Most employers are ignorant of the needs of the handicapped worker. The problem is how to make the employer aware of these needs and also to convince the employer that once these needs are taken care of, the handicapped worker will be a productive worker.

STEVE KEPPEL: Use money as an incentive. Tax breaks are the best way of doing this.

FRANK JOHNSON: Many smaller companies are not aware of the tax incentives which already exist.

JACK M. EAST: Any new write offs and tax shelters should be targeted at private enterprise and small business--they offer the most opportunities.

DENNIS MAKI: The problem with smaller business is that most of them haven't had any previous experience with handicapped workers and they are unwilling to take any chances.

GRAEME HOPPLE: One problem with tax incentives is that they involve too much paper work for small business to bother with.

JACK M. EAST: Doors will open if government will make it profitable to hire the handicapped. Money is by far the strongest incentive to business.

GRAEME HOPPLE: Placement agencies can do a better job of marketing the handicapped worker. They should also show business that it can be profitable to hire the handicapped. In the proper job the handicapped worker is comparable to any other worker.

DICK JUERGENS: A good way to market the handicapped worker is to have job fairs. Another way is to create a pool of workers and employers and then match them up. The proper match up is what's important because job readiness (in worker) is the key to success. Also, if the worker isn't able to perform well enough in his new job, the placement agency should take the brunt.

GEORGE PATTERSON: Job fairs work best for big business. A smaller business is suited for the worker who might need individualized modifications done in the workplace.

CATHY REDD: Dennis, what has your experience been?

DENNIS MAKI: I've been looking for a job for a year and a half. Many employers express an initial interest in me, then they find out I'm handicapped and their attitudes change. They seem unwilling to help solve any of the problems involved in hiring me. I've been forced to lower my standards and apply for jobs I'm overqualified for.

JACK M. EAST: Sometimes the handicapped person gives up too soon when job hunting. He should be aggressive despite his handicap--some employers are actually looking for this.

RANDY BLACK: The handicapped might try tactics similar to ones other minorities have used successfully, i.e., the legal system.

STEVE KEPPEL: It would be better to attack the attitudinal barriers of the employer than to thrash on it in court. Most attitudinal barriers that stand in the way of the handicapped stem from ignorance.

GRAEME HOPPLE: It's time for a more aggressive marketing approach. The soft sell approach hasn't worked well. A business's prime job is to make money, so prove to business that a handicapped worker can be a profitable worker.

GEORGE PATTERSON: Use the results of the various studies that have been done to document the potential of handicapped workers and add that to a package of tax goodies. Also, job placement agencies can play a major role in marketing the handicapped worker. They should make a better effort to share their information with each other.

RENEE SANDY: Placement agencies should also try to achieve a rapport with personnel departments in businesses.

GEORGE PATTERSON: It's important at some point to talk to employers and find out what they are looking for in prospective employees and how far they are willing to go to hire the handicapped. Then call upon the legislature to make the proper incentives--then use placement agencies to tie it all together.

GRAEME HOPPLE: Sometimes an employer makes certain modifications for a handicapped worker; then the worker quits. The employer gets burned if he can't hire another similarly disabled worker to fill the spot. I think it's important to guard against this happening.

In conclusion:

Each group member can organize some kind of seminar on the local scale, capitalizing on his or her particular area of influence and knowledge.

Each group member could benefit from forming a reference network composed of other group members they met while attending the workshop.

Handicapped persons should study their situation and isolate the reasons why they haven't been very successful in achieving their goals. Perhaps they could organize a political action group to be better heard by lawmakers.

It is important that handicapped people are trained in job seeking skills as well as in vocational skills.

Group Discussion II

Following are the members of the group.

- John Schatzlein
  Administrator and Counselor
  Homework Project, Control Data Corporation
  Minneapolis, Minnesota
- David McCaffrey
  Assistant Scientist
  Department of Physical Medicine and Rehabilitation
  University of Minnesota
  Minneapolis, Minnesota
- Dennis Nelson
  (formerly) Staffing Manager
  3M Center
  St. Paul, Minnesota
- Tim Sheie
  Teacher of Hearing Impaired Students
  Coon Rapids Junior High School
  Coon Rapids, Minnesota
- Dania Smith
  Vocational Rehabilitation Counselor
  Office of Vocational Rehabilitation
  Hempstead, New York
- Gerald A. Nelson
  Mechanical Engineer
  FluiDyne Engineering Corporation
  Minneapolis, Minnesota
- Doug Johnson
  Employment Specialist
  Minnesota Services for the Blind
  St. Paul, Minnesota

- Pam Tschida
  Employment Specialist
  Minnesota Services for the Blind
  St. Paul, Minnesota

- Paul Charlebois
  Administrator
  Saskatchewan Council for Crippled Children and Adults
  Saskatoon, Saskatchewan, Canada

- Robert Morrison
  Chemistry Professor
  East Carolina University
  Greenville, North Carolina

- Jacki Stalley
  Counselor
  Metropolitan Center for Independent Living
  Minneapolis, Minnesota

- Raymond Fulford
  Rehabilitation Engineer
  Courage Center
  Golden Valley, Minnesota

- Linda Gress
  Executive Director
  The Coalition for Disabled Persons
  Fargo, North Dakota

- Noel Anderson
  Coordinator of Vocational Services
  Minneapolis Society for the Blind
  Minneapolis, Minnesota

- Herb Evert
  Assistant Registrar
  University of Wisconsin
  Madison, Wisconsin

- Virginia Stern
  Senior Program Associate
  Project on the Handicapped in Science
  The American Association for the Advancement of Science
  Washington, D.C.

- Jiri Vasa
  Electronics Engineer
  Biomedical Engineering Unit
  Queen's University
  Kingston, Ontario

I. Session #1: Introductions and Sharing of Expectations

II. Session #2: Needs Identified

A. The need for a change in the attitudes about disabilities among employers and educators and for providing them with correct information.

1) There is a need to allay the fears of potential employers about the possible risks of hiring disabled persons.

2) There is a need to change employers' negative attitudes about deafness (as well as other disabilities).

3) There is a need to find more experiential on-the-job learning sites for deaf students (as well as other disabilities) because of employer resistance to such learning experiences.

4) Because many physically disabled persons also have emotional problems, there is a special need to change negative employer attitudes about this group of disabled persons.

5) There is a need to change educators' attitudes about disabilities in order to insure the equal treatment of disabled persons in educational programs (e.g., blind students in chemistry labs).

B. The need for better communication between counselors and potential employers in the job placement process.

1) There is a need for employers to describe in detail various jobs in their companies as to job duties, worker characteristics, and critical skills needed; this would serve to help counselors be better able to match jobs with the most qualified clients.

2) There is a need by employers to know where to find qualified disabled persons to fill job openings and to know the best ways of recruiting them.

3) There is a need among counselors to know which person in a given company is the best person to approach for providing general information to the company about disabled workers in general and which person is the best to approach when trying to place a specific client.

4) There is a need for more direct client advocacy with potential employers by counselors when they are placing clients.

C. The need for the development of technology-oriented training opportunities for the disabled.

1) There is a need among deaf clients to develop better reading skills to prepare them for jobs in a growing technology that emphasizes the written word (i.e., computers, word processors, etc.)

2) There is a need to produce from training programs disabled graduates who are flexible because they have acquired many different skills rather than one skill, as in the past.

3) There is a need for more education in the sciences and in technology for deaf clients (and other disability groups) and for a change in public attitudes about the ability of deaf students (and other disability groups) to learn about these areas and use this kind of learning in future jobs.

4) There is a need for disabled persons to have greater access to training programs in general.

D. The need for the improvement in the cost-effectiveness of assistive devices and for educating clients and employers about the cost-effectiveness of devices.

1) There is a need to show employers that paying for adaptations and assistive devices and the use of personal aids for disabled persons is truly cost-effective for companies.

2) There is a need to call employers' attention to the adaptations that are frequently made for able-bodied employees as indicative of the cost-effectiveness of similar modifications for disabled employees.

3) There is a need to find better ways to measure cost-effectiveness in engineering services.

4) There is a need for a greater mass production of devices in order to improve their cost-effectiveness.

E. The need for improvement in the training of counselors and job supervisors.

1) There is a need for counselors to learn more about technological advances in devices so that they will know how to place clients in the best possible jobs.

2) There is a need for counselors to think more about transferable skills.

3) There is a need to advocate for the development of more assistive devices for the skilled, blue collar workers.

4) There is a need in work settings where there are a number of employees with different disabilities to cooperate by mutually sharing their abilities in order to help each other compensate for limitations.

5) There is a need for counselors to help disabled persons believe in the importance of their being efficient in their work, and, therefore, of value to an employer and also to believe in the importance of their being "competitive" workers.

6) There is a need to keep some low-paying, sheltered workshop jobs for persons who will never be able to do "competitive" work because of the strictly therapeutic value of such jobs.

7) There is a need to be realistic about the limitations of disabled clients and to not deny that their disabilities do exist.

F. The communication needs of engineers--among themselves, with their clients, and with employers.

1) There is a need for engineers to communicate better with clients when discussing the cost of their services.

2) There is a need for engineers developing assistive devices to communicate better among themselves in order to avoid duplication of effort and to anticipate better the costs of development.

3) There is a need for engineers to follow the "KISS" (i.e., "Keep it simple, stupid") principle so that the simplest and cheapest methods will be developed for assistive devices.

4) There is a need for the development of methods for orienting and training clients in the proper use of mass-produced assistive

devices; this will also help keep clients' expectations realistic about such devices.

III. Session #3: Sharing About What is Already Being Tried to Meet Needs of the Disabled in Employment

A. Dania Smith reported on the New York State DVR placement unit's recent day-long training session for the State Power Authority to help improve plant managers' awareness about disabled persons and about affirmative action as it relates to handicapped individuals. It involved:

1) Sensitivity exercises concerning disability.

2) An explanation of the #503 and #504 regulations and their implementation.

3) Role play interviews with three disabled clients conducted by plant managers, with the opportunity for mutual feedback.

4) A very non-threatening atmosphere where managers could analyze their feelings about the disabled and deal with fears about asking embarrassing questions during interviews.

B. Dennis Nelson reported about how the 3M Company has developed Focused Interview Training (FIT) for supervisors.

1) Its purpose is to teach supervisors who will be interviewing job applicants how to keep their interviews focused on the requirements of the job and how to match the job with the best applicant.

2) It also helps desensitize supervisors about their fears of possible lawsuits resulting from asking illegal questions during their interviews.

C. A deaf participant who is working in industry reported that he has decided to return to school and enter the field of business administration and seek work as a supervisor in industry.

1) He feels that deaf people working in private industry are "stuck" because without the necessary assistive devices and adaptations they cannot seek better jobs in their companies; lack of training opportunities is another reason why they feel "stuck."

2) Since the rehabilitation system will not advocate for them, they must become their own advocates.

3) However, because this participant fears hurting himself personally and professionally by advocating as an employee, he has decided to enter business administration and look for ways to "marry private industry to rehabilitation."

D. Herb Evert reported on the positive effects of hiring the first disabled person in the Registrar's Office at the University of Wisconsin at Madison.

1) Initially, his office was forced to hire a blind applicant because of Regulation #504.

2) Because of the many adaptations that had to be made in his office, for a visually-impaired person (e.g., a computer terminal with a

Braille printer), when the first blind person who had been hired died suddenly, it was to the employer's advantage to look for another blind person for the job.

3) The excellent work done by the second blind employee, as well as the writing done by the University's research faculty about disabled workers after the hiring of the blind employee, resulted in a great reduction in employer resistance to handicapped employees at the University.

4) Since the hiring of the first blind employee, the Registrar's Office has also hired a paraplegic and an amputee.

E. John Schatzlein reported on a variety of programs relating to disability that the Control Data Corporation has developed. They include:

1) The Plato System (an educational computer system with interactive capabilities for students in a wide range of settings covering a wide range of course areas) which is being used by CDC supervisors for sensitivity training and is also being offered to other companies for the same purposes.

2) All employees who are out on short-term or long-term disability have access to a rehabilitation counselor and can develop career change plans either through the Plato System or job-improvement training while out of work so that when they return to work they are prepared for a better job.

3) The Homework Project, which is a computer program that is used on an interactive terminal in the client's home to teach her/him computer programming. (Used by CDC employees on long-term disability or medical leaves or by DVR clients, clients in rehabilitation facilities, and others.)

4) Employee Advisory Resource (EAR) which is a 24-hour hotline offering all CDC employees throughout the country access to legal, rehabilitation, financial, and other social services.

5) Stay Well Program, which is a health prevention education program for CDC employees and also sold to other companies, covering such areas as stress, use of alcohol and other drugs, smoking, and weight control.

F. Jiri Vasa strongly urged participants who had reported on the above programs that have already been developed to agree to publish conjointly about those efforts so that a larger number of rehabilitation professionals, supervisors in industry, and disabled employees can be informed of those programs.

La Jolla: Issues in Technology for Daily Living

Action Plans

- Develop a working relationship with the engineering community to use technology available in problem solving for mobility, recreation, and assistive devices for children with physical disabilities.

- Create a San Diego County area coalition of individuals for the sharing of ideas on technology

- Publicize available resources, e.g., ABLEDATA and Project Threshold, through articles describing these services as well as new technology.

- Establish a non-profit disability device design group that will provide a conduit for disabled researchers to receive financial support and needed facilities to pursue their ideas and still retain rights to the device that is developed.

- Start interdisciplinary continuing education courses with the engineering and health field departments.

- Plan and build a health improvement (i.e., rehabilitation) center at a community college.

- Contact another participant of this workshop and work together to initiate an engineering project, similar to that at San Diego State, at California State University, Long Beach, to interest engineers in disability issues.

- Make adaptations of laboratory courses (basic physical science and biology) for maximum access by disabled and able-bodied students.

- Meet with Barrier Breakers Club and Special Needs Office at the community college to identify areas where our local level of technology can be applied.

- Incorporate into the teacher training curriculum information about technology/design for disabled people.

- Take two physically disabled persons to explore the local "Do It Yourself" stores, including a hardware store, lumberyard, hobby shops, electronic store, and surplus equipment store.

- Meet with science and technology, social science, and business divisions at the community college to get a dialogue going about technology needs of disabled persons and new ideas for solutions.

- Search for funding to support adaptation of equipment to better serve disabled students in science courses.

- Develop a counseling program about careers in science and engineering for disabled students.

- Write up a student proposal to design a fishing aid for a person in a wheelchair.

- Visit and observe local school with classes for disabled children to determine specific items needed by students. Forward this list to the university engineering department to be used for student projects.

- Form an information network of people with technical background to help solve problems that arise in local wheelchair repair shop.

- Go skiing in an *Arroya* sled. Looks fun!

<u>Rochester: Issues in Technology for Education</u>

<u>Action Plans</u>

- Disseminate information regarding questions and needs of disabled students to the local Apple Users Club.

- Develop computerized language equipment which will allow students to learn a foreign language and assist aphasic patients in communication.

- Disseminate specific information from workshop through Computer Oriented Information Network (COIN), coordinated at Western Pennsylvania School for the Deaf, 412/371-7000 x72.

- Develop manual of assistive devices for New York State Office of Vocational Rehabilitation, for use by vocational rehabilitation counselors, clients, and administrators.

- Coordinate with Little People of America in efforts to update an aids directory, including devices useful to Little People in science, e.g., chairs, stools, reachers.

- Improve controls modification to make artificial larynges and voice amplifiers more easily used by multiply handicapped individuals.

- Prepare paper on need for creation of regional engineering support centers for prototyping of design ideas, particularly for designers without sufficient institutional and/or grant support.

- Contact local universities to determine if there are students with needs that can be fulfilled by technical solutions either commercially available or to be designed. Transfer information to students on what is available and transfer problems to design staff for work on solutions.

- Prepare a professional journal article on modifications of physical geology laboratory exercises for disabled college students.

- Set up two-day training with NTID telephone department on how to use the loop system in an auditorium and how to use the phone amplification system.

- Test market and field test system for captioning existing motion pictures, developed for classroom use at NTID with cooperation of Research Department, National Film Board of Canada.

Minneapolis: Issues in Technology for Employment

Action Plans

- Hire able-bodied students to work with me, a severely disabled individual, in my business so that they may have an understanding of disability when they grow up and become employers themselves.

- Translate publication of Swedish Institute for the Handicapped entitled, "Idea Book of Technical Work Aids for Disabled Persons."

- Coordinate computer programs that will assist in the communication (vocal or non-vocal) of persons who lack motor coordination and/or are vocally impaired.

- Seek out hearing impaired members of the work force to speak to my hearing impaired secondary school students about careers.

- Ask my company to publish stories of disabled employees' use of technology in our internal newsletter.

- Instruct the administrators at the university where I work on job adaptations so that they may employ more blind and visually impaired students.

- Invite disabled children and their parents to discuss the use, adaptation, and repair of wheelchairs with the rehabilitation engineers who work at Children's Hospital.
- Serve as a role model and career counselor to disabled high school youth, sharing my own experiences as a severely disabled person working in science.
- Develop an information exchange between my company, vocational rehabilitation office and local Projects with Industry to secure employment of disabled people.
- Devise a system to demonstrate cost-effectiveness of devices to employers of mobility-impaired people.
- Develop a list of local engineering personnel engaged in adaptive equipment and product design.
- Inform my personnel department of the support systems which are available for newly-disabled people.
- Describe the resources offered at our center on job adaptations and technology to local personnel directors.

WORKSHOP ON SCIENCE AND TECHNOLOGY
FOR THE HANDICAPPED

May 11-12, 1981

ISSUES IN TECHNOLOGY FOR DAILY LIVING

La Jolla Village Inn, La Jolla, California

presented by

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS)

with support from

THE NATIONAL SCIENCE FOUNDATION

* * *

Monday, May 11

8:30 - 9:00 a.m.	Registration
9:00 - 9:15 a.m.	OPENING SESSION Introductory Remarks: *Martha Redden,* Director, Project on the Handicapped in Science, AAAS Welcome: *Harriet Kopp,* Acting Dean, College of Human Services, San Diego State University
9:15 - 11:00 a.m.	PANEL PRESENTATION: "Daily Living Technology for the Disabled: Can it be a Viable Business?" *Barry Unger,* President, Innovation Support *John Rogers,* Medical and Engineering Consultant, Rogers and Associates *Martin Frank,* Senior Vice President, Marketing and Government Relations, Abbey Medical/Abbey Rents, Inc.

(continued on next page)

James Marsters, Orthodontist and President, Applied Communications Corporation
George Chandler, District Director, U.S. Small Business Administration
Vernon Nickel, Professor of Surgery/Orthopedics and Rehabilitation, University of California, San Diego and Director of Rehabilitation, Sharp Rehabilitation Center

11:00 - 11:30 a.m.	Coffee Break
11:30 - 12:30 p.m.	SMALL GROUP DISCUSSIONS Leaders: *Don McNeal*, Co-Director, Rancho REC, Rancho Los Amigos Hospital *Barry Unger*, President, Innovation Support *Ray Lifchez*, Architecture Professor, University of California, Berkeley
12:30 - 1:30 p. m.	Lunch
1:30 - 1:45 p.m.	"Psychological Aspects of Rehabilitation Engineering" *Carolyn Vash*, Vice President, Institute for Information Studies
1:45 - 3:00 p.m.	PANEL PRESENTATION: "An Engineering Department Looks at Technology for Disabled Persons" *Robert Murphy*, Professor of Mechanical Engineering, San Diego State University *David Ussell*, Adjunct Professor of Mechanical Engineering, San Diego State University and Coordinator of Biomedical Engineering at Children's Hospital *Mitch Hart*, Student, San Diego State University *Robert Cunningham*, Student, San Diego State University
3:00 - 3:30 p.m.	Coffee Break
3:30 - 5:00 p.m.	SMALL GROUP DISCUSSIONS
6:30 - 7:30 p.m.	Reception
7:30 p.m.	Dinner Speaker: *Vernon Nickel*, Professor of Surgery, Orthopedics and Rehabilitation, University of California, San Diego Director of Rehabilitation, Sharp Rehabilitation Center, San Diego

Tuesday, May 12

8:30 - 10:00 a.m.	PANEL PRESENTATION: "Technology for Recreation"	*Chester Land,* Director, Recreation Therapy, Rancho Los Amigos Hospital, Downey, California *Roy Gash,* Community Services Center for the Disabled, San Diego *Marti Hacker,* Peer Counselor, Community Services Center for the Disabled, San Diego *Marri Taylor,* Community Worker, Community Services Center for the Disabled, San Diego *Peter Axelson,* Rehabilitative Engineering Research and Development Center, Palo Alto
10:00 - 10:15 a.m.	Coffee Break	
10:15 - 12:15 p.m.	SMALL GROUP DISCUSSIONS	
12:15 - 1:15 p.m.	Lunch	
1:15 - 3:00 p.m.	PANEL PRESENTATION: "Technology for the Living Environment"	*Raymond Lifchez,* Architecture Professor, University of California, Berkeley *Larry Leifer,* Mechanical Engineer, Design Division, Stanford University and Director, Rehabilitative Engineering Research and Development Center, Palo Alto *Heidi McHugh Pendleton,* Project Threshold, Rancho Los Amigos Rehabilitation Center, Long Beach *Cheryl Davis,* Berkeley
3:00 - 4:00 p.m.	Wrap-Up	
4:00 p.m.	Adjourn	

WORKSHOP ON SCIENCE AND TECHNOLOGY
FOR THE HANDICAPPED

July 9-10, 1981

ISSUES IN TECHNOLOGY FOR EDUCATION

Rochester Institute of Technology (RIT), Rochester, New York

presented by

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS)

with support from

THE NATIONAL SCIENCE FOUNDATION

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Thursday, July 9

8:30 - 9:00 a.m.	Coffee and Registration
9:00 - 9:15 a.m.	OPENING SESSION Welcome: *Jack Clarcq,* Associate Vice President, Technical Assistance Programs, National Technical Institute for the Deaf, Rochester *Martha Redden,* Director, Project on the Handicapped in Science, AAAS
9:15 - 10:30 a.m.	PANEL PRESENTATION Chair - *Ed Cain,* Rochester Institute of Technology "Low-Budget Ideas for the Visually Impaired in Science" *Dorothy Tombaugh,* Travelling Science Consultant, Lyndhurst, OH

(continued on next page)

"Modifications of Effective Teaching of Handicapped Students"
Robert Menchel, National Center on Employment of the Deaf, Rochester

"Talking and Voice-Entry Computers for the Chemistry Lab"
David Lunney, Professor of Chemistry, East Carolina University, Greenville, NC
Richard Hartness, Department of Chemistry, East Carolina University, Greenville, NC

10:30 - 11:00 a.m. Break

11:00 - 12:30 p.m. SMALL GROUP DISCUSSIONS
Leaders: *Michele Aldrich*, Project on Women in Science, AAAS
Ed Cain, Rochester Institute of Technology
Cricket Levering, Project HEATH, American Council on Education, Washington, DC

12:45 - 1:45 p.m. Lunch

2:00 - 2:30 p.m. "Laboratory Techniques for Orthopedically Impaired Students"
Dorothy Tombaugh, Travelling Science Consultant, Lyndhurst, OH

2:30 - 4:00 p.m. TOUR OF EDUCATIONAL TECHNOLOGY AND OTHER PROGRAMS
Coordinator: *Ella Ford*

4:00 - 5:00 p.m. SMALL GROUP DISCUSSIONS

6:30 - 7:00 p.m. Reception and Dinner
"Technology Over the Horizon"
Larry Leifer, Director, Rehabilitative Engineering Research and Development Center, Palo Alto, CA

Friday, July 10

8:00 - 9:00 a.m. Breakfast

9:00 - 10:30 a.m. PANEL PRESENTATION
Chair - *Martha Redden*, Director, Project on the Handicapped in Science, AAAS

"Disabled Educators Project"
Diane Merchant, American Association of Colleges for Teacher Education, Washington, DC

"Creating Accessible Programs: Some Guidelines for Identifying Needs and Selecting Assistive Devices for Handicapped College Students"
Roy Nord, National Association of College and University Business Officers, Washington, DC

"Technology Utilization in Mainstreaming"
Robert Hall, Northside Surgical Supply, Rochester

10:30 - 10:45 a.m.	Break
10:45 - 11:45 a.m.	SMALL GROUP DISCUSSIONS
11:45 - 1:00 p.m.	Lunch
1:00 - 2:30 p.m.	PANEL PRESENTATION: "Technology in Education for the Hearing Impaired" Chair - *Douglas Sargent*, National Technical Institute for the Deaf, Rochester

"Acoustic and Vibrotactile Aids for the Hearing Impaired"
Linda Palmer, National Technical Institute for the Deaf, Rochester

"Computer-Assisted Lipreading Training for the Deaf Using the Dynamic Audio Video Interactive Device (DAVID)"
Donald G. Sims, National Technical Institute for the Deaf, Rochester

"Closed Captioning of Motion Picture Film for Use on National Television and for Delayed Broadcast by Affiliates"
Robert H. Murray, National Technical Institute for the Deaf, Rochester

"The Use of Speech Displays with the Hearing Impaired"
Judy L. Braeges, National Technical Institute for the Deaf, Rochester

2:45 - 4:00 p.m.	SMALL GROUP REPORTS AND ACTION PLANS
4:00 p.m.	Adjourn

WORKSHOP ON SCIENCE AND TECHNOLOGY
FOR THE HANDICAPPED

September 14-15, 1981

ISSUES IN TECHNOLOGY FOR EMPLOYMENT

University of Minnesota, St. Paul, Minnesota

presented by

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS)

with support from

THE NATIONAL SCIENCE FOUNDATION

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Monday, September 14

8:30 - 9:15 a.m.	Registration
9:15 - 9:30 a.m.	OPENING SESSION Welcome: *Martha Redden*, Director, Project on the Handicapped in Science, AAAS
9:30 - 10:15 a.m.	Keynote Address: "Considerations in Choosing Technology for the Job Site" *Nancy Crewe*, Associate Professor, Department of Physical Medicine and Rehabilitation, University of Minnesota
10:15 - 11:15 a.m.	"Skid Loader Modifications for a Quadriplegic Farmer" *Ian Hofford*, Farmer, Kingston, Ontario *Jiri J. Vasa*, Electronics Engineer, Biomedical Engineering Unit, Queens University, Kingston, Ontario, Canada

11:15 - 11:45 a.m.	Coffee Break
11:45 - 12:30 p.m.	SMALL GROUP DISCUSSIONS
12:30 - 1:30 p.m.	Lunch
1:30 - 2:30 p.m.	"The Development of a Workplace for a Visually Impaired Information Specialist: One Case" *Randy Black,* Academic Specialist, University of Wisconsin, Madison, WI *Herbert D. Evert,* Assistant Registrar, University of Wisconsin, Madison, WI
2:30 - 3:30 p.m.	"Barrier Free Office Design" *Jack M. East,* Executive Director, American Amputee Foundation, Inc., Little Rock, AR
3:30 - 4:00 p.m.	Coffee Break
4:00 - 5:30 p.m.	SMALL GROUP DISCUSSIONS
5:30 - 7:00 p.m.	Reception, Exhibits, Socializing Dinner "Innovations in Adaptive Equipment and Job Site Modifications" *Don R. Warren,* Wisconsin Institute of Applied Technology

Tuesday, September 15

9:00 - 9:15 a.m.	Announcements
9:15 - 10:15 a.m.	"Employment for Disabled Individuals: Skills Needed to Meet the Needs of Employers" *Jack R. Clarcq,* Associate Vice President, Technical Assistance Programs, National Technical Institute for the Deaf, Rochester, NY
10:15 - 10:45 a.m.	Coffee Break
10:45 - 12:00 noon	SMALL GROUP DISCUSSIONS
12:00 - 1:00 p.m.	Lunch
1:00 - 2:00 p.m.	"Use of the Computer as a Multi-Task Tool By a Vocally Impaired Accountant" *James R. Carlisle,* Licensed Public Accountant, Carlisle Accounting Services, Minneapolis *Raymond Fulford,* Director, Rehabilitation Engineering Program, Courage Center, Golden Valley, MN

2:00 - 3:30 p.m.	"Access to the Total Work Environment"
	Raymond Lifchez, Professor of Architecture, University of California, Berkeley, CA
3:30 - 4:00 p.m.	SMALL GROUP REPORTS AND ACTION PLANS
4:00 p.m.	Adjourn

Presentations

1 Issues in Technology for Daily Living

Panel

Daily Living Technology for the Disabled: Can It Be a Viable Business?

Following is the list of participants and their respective affiliations:

- Barry Unger
  President
  Innovation Support
  Arlington, Massachusetts

- John Rogers
  Medical and Engineering Consultant
  Rogers and Associates
  Anaheim, California

- Vernon Nickel
  Professor of Surgery/Orthopedics and Rehabilitation
  University of California at San Diego, and
  Director of Rehabilitation
  Sharp Rehabilitation Center
  San Diego, California

- Martin Frank
  Senior Vice President of Marketing and Government Relations
  Abbey Medical/Abbey Rents, Inc.
  Hawthorne, California

- James Marsters
  Orthodontist, and
  President
  Applied Communications Corporation
  Pasadena, California

- George Chandler
  District Director
  U.S. Small Business Administration
  San Diego, California

BARRY UNGER: I'm going to let our panel introduce themselves when they give their presentations.

The panel has two names: "The Business Side of Producing or Distributing Technology for the Disabled" or if you're more of a pessimist, "Can Daily Living Technology for the Disabled Be a Viable Small Business?" We're hoping that this will be of interest to you, that ~~many of you have thought about or are inter-ested~~ in producing technology for the disabled. The production and distribution of technology for disabled people would be a small business, with all the attendant problems in that area. So I've asked the panel to sort of tell us their problems today, not their successes, so you'll get a fair idea of what's involved. All of our panelists in one form or another have been involved with running businesses devoted to producing the technology that disabled people would use.

We also hope that from this meeting we will get useful input that we can deliver back to Washington, in terms of our national policies. Do they help the creation of businesses that produce technology for the disabled, or are they really, despite all best intentions, not working?

We are looking at the question more and more of who produces the innovative and appropriate technology. Is it our universities? Is it our IBMs? Numerous studies in the last 20 years have shown again and again that independent inventors and small businesses are the predominant producers of the new, innovative technology in this country.

Just to give you a few examples, separate from the disabled area, the automatic transmission was not produced or developed by General Motors. Instant cameras were not developed by Kodak. Minicomputers, large integrated circuits were not developed by IBM. Basic oxygen steelmaking, the prime method in steelmaking, was not developed by U.S. Steel. And the list goes on and on to all sorts of antibiotics or pesticides or whatever.

I won't throw a lot of statistics at you, although there are pages and pages of statistics on this subject. I'll give you one statistic that is critically appropriate since the National Science Foundation is paying our bills today. An NSF study done about four years ago showed that smaller firms have been responsible for over half of all major industrial innovations since World War II.

Now why am I talking to you? I guess I'm saying that one of the things we're doing here is consciously recognizing that when we're talking about technology for the disabled, we're really talking about small businesses.

This past year I visited the Sensory Aid Center in the Justice Department in Washington. They've got about three rooms filled with all sorts of equipment for the visually-impaired and deaf. They've just stockpiled it, and are evaluating and testing it. Then they advise other government departments on which pieces of equipment are worth buying.

With the exception of several electric typewriters, with an obvious big company name on them, all the rest of the equipment came from very small companies, such as our computer products, Telesensory Systems, and smaller firms that I'd never heard of. It really occurred to me how important, in this area of producing technology for the disabled, are small businesses.

There are a lot of reasons. People say that small businesses don't have marketing clout, and they have to have innovative products to get them going. They've got to be smart to make money and sell their products. In many cases small companies are developed by somebody just to get an invention going. I think that's true of some of the cases we'll hear today.

In other cases, it's been said that the marketing plans of large companies dictate that technical improvements to their products be held to a minimum, because if they have to retool it will cost them money. This has been said about our steel companies. It's also true of some of the firms in the wheelchair business. They've tried to keep technical improvements in their products to a minimum because it would just be a financial loss to them to start trading in new products requiring new tooling, etc. Therefore, I think it's clear that it's your small businesses that are your source of technology for disabled people.

The question, then, is what care and feeding do these small businesses require?

The AAAS held a conference like this in Boston this past September, and the feeling there was very upbeat. It was felt that with a little research and development help from the government in terms of research contracts and research grants and with some fair tax laws that encourage people to make investments, such companies producing technology for the disabled have a good chance at making it to a self-sustaining state. Maybe if the government put in money at the beginning, to help with the high cost of developing a product, then the business would make it.

I'm not sure if we were properly optimistic, because we were talking about things that had fairly large markets, like a device that would be useful for a large number of blind people. We're beginning to talk critically as we get into multiple handicaps and daily living things where the markets may be much smaller. Certainly times are changing. Government funding is now decreasing. Money is very tight, even if a company wants to get loans. It's getting tougher every day. In addition, some of the needs we're beginning to talk about, i.e., daily living needs, may not be so easily reimbursable. They're not a clear educational or vocational expense.

I've asked the panelists to talk about their businesses as businesses, how they pay the rent, their financial and marketing history, strategies they've used to keep going, where they've depended on government funds, and any difficulties in getting their product approved by third-party reimbursers and then paid for. We have problems in Massachusetts. I understand it's similar in California. There are many issues, e.g., how to deal with the market, strategies of customizing products or, conversely, mass selling products. Also of issue are any difficulties in reaching customers and letting customers know that the product is available.

Each person is going to introduce himself. In addition to our three inventor-entrepreneurs, we also have Mr. George Chandler, who is the district director of the Small Business Administration for this part of California. He'll talk about the programs the Small Business Administration (SBA) may have, particularly for disabled people starting businesses. We've also been fortunate to get Vernon Nickel, who has seen a lot of companies in this field, both good and bad ones. He has seen them come and seen them go.

Mr. Rogers, would you like to start us?

JOHN ROGERS: I started out in the power field many years ago, and then became a little disenchanted with the corporate infighting and went into OB-GYN childbirth training, which is pretty much akin to engineering. I was fortunate, or unfortunate, to have some people that worked for me in aerospace linked to Rancho Los Amigos Hospital. I went there for a week and I stayed 10 years.

My talk today is directed toward the problems involved in product conception, research, development and marketing.

My viewpoint is biased as are the products I have developed. They are in the marketplace, not as revisions or rehashes of existing products, but rather as devices based on new concepts.

In order to develop any product an idea of need is first established. Our problem is to define what is a "requirement" and what is a "desirement." To illustrate this point, I developed a device for a physician who said the marketplace was wide open for such a device. As you may have already guessed, I had a grand marketplace of *ONE*--too little return for a large investment of both time and money. So we must first consider what are the basic needs, development costs, timing and potential marketplace. If a person like myself has to develop a product from conception to finished item, then that person had better define the total program or a lot of time and money may be wasted. Keep in mind that you can have the greatest device known to man but if it is not properly protected and marketed it will forever abide in your closet.

Getting back to my initial point of defining need, it is of prime importance to establish the needs of handicapped people by considerable investigation that includes input from disabled individuals as well as your own observations. When it looks as if a new device will resolve the problem, then a proper set of specifications, suitable for manufacturing, must be prepared if you or a friend are unable to build a pre-prototype.

Note the word "pre-prototype." Some may refer to this as a "breadboard" or "brass board." Even armed with a pre-prototype, the cost of manufacturing a "manufacturing-ready" or production model may be expensive. Always keep in mind your own protection. Written disclosure signed by witnesses and presented to a patent attorney will provide you with some protection until a patent is applied for. This is your only protection. Copyrights are not applicable to products. And, contrary to some opinions, patents will not inhibit distribution. It is rather the opposite in most cases. If you are to transfer your rights to a large company, they will not even talk to you if you don't have coverage. On another point about patents, it is common knowledge that court resolutions are very slow and legal maneuvers by attorneys can drag a case on for years, but the attorneys must be paid--by who?

So you think you have a great idea and want to make a prototype. Have you thought about funding? Who is going to develop your device? Detailed research is mandatory if a complicated process is involved. Then, with all parameters developed by the researcher, how do you turn these parameters into hardware? You need a designer who has knowledge of manufacturing tolerances.

If you are fortunate, you have a large bankroll, work in a government-funded project or have friends willing to back you.

If you are like many, you have to approach a government agency--with their myriad of requirements--or your banker. Now you get very depressed. Interest rates are high. Your collateral is low and research and manufacturing costs are escalating at such a rate that firm quotes are time-limited. Most lending institutions are not speculative and unless you have some track record you stop here. You may be able to put your savings and/or home up as collateral; however, most people will feel a little skittish as they want something to "fall back on." If you can raise venture capital, be prepared to give away a large portion of your ownership.

So you are now able to get money together and get a prototype made for production. You may even have a number of prototypes made and farmed out for evaluation and, unless you are an exceptional person, you will have to foot the bill for redesign and another evaluation--and so on.

Now you have all the bugs out and your product is ready for manufacturing. What investment have you made and what return are you expecting? If you are having someone else manufacture, what is their cost to finish and package? Does this include liability insurance? After all, are you going to pay any suits that may be aimed at your device? You must be protected or your manufacturer must be protected as suits are passed on these days to everyone the attorneys can lay claim to.

If you are going to do your own manufacturing you should be prepared to live without salary for two to three years as a rule-of-thumb. Regardless of how you are subsidized, you have to get your money back with interest that at least equals the return on your savings plus enough to cover inflation. Remember a large chunk of inflation is due to salary increases and if you are collecting a salary for yourself, your income must exceed the inflationary rate to stay ahead. If it doesn't, you may as well keep your money in a high-interest account, buy oil, gold or energy-related investments and keep your job.

With your own manufacturing there are not only salaries to consider, but also rents, utilities, capitalized equipment, materials, tools, legal and accounting fees, insurance fees, cars, gasoline, repairs, office equipment, retirement benefits, etc. All this without any return from your sales for at least two months with today's methods of payment. A small business doing $100,000 in sales per year would, we hope, have material costs of less than $48,000. Using that number, this business has to then pay out $4,000 a month to their suppliers even if they don't turn that material around immediately.

Let's assume you have gone through all these setbacks and are now ready to sell. If you are making wheelchairs or other regularly-accepted devices you may wish to open your doors and sell directly to the end user. If you elect to go through a dealer you will lose half your income immediately, assuming you sell the same number of devices. This is because the so-called "middle man" or dealer may wish to make 100% on his costs; this depends on the type of device and *his* overhead.

Marketing then becomes a prime consideration. The possibilities are mail order, direct sales with your own sales force, or through established dealers or distributors. Mail order seems to be a neat way, with little overhead and no markup. But, there is limited exposure when using direct-mail advertising for mail order, as not everyone reads their mail, and you cannot always contact the "buyer."

Direct sales require samples and salespeople with attendant traveling expenses. With dealers or distributors, you are paying for their exposure, advertising, mail-outs, brochures, personnel, etc. You are competing with other products purporting to do the same thing and internal conflicts of interest for dealers result: do we make more by selling this, or the other one? What are delivery problems. Can one manufacturer drop ship and thus require low inventory? Will consignment work?

Now that you have heard all this, I am sure you will all want to rush out and start selling new products for the handicapped.

It is very hard to meet all business requirements and still make a reasonable living, especially with a limited marketplace like that for handicapped people, unless you are going to sell throwaway items like mattress covers. The portion of the market you can capture may be small when you consider how many companies are trying to penetrate this particular market and how many competitors have considerably more money available than you do.

BARRY UNGER: What are the products you're most associated with?

JOHN ROGERS: I'm sort of a specialist in tissue breakdown prevention, which I established at Rancho Hospital. I am also known for introducing the concept of measuring pressure profiles and stopping tissue from breaking down. I'm a consultant primarily with a number of physicians now. I just consulted on a new wheelchair coming out, which I'm excited about, and I have a new piece of dental equipment I'm working on. I also have a new matrix for some orthopedic surgeons.

QUESTION: How do you find potential customers?

JOHN ROGERS: Well, that's another problem. You try and get mailing lists. Some companies make a profession of compiling mailing lists, but they don't necessarily give you good mailing lists. You really have to have the direct contact. I think we know of two or three mail order houses that have disabled persons' names.

BARRY UNGER: What is your mode of business? Does a doctor contract with you to produce a certain wheelchair or device for a patient?

JOHN ROGERS: Yes, partly that, yes.

BARRY UNGER: And you're reimbursed, or allegedly reimbursed, by?

JOHN ROGERS: By the doctor. He's got the money.

VERNON NICKEL: There is one thing you left out that is very important. Why does anyone want to be independent? You've listed all the negatives, what are the positives?

JOHN ROGERS: Being independent.

VERNON NICKEL: Right. What else?

JOHN ROGERS: First of all, as an engineer, you have a challenge to solve a problem. This was primarily my goal. It was a long goal, and you have to sway that a little bit with your desirement and your requirement. You've got to make money. I am getting to where I should retire, but I don't have that much of an income to be able to do that. I should have thought about the money aspect, and really pushed the type of thing that would give me the most return.

VERNON NICKEL: There are many advantages. The other thing that permeates through this is that it is somewhat sinful to make money off handicapped people. That's one of the most evil things that can happen, because everybody that doesn't make money goes absolutely belly up. A $500 splint might save a person some months in the hospital, or special cushions and things. Through this needs to permeate a new attitude that profit is the way of life. If you don't make a profit, nobody gets anything. It's just that simple. I think that there ought to permeate a very positive viewpoint that it's got to be a profitable business or there is no business.

BARRY UNGER: I think one of the key issues is, can you make a profit? Do you keep open competition going in an area? It's open competition that really assures that the profits are not excessive, and that the best product is winning. One of the things we're hopeful for is that we're presenting a panel of people who are not the consumers, but the producers and yet it turns out that the producers and the consumers are not all that far apart. It's not necessarily an antagonistic relationship. We're dealing with people who are sensitive to the issues of this field, and the issue of profit is what allows them to do things that are useful. You don't have your usual dichotomies.

QUESTION: I have a question for Mr. Rogers. You say you're ready to retire, and you don't have that much money. Do you find your basic business policy changing with that in mind?

JOHN ROGERS: Sure.

QUESTION: What do you do differently?

JOHN ROGERS: I'm looking more to saving money, and trying to make the business more profitable; which I should have done in the first place. I wasn't a businessman, you see; that's one of the problems you're faced with as an inventor.

QUESTION: Did you have a problem with other companies using your designs or stealing parts from it?

JOHN ROGERS: Yes, I've had six companies start out with my ideas, unfortunately, which is a very hard thing to live with. It's the way of life; you have to expect that. I guess that's a compliment, but it really does take away your income. I don't know how you protect that. I guess you just have to keep ahead of the game, coming out with something new all the time. It's very hard. I feel a little bitter about it.

It's not all that bad. If you have university affiliation or you can get somebody to subsidize you for a while or you have some associates somewhere, and you can interest a big company, you can do it all right, but it's hard.

BARRY UNGER: Thank you. Our next speaker is Martin Frank of Abbey Medical/Abbey Rents, and he'll continue on this. Introduce yourself a little bit.

MARTIN FRANK: My name is Martin Frank. I'm only recently with Abbey Medical. I spent 31 years as an independent distributor of medical equipment. Much of what John says is true, although the job is not an unsalaried job. I enjoyed a salary of $20 a week for the first five years I was in business, out of which I paid the operating expenses on my car.

I find myself in a defensive position, based upon some comments John made. I almost have to go back to basic economics and time-and-place utility. You have to have profits in order to survive, and I think that you need to recognize that this is basically a service and a caring business, both of which are very important.

In order to provide service, you have to have profits, because service is expensive. You're buying labor to provide the service. You really have to care about what you're doing in this field because you are dealing with the disabled population. The people do have needs, and the distribution system is very uneven, as far as its quality is concerned.

I spent 30 years trying to practice what I preached: provide a decent living for the people who worked for me, and care about the people who I served as customers.

There were a lot of problems involved in it. I got rid of all the problems by selling the business to Abbey Rents last year, and that was really a momentous time. It'a a fair burden to carry around a business that deals with the needs of the disabled population. You're always concerned about everything being done perfectly.

The help that you get at the supply level is not distinguished. Some of the comments that were made here about the resistance of the entrenched supplier are quite true. It takes dynamite to get change made.

But let me address the problems of taking a device into the market, from the standpoint of distribution. It is very, very difficult to do it. It is very costly. Part of my present job description is to examine all kinds of products that have merit, and those that do, we select as a retail distributor for research, development, and manufacturing. Our company was very recently acquired by American Hospital Supply Corporation, and their point of view is that vertical integration is part and parcel of this business. If you can't get it done in the right way, make it yourself, but for the small, individual entrepreneur to take a product through research and development, up through prototype, and into distribution is very costly. That in itself is not enough, because you're having to deal with the additional problem of funding.

Many of the items that are addressed in the material are not funded at the consumer level. The consumer level is a third-party payer, i.e., an insurance company, the government, or someone other than the individual. Unfortunately, the financial impact of catastrophic illness or injury is enormous. Somebody has to pay, and yet we have insurance company policy that says, I will not pay for environmental control items. I will not pay for two wheelchairs, one electric and one manual. I will not pay for a wheelchair elevator that will give the person access to an apartment, even though that's the only apartment he or she can afford. So we have a serious problem of government attitude.

Thirty years taught me a lot about costs. I started with $3,000, more guts than brains--and a working wife. A working wife provided the cash flow that the family needed to survive. At the end of 30 years we were doing $1,300,000 a year, and it was costing. I had to earn $45,000 a month profit before I took home a nickel.

I employed 23 people. The problem of insurance was mentioned. There was a time where my insurance premiums for doing $1,300,000 went from about $2,000 to $21,000 a year, and I was essentially being reinsured. The manufacturers that supplied us with the products ostensibly had product liability insurance, but because of medical malpractice problems, we were faced with an enormous escalation in insurance.

BARRY UNGER: What kind of products were you basically making?

MARTIN FRANK: We weren't making products; we were distributing them. Remember we are second in line. The manufacturer would be first in line, so any lawsuit that embraced us would be simply a gathering up of defendants.

BARRY UNGER: What kind of products were you distributing?

MARTIN FRANK: Wheelchairs, hospital beds, walking aids, wheelchair elevators, ramps, communication devices, all the kinds of things that are necessary environmental controls. Many of the products had very little product liability exposure, yet they were all embraced by this very high rate, about $18 or $19 a thousand.

QUESTION: Even though you didn't manufacture, only sold, you're still subject to suit?

MARTIN FRANK: Oh, yes, you are indeed. You will find the attorneys very aggressively pursuing anyone that would have any relationship to a lawsuit.

They will gather you up, and when you are named in a suit, you can count on $25,000 expenditure. You cannot be without product liability. As a matter of fact, it is one of the first questions we ask to a new supplier bringing a product in to us: "Do you have products liability? Will you name us as an additional insured?"

That's one of those kinds of problems that just comes out of left field. You continue with a products liability insurance load that you feel is very modest, and all of a sudden it goes up 3,000 percent. Making it on one individual product, or even taking the product of government research through the cycle to market, is very difficult to do. You need a whole menu of products. You need some distribution of risk.

Dr. Nickel asked what are some of the other satisfactions of business life. One of the other satisfactions is a 70-hour week. Another is bailing your employees out of jail when they get drunk; you have to go down and get them out at three o'clock in the morning. You do have the advantage of being able to tell yourself to go to hell, without any downside risk in it, but over the years I've found that I had to exercise great restraint with a number of customers; thus in a way my customers were my bosses. So even that privilege was severely restricted.

Being in business for yourself is an experience. It can be very, very punishing. It can be very pleasurable. It can be only moderately financially rewarding, given the economic climate that we have. I made as much investing in two pieces of real estate as I did investing in 30 years in this business.

There's been some discussion about the method of distribution. How do you meet customers? How would you obtain mailing lists? I'll give you the benefit of a recent promotion we did. We gathered names from our own mailing list, the Abbey Medical organization, and then we bought names for several thousand dollars from a mailing service. We produced what I thought was a very nice catalog, which we sent out. We lost $50,000 on it.

Developing business leads for mailing lists is pretty hard, unless you are zeroed in on a disabled population. I wouldn't encourage you to do it because I don't think that you can buy a list, get out a mailing, and expect to have any great degree of success in dealing with the disabled community.

QUESTION: Was there something wrong with the list?

MARTIN FRANK: Yes, there was a lot wrong with it. The only money we made off of it was the customers that we developed ourselves, that is, our own recent mailing list. Those that were related to people of 65 and over, and given zip code areas, or economic income brackets of the aging population, which is what we were focusing on, produced nothing in relationship to the cost of the effort.

We spent over $100,000 on it, and got back maybe $50,000. So if we hadn't had an additional use for the catalog, which was to send out to each of our own customers, it would have been really a minor business disaster.

Carrying accounts receivable, if you decide to go the retailers route, is another extremely difficult problem. In a business the size which I have described to you I had over a half a million dollars in accounts receivable, most of them government. I had the pleasurable experience of starting up with a computer, but outgrew it in two-and-a-half years. That was the time I decided to sell the business because another investment was in order, another $50,000 to $60,000 for a small business computer consistent with my needs.

In this day and age, if you're going to go into retail distribution, a computer is absolutely essential. You're dealing 70 percent with third-party payees, and in order to somehow manage this enormous paperwork load, you just have to have a computer.

The computer experience is another delight all by itself. When you start up, you bleed from every pore, because every time the computer goes down, you're out of business. You run parallel, and you do all the things they tell you to do, but there is some little tiny component in some massive circuit board that blows out, and you are down, and the promised response time does not appear.

So you walk in, in the morning, and you see ten long faces of your office staff. The computer is down. That's an experience I wouldn't want any of you to share, but it's something that you have to live with, because being in this business without a computer is impossible.

If I were an inventor and I had a creative idea, I'd bring it to a counterpart in industry that has the resources to take it to market. At the same time I might get a good job offer because companies are often interested in employing people who are creative thinkers.

The risks involved in taking a single product are quite substantial, but there are companies like ours that view with a great deal of interest any product of merit. I am currently working on some products of that type. Two inventors came in with a product that I thought had merit. They were producing it. They had targeted a retail price of about $70 on it. I viewed it as being a candidate for a die-casting method. In order to die-cast a product, the first figures that have come in to us are $24,000 just for the dies to run the items.

Nevertheless, we're going to consider doing it. We're going to pay them a royalty, and we're going to contract with them for engineering services. So, many of you who may be sitting on some good ideas might want to consider that as an alternative.

QUESTION: I was looking at a pneumatic switch that I found could be supplied by a company called Abbey Rents. I think it was about $30. The manufacturer was Fairchild; I thought it might be less expensive through them. It was $12. I finally found it at Edmonds Scientific on the East Coast, known to be a little expensive, for $3.50.

MARTIN FRANK: Fairchild was higher than the other distributor? Fairchild is the manufacturer of the switch. The company on the East Coast either got them from the Midnight Switch Supply, or they were on auction. You have to understand there is time-and-place utility at Abbey Rents, and that store probably costs $50,000 a month to operate. So, to talk about one product and say it's $12 at one place and it was $30 at Abbey Rents is not a fair comparison. Abbey probably bought it from an OEM who bought it from Fairchild. So the $30 switch probably cost Abbey $18 to $20. The $10 profit is absolutely essential to put that store in that location and to stock the store with the switches. You have to address those things in perspective.

BARRY UNGER: In addition, pricing on given items can vary widely. Different organizations may use different strategies for developing their pricing. They may be making more profit on one item than another.

QUESTION: I think that a profit is necessary; obviously you have to make money on the money you put in to even keep up with inflation. You find me a company that gives you 30 percent on your money, and they're just breaking even, with the cost of living and inflation and salaries.

JAMES MARSTERS: I think you have to get a factor of 1.3 times your price. Even then, it's hard to sell someone something and get 30 percent because the distributor marks it up 30 percent, and then the retailer marks it up some more. It's a very expensive process, and it's very difficult when we find somebody selling something for say $12, $14, and another supplier has it for $3.50.

BARRY UNGER: The price of a given product reflects many things. It reflects direct costs, indirect costs, the kind of time-and-place utility, and the cost of the sales force. The sales force actually performs a service of reaching people, distributing, and they have to be paid. In addition, insurance has to be factored in.

Our next speaker is Dr. James Marsters.

JAMES MARSTERS: I've had my own office for 30 years in Pasadena. I was born deaf from rubella, or German measles. I don't wear a hearing aid because I can't use one effectively. I'm strictly a lip reader, and I was brought up to learn to speak and to lip read and try to cope with the normal world rather than being segregated into the world of the deaf.

Over the years I've found it frustrating not being able to use the telephone, so I adapted the phone to fit my needs. One adaptation was to take an old hearing aid and splice it into the base of a telephone. Then I would give the receiver to my friend to tell me what was said. My friend would hear what the person was saying and silently tell me. The person at the other end wouldn't know I'm deaf and would not become uncomfortable.

A serious problem is those people who tell me I can't use the telephone because I'm deaf. My peers who are deaf are sometimes worse than hearing people because, unfortunately, we have so many negative expectations given to us by our teachers, doctors, and other professionals. We get put down, so we have very few expectations, and I think that's unfortunate. The handicap is like a balloon. You can blow that balloon up or other people most likely blow it up for us. The balloon becomes so big that people can't see us anymore.

I was very aware that most deaf people cannot speak intelligibly like I do. This has not always been so for me. I was very concerned about deaf people not using the telephone and not being able to speak intelligibly. So how can we take care of this problem?

I heard of a deaf physicist, Robert Weitbrecht, who worked at Stanford Research Institute. He was an astronomer with two degrees, who was frustrated because astronomy was discriminating against him despite a lot of wonderful work he had done. Stanford Research Institute (now SRI International) existed primarily by government grants. I heard that this physicist was a pioneer of ham radios. I wondered if it was possible for deaf people to use some of the old teletype equipment that's been used by Western Union or the telephone company. The equipment has been phased out in favor of computer equipment, which is much more expensive and which can't be afforded by the handicapped people, as 69 percent of the deaf people in California are on welfare.

The telephone seemed to be one of the most important devices to potentially improve the language of deaf people. If deaf people can use the teletype equipment, they could see the standard way you express yourselves. They emulate your example. I do the same when I watch you speaking. I might see a word somewhere I've never used or pronounced. If I make a mistake in pronouncing something, I hope some of you would have the courage to put your hand up and say, "No, you say it this way."

I may make a try and say, "Is this right?" and I hope you will correct me. I learn more from making mistakes, from falling on my face and getting up again; people who are afraid to make mistakes, and don't try, and never learn anything, they'll never get ahead.

I got hold of Bob Weitbrecht and I said, "You were responsible for helping the radio hams use teletype equipment over the radio. You were the man. Now, how about making something to help the deaf people use teletype equipment over the telephone as well as over the radio and other ways?"

So we began. We also had the assistance of another man, a deaf man, Andrew Saks, who is an industrial manager.

The three of us started a business called the Applied Communications Corporation in a garage. There are many businesses started in a garage.

We went to the American Telephone & Telegraph Company in New York and they called us into the office with the corporate lawyers and some top people, and we demonstrated the equipment to them. They couldn't believe it. They were amazed. We asked them if they would provide us with teletype equipment. They said, "Yes, we will, if you will use the dataphone lines."

I said, "Thank you, gentlemen, but we cannot accept your offer." The lawyer said, "Do you realize that represents a million dollars worth of equipment?" I said, "Yes, but what good is it? Do you have a dataphone line in a telephone booth? No. Does your mother-in-law have one at home? Do you have one? No. Then why push this on the deaf people who can't afford it? The dataphone lines are much too expensive."

They said, "We're sorry, but we have the antitrust suit against us. If we give you permission to use this equipment on our telephone lines, we will have to open the door to everybody to put everything they want on our telephone lines. I'm sorry."

I said, "What do you propose we do?" They said, "Well, you do what you can, but you stay away from our dataphone line."

So we did that. We bought equipment and we developed the device from the grass roots.

Now, just because you make a better mousetrap doesn't mean the people are going to want that new mousetrap. It's scary to try new things. I don't like to try new things sometimes. You have to sell me something. We call that marketing. We had to educate the people.

Now deaf people and their parents and professional people very often have a block. They say, "Don't try to tell me I can use the telephone. I'm deaf, that's it." We had to get in there and work at it. You had to keep encouraging them. I saw a lot of hesitancy because many people didn't want to expose their poor language.

We had to tell them, "Look, my language is terrible. I had to learn too. Gradually, I developed my language by using it. Don't you want to talk to your friends?" Marketing is hard work, the advertising, the traveling, the conventions, the meetings. That's why I'd rather pay so much more for a product.

We have over a hundred thousand of our units around the world now. Our company had to go into London and set up a full-time office there to help the deaf people break through the post office and get a license. We had to pay for that because the deaf people over there couldn't do it. We gave them the time and expenses. It cost us a lot of money, but we turned it over to them for free.

Now you probably are wondering if we made any money out of this? No. We are involved in it emotionally and it has become an ego thing.

Meanwhile, we have more than ten competitors who've come onstream. We have a patent, but the people who make the most money on patents are patent lawyers. It costs a minimum of $100,000 to sue somebody through the patent courts. The government won't do anything for you. All they do is give you a patent, but they will not protect you. You have to do it.

The question is, shall we use the $100,000 to research and develop new products or would it be better to go after all the competitors? We want to see our product grow.

I think the companies can exist without government funding. I think we're going to have to, with the big cutbacks. We have to be smarter, and manage and plan better. I realize we can't do everything all by ourselves.

We should divide it up; some of us are better at management; some of us are better at working with our hands and putting things together; some are better at getting the money; and others are better at selling. I think we need to establish a central group of handicapped people who could consult on specific needs. Not only would the business benefit, but the handicapped person would also gain a sense of pride.

I am mostly concerned about devices to be used by the widest majority of the handicapped group. If I had the amount of time that it takes to develop a specialized device for just one person, I would take that time and spend it on a device that will help a hundred to a thousand or ten thousand people.

There are new devices coming onstream for the deaf. We now use computer equipment. We may use outside people and devices that they have already developed. We changed our equipment so that computer equipment will work over the telephone, for the deaf.

Also I want to use the equipment whereby the secretary sits down with a keyboard on her lap and types away at what's being said. It doesn't have to be verbatim, repetitious, or redundant. The television screen shows the deaf people what's being said. This device is also beneficial to a hearing person who dozes off during a conversation.

There's a small printer that's very quiet. The printer is 80 columns wide, which means 80 characters or more. It prints out what the secretary is typing. She doesn't have to use her notes and the chairman of the board or the officers can refer to what was said right there; they can walk out with copies.

The most important point is that I have to think, not only of myself, but of other people. How can I sell it in terms of other people, not just me? It's more likely to get somewhere.

I think I have said enough for now. Any questions?

QUESTION: Does your equipment use the ASCII or Baudot system or both?

JAMES MARSTERS: Our equipment does use the ASCII code for computers, but it goes through a modem, or black box, that converts it to Baudot code for the deaf. ASCII is an overkill for communicative purposes. I think there is a tremendous demand for Baudot equipment. ASCII has more characters available, and more functions you can do with it. It's more flexible, but it's an overkill. Baudot is more reliable, as it uses a prorated transmission and you are less likely to lose the information in the garble. With ASCII you do lose a lot more.

BARRY UNGER: I want to thank Mr. Marsters for that. We're running a little short on time so instead of more questions right now, why don't we go on to Mr. George Chandler.

GEORGE CHANDLER: Just a little word about my background. I'm the district director of the Small Business Administration, San Diego District. This district includes three counties--Imperial County, Riverside County, and San Diego County. My job started in January of this year.

Previous to that I was with the National Aeronautic and Space Administration headquarters in Washington for about 17 years, Apollo and Gemini before that, and Skylab for a bit. Most recently I was the director of the Scientific and Technical Information Office. We were a sister office to the Technology Utilization Office, which I noticed was written up on one of the recent letters as having developed, or contributed, through some sponsoring organizations, to the development of some utilities for the handicapped.

Let me say a little about the Small Business Administration. We're a federally-mandated organization with about 80 district offices throughout the country. Our primary goal is to help businesses get started or help businesses that are started to survive and prosper, and we do that through about four different programs.

These programs are delivered to minority, majority, disadvantaged and non-disadvantaged people. The only criterion is that the businesses are small.

The definition of a small business is one that is mostly independently owned and not dominant in its field. In the United States there are around 13 million businesses, aside from the farming industries. Of those 13 million, around 12.8 million are small businesses. Those small businesses employ roughly half of the work force in the United States and put out approximately a little less than half of the goods and services.

The four programs that we provide at each one of our offices are: the Management Assistance Program, the Financial Assistance Program, the Procurement Assistance Program, and the Advocacy Program. These services are provided free of charge.

Upwards of 90 percent of the businesses that fail do so because of inadequate management expertise and/or experience. The Management Assistance Program tries to assist companies in various management techniques. We have counselors at each one of our offices and we have counseling offices throughout our whole district, typically at the Chamber of Commerce buildings in the cities. In our district, we've got about seven counseling offices, in addition to the one that I have right downtown in my office.

These are typically run by people in our SCORE program. SCORE is the Senior Corps of Retired Executives. These are people who have been successful as businessmen themselves in various capacities, and have retired, but have donated their services to us. They work without pay, but if they have to travel to a counseling site, we pay for traveling expenses. They provide counseling services in our offices or in these SCORE counseling offices in the various Chamber of Commerce buildings, but they also provide counseling at the business itself. They'll go out and work with the clients at the business.

They also provide workshops periodically. Workshops are about every two weeks, and focus on the requirements or skills necessary to go into business, or to keep a business alive and prospering. They cover accounting, finance, marketing, management control, cost control, and a number of other facets that are necessary for a business to operate.

The Financial Assistance Program is divided into basically three parts. First of all, we help businesses find financial assistance through a bank, we help establish a banking relationship, and, where necessary, we help with the preparation of financial statements.

If the business can't get a loan from the bank directly, then we help them get a guaranteed loan, where the government, through the Small Business Administration, actually guarantees up to 90 percent of the loan from the bank. The guarantee makes the bank far more interested in making the loan if a business is financially marginal. If the bank is still unwilling to make a loan even on the guaranteed basis, then we have a direct lending program where we actually loan the money directly ourselves.

There are some additional features of the direct program, such as some money that is set aside for particular situations, one of which is what we call the HAL program. HAL refers to the Handicapped Lending Program. The HAL program is divided into two parts. One is the Handicapped Lending Program for sheltered workshops. The sheltered workshops must be non-profit and are organized to produce products and services by at least 75 percent handicapped people. The maximum amount of that loan, or that assistance, would be $100,000, with a low interest rate. It can be used for working capital, marketing, construction, and other such areas.

Unfortunately, due to the budgetary squeeze that has occurred since the new administration, this program has dried up for this fiscal year (through September 1981), and we do not know where it will stand for next year.

This is not to say that our whole program is affected. If there is no money in the Handicapped Lending Program, the people who would normally qualify for it would simply go into one of our other programs, such as the guaranteed program or the other features of our direct program.

The second part of our Handicapped Lending Program, for which there are currently no funds for the remainder of this year, is for acquiring an independent business, for-profit individual business, or starting up such a business. The funds can be used for working capital, machinery, debt, construction, as well as purchasing a business.

The period for these loans, and for the other loans in our program is seven years for working capital, ten years for machinery, and 20 years for real estate.

QUESTION: What's the maximum a business could borrow through the Handicapped Lending Program?

GEORGE CHANDLER: For both HAL 1 and HAL 2 the maximum is $100,000, and the interest rate is low. Up to now the interest has been something on the order of 3 percent.

Again, I don't know what's going to happen next year, but I can give you an idea. They're thinking of taking our direct lending program, which has 9-3/4 percent interest and moving that up to market rates, which would be 17, 18 or 19 percent. Then there wouldn't be any edge. I don't know what will happen with the Handicapped Lending Program.

BARRY UNGER: From what I hear you saying, a person doesn't have to have a particular background to utilize the management assistance or to attend the workshops on various areas.

GEORGE CHANDLER: Right.

BARRY UNGER: Although there's a problem with the loans, one could still get free management counseling and advice on starting things?

GEORGE CHANDLER: There are no problems with the direct and the guaranteed program. We don't have any particular restrictions right now.

BARRY UNGER: Who would people contact who want to use SBA services in terms of either management assistance and counseling services, or who want to inquire about their personal situation and the type of loan that would be appropriate?

GEORGE CHANDLER: Here in San Diego, the number is 293-5430. There is a brochure which has the phone number for every district office in the country, so that depending upon where you're located, you can call the appropriate one.

If the request is for management assistance, we would have a SCORE counselor talk with you and set up an appointment with you, either at our office or at your place of business. If the problem concerns financial assistance, we would direct you to one of our loan officers who could chat with you and either steer you to a bank or perhaps help directly.

Let me just briefly wrap up. The final two parts of the program are the Procurement Assistance, where we provide assistance in getting contracts with the federal government or even with state and local governments. We've had some procurement conferences. We're having one in August and another one in September that we're cosponsoring with the Chamber of Commerce and with the Congressmen in the area.

One feature of this is an 8A Program, which is actually a paragraph under our enacting legislation where the socially and economically disadvantaged organizations can be reviewed, placed in the program, and then given assistance in direct contracts with the federal government.

We attempt to advocate on the part of small business. We've got a couple of new regulations which we've helped get passed this year on the federal level, and as I understand it, the state of California is just about to pass one--a Regulatory Flexibility Act, where any new regulation which would impact on small business must get the Small Business Administration's approval before implementation. As for any existing regulations which impinge upon your ability to do business, we would go to bat with you, hopefully to try to figure out a way with the sponsoring agency to work a way around it if possible.

BARRY UNGER: I also wanted to mention that the SBA has many free documents and booklets, written by top-notch people in the field. You name the topic, whether it's doing your budget or writing a business plan, and the SBA probably has it. These supplement their workshops, which are perhaps one of the greatest resources they offer. You just pick and choose the materials you want to read.

VERNON NICKEL: I have one question. There are two types of businesses that you're talking about. One is businesses of any type for handicapped individuals, right?

GEORGE CHANDLER: Right.

VERNON NICKEL: The other, also legislated but not yet in effect, is small business support for those businesses to help the handicapped. The businessmen may or may not be handicapped. Is there such legislation in effect where priority is set for those businesses that want to help the handicapped, whether or not the businessman himself is or is not handicapped?

GEORGE CHANDLER: I'm not sure.

VERNON NICKEL: I heard there were some Congressional hearings and the words used were, "Small businesses flaunted the will of Congress." To my knowledge there is legislation to support, on a priority basis, businesses that will help the handicapped.

GEORGE CHANDLER: If I had anything to do with it, I would certainly give an edge to one that was trying to help the handicapped.

BARRY UNGER: I believe Dr. Nickel is, incidentally, correct on this in terms of legislation, which points out that legislation is nothing if it doesn't have money appropriated behind it.

VERNON NICKEL: It wasn't just money. This was in hearings of Mr. Olin Teague, who's very interested in this particular subject. He was very, very hostile to some of the bureaucrats who he felt had directly and probably criminally flaunted the will of Congress.

I'd like to make a comment. A lot of money has been spent for research for devices, and for ideas, yet there has not been implemented any way of getting this into the marketplace. That's one of the biggest lacks. The VA has a system that has been inoperable now for about 20 years.

BARRY UNGER: I would guess, from what Dr. Nickel is saying, that one way in which progress can be achieved in this area, if these laws are on the books, is through aggressive implementation. Handicapped consumer organizations must lean on Congress or whoever else to make sure these laws are implemented.

I'd like to thank all our panelists.

Carolyn L. Vash

Psychological Aspects of Rehabilitation Engineering

Background

In order to understand why certain consumers accept or refuse to accept technological aids, it is necessary to first understand whether, how, and how well they accept their disabilities. In the most obvious cases, people who are inwardly convinced that they are going to walk, see, hear, or whatever again will have little interest in devices they are sure won't be needed as soon as their cures take place. People who entertain such beliefs are not as easy to identify as you might think, because they have been "punished" for them--by ridicule, somber-faced lectures, and angry denunciations of their unrealistic attitudes--long enough to "go underground" and keep such hopes to themselves. They will play the games of evaluation, fitting, testing, and so forth, but when the games are over, they will not use the devices. In fact, they may hide them, because their presence challenges dearly-held beliefs and threatens to catapult them into depression.

Beyond this extreme situation, the issues become more subtle. In the first place, the phrase "acceptance of disability" has become cliche and, like most cliches, it means whatever the user wants it to mean and, quite likely, something else to the listener. I described what I meant by it in 1975--and made reference to accepting the facts that I would never again hear whistles when I walked, or go dancing, or ride in a horse show, or go to the bathroom by myself.

Four years after that was written, it turned out that even though I still couldn't walk, dance, or ride horses, I *could* go to the bathroom by myself--thanks to rehabilitation engineering. The insightful recombination of very old technology--an I-beam, a chain drive, a hoist, an electronic control box, plus three strong fabric straps--made it possible for me to go to the bathroom without someone around to lift me for the first time in twenty-eight years. The lift was invented by another postpolio quadriplegic who wanted to be independent of other people in toilet and bed transfer.

What were the advantages to me? Very practical ones, of course. I no longer needed to have an attendant who would be available during the day to help with toilet transfers. I could hire a housekeeper without concern for whether she was strong enough to lift me, and could be very flexible about working hours. Since my assistants live in a guest house on our property, it is very nice to be free to select mainly on the basis of personal compatibility. Also, I no longer had to place constraints on my husband's time away from home during evenings and weekends, when my attendant was off duty, or restrict fluid intake--a practice not known for its health advantages. But the most significant, even startling, change was the fact that my *dreams* changed dramatically within less than two weeks. For twenty-eight years, ten to fifteen percent of my dreams contained some form of symbolism of my dependency on others for this basic biological function that we are strenuously programmed to *control,* without error, from the earliest months of life. Although consciously, I accepted this dependency with good nature, my dreams showed that it was not a comfortable state of affairs at those deeper levels of consciousness referred to as the "unconscious."

Note that I made reference to the inventor's desire to reduce his dependency *on other people*--not that he envisioned reducing his dependency, *period*. Paralyzed people like him and me can expect to be dependent on either people or machines for a number of essential functions. And the more varied you want your life experience to be, the greater the number of such dependencies you may create. However, one does not tend to feel embarrassed about "bothering" a machine to lift one onto the toilet three times in an hour when the flu bug bites, nor a "burden" over the years for continually asking, "Will you please...this," "Would you please...that." To be dependent on a machine that one can operate without help, and which works reliably, feels as respectable and self-sufficient as "everyman's" reliance on electric shavers, automobiles, food processors, and the myriad other time- and labor-saving devices on which people-in-general have grown dependent.

The lift was not the first time rehabilitation engineering caused a cataclysmic change in the degree of my psychological well-being. Fifteen years earlier, my first motorized wheelchair made an even more significant difference. From late 1958 to early 1961, I served a psychological internship at Rancho Los Amigos Hospital. At that time, motorized wheelchairs were spurned there, as a matter of rehabilitation philosophy. It was considered better to encourage patients (and disabled psychological interns) to wheel manual chairs, not only for the exercise; a value was placed on independence from electronic devices. That was fine with me. There was no way I wanted one of those weird-looking, cumbersome contraptions that made their users seem even more disabled than they were.

To add perspective to this "case example," I had totally abjured learning to wheel my chair throughout my undergraduate school years because I felt a helpless, serene, feminine image would serve me better than a struggling, independent, sexually-neutral one. It did, until I started my internship. Then I found it necessary to get a one-arm drive, manual chair which I could propel to do ward rounds and see patients spread over a huge, one-story hospital. I was willing, then, to give up the "serene" image for a "struggling" one because: a) I had accomplished what I needed the former for--hooking a good man, and b) I now had a different life task before me--hooking a good job--and to that, independent mobility was essential. This is a very important point to keep in mind when trying to predict whether a consumer will use a device (or understand why she or he didn't). How does the device fit into the life tasks the consumer sees as important?

When I returned to Rancho to take a staff position in 1963, I found a revolution had taken place with respect to motorized wheelchair philosophy. They were now being strongly recommended for anyone with a significant degree of arm weakness. The memory of how exhausting ward rounds had been with a manual chair eliminated any traces of resistance to the idea, along with role modeling provided by a minimally disabled physician who was, by then, using one to save her time and energy.

I have just finished writing a textbook on *The Psychology of Disability*. The impact of rehabilitation engineering on the users of its products is cited in nearly all of the fourteen chapters. This reflects my view of its importance in virtually all aspects of life performance: surviving and living independently, getting educated and working, enjoying leisure time and friendships, maintaining a home and family love relationships, even transcending disablement--or transforming it into a positive experience.

Rehabilitation engineering is one of two *non*-psychological phenomena repeatedly cited as having powerful influence on the psychological well-being of disabled people. The other is the civil and human rights movement, which has begun to acknowledge that disabled people have been denied their constitutional rights since the constitution was written, and has also begun the long, arduous process of trying to correct that. If there's anything that can erode your good feelings about yourself and the world, it's being stripped of your self-evident, inalienable rights. Psychophysiological research dating back to the fifties (e.g., Richter, 1956) has clearly demonstrated that the sense of helplessness, or powerlessness, to influence your own destiny, can not only depress, it can kill. It caused millions of Jews to walk, knowingly, to their own executions; it continues to cause "voodoo" and unexpected surgery deaths; and it caused the widely-publicized suicide of Lyn Thompson--in conjunction with anti-humane Social Security Administration procedures which she believed would force her into a custodial institution.

The civil/human rights movement and rehabilitation engineering technology are advancing--in parallel to return the power to the people; in this case, disabled people. Some important changes are also happening in psychological service techniques, such as the use of peer providers, and the influence of the holistic health/human potential development movement on rehabilitation psychology. However, and this may seem a treacherous statement from a psychologist, the advances in civil rights legislation and the technological solution of disability-related problems, strike me as more important influences on improving the psychological status of disabled individuals! George Hohmann, a rehabilitation psychologist who became paraplegic during World War II, indicates, "Being disabled just isn't as depressing as it was when I was first injured." The reasons he cites have to do with advances in medical science, technological development, and protective legislation--not improved psychological methods for helping disabled people accept their handicapped status.

The point is this. Equal protection under the law and appropriate applications of technology can *reduce* the handicapping effects of disability. Why counsel people to accept what can be resolved? Remember the Alcoholics Anonymous maxim, "Got grant me the courage to change what I can, the serenity to accept what I cannot change, and the wisdom to know the difference." Legal advocates and rehabilitation engineers play their roles in concert with the first clause--changing what can be changed. After this has been accomplished, the psychologists play their roles in attending to the second clause--helping people accept whatever residuals, at a given point in state-of-the-art development, are impervious to change. Both, working together and with the disabled people involved, must continually attend to the third clause--knowing when to attempt change (through technological applications) and when to promote acceptance of the way things are. Another way of looking at it is that disabilities--which are unchanging givens--must be accepted. Handicapping effects of disabilities, which can sometimes be resolved through the right mixes of inner and outer resources (e.g., motivation plus feasible technology)--should be rejected until the evidence is clear that no resolution is possible. If and when that happens, handicaps, too, must be accepted, serenely, if a secondary emotional disability is to be avoided.

Just as technology has advanced, so has the psychology of rehabilitation engineering. Fifteen years ago, I was inclined to promote the development of accessible cars over accessible vans in the interest of "normalization." That is, nondisabled people tend to use cars, not vans, and "Ironsides" vans seemed to heighten the visibility of differences between "crips" and "walkies." It seemed valuable, then, to minimize the visible differences in order to minimize the social distance between disabled and nondisabled--even at some expense to functionality. In other words, the functionality of appearing more "normal" seemed as important as maximizing physical independence.

Today, any inclination to promote cars over vans relates to gas mileage, not normalization. Some renegades, myself included, have even come to abjure the concept of "normalization" as refuting the growth catalyzing, positive aspects of being *different*. We regret the time and energy that went into trying to help (spelled f-o-r-c-e) disabled people to look as normal as possible, and the pain that resulted from such futile, misguided efforts. The learning process has been a slow one. Only five years ago, in speaking to a group assembled at Rancho Los Amigos Hospital (Vash, 1975b), I made a stronger case for attending to cosmetic aspects of continually-used devices than I would today. Because of our improving political status, disabled people are less dependent now on being found "acceptable" by others in order to get some fun out of life. We are now more inclined to "do our own things," however peculiarly we have to do them, because the "movement" has allowed more of us to become task-oriented (oriented toward self actualization) rather than ego-oriented (oriented toward attaining some minimal level of self esteem).

This does not mean, however, that cosmetics no longer matter. The human potential development movement has led people, generally, to be more concerned about doing their own things and, concommitantly, to be less emotionally dependent on others, less needful of external "strokes." Still, it has not harbingered the collapse of the cosmetic industry. Nor has it altered voluminous research findings that physical beauty is an extremely powerful predictor of personal success. Looks still matter mightily. What has changed is disabled people's reactions to cosmetic issues. They are more practical and realistic, less "neurotic," if you will, than they were even five years ago. The balance point between accepting an unaesthetic device because of its functionality, versus rejecting it because of its social liabilities, has shifted toward practical functionality. The rehabilitation engineer who can maximize functional practicality and, at the same time, minimize social liabilities, will serve the consumer well.

Direct Work with Consumers

The most frequent source of consternation I hear about, from rehabilitation engineers, is rejection of devices by consumers--either outright refusal to accept and use them, or polite acceptance followed by immediate or gradual non-utilization. It's disappointing, frustrating, and irritating when it happens--after weeks, months, or maybe even years of effort to produce something that will help and be appreciated--and some ungrateful soul won't try to work with you to de-bug it if it has problems, or just use it if it doesn't. I'll take several steps to try to place this unpleasant turn of events in perspective.

First, it may help to realize that the designers and manufacturers are simply in the same boat with rehabilitation providers. That is, unlike most people who produce products and deliver services, they are working with clients who, generally, are *not* ecstatic about being their customers. To give you, quite literally, a *feeling* for what some customers may be going through, the following passage, from a paper on the topic of denial versus acknowledgement of disability, is offered:

> I was depressed. No Gloomy Gus on the outside, I smiled and smiled and smiled...another form of denial. But on the inside--such self loathing, such world weariness, such cosmic depression as few are privileged to experience. I'd wake up and look across the room at my wheelchair and the hydraulic lift used to put me in it and think, "No! No human being was ever meant to be like this...a useless blob of protoplasm that has to be moved from one place to another with a crane."

Twenty-eight years later, everyone who came into the house would be dragged back to the master bathroom to view the new "potty machine" because I *was* giddy and excited about it, and no longer equated my need for such with being "a useless blob of protoplasm." Twenty-eight years ago, had my wonderful lift been proffered, I probably would have smiled and said, "Oh yes, that would be very nice," and then cried myself to sleep over it for a month. And I would have tried every trick in the book to avoid using it for the simple expediency of trying to protect myself from contemplating suicide. By the time it *was* proffered, I had been wishing someone would invent such a thing for nearly ten years. I was ready for it... practically, and psychologically.

Acceptance of Disability

Acceptance of disability is, perhaps, the most critical, single variable influencing user acceptance of devices. It is related to such factors as: time since onset, general emotional stability or mental health, the extent to which pre-disability lifestyle and preferences were disrupted by disablement, the amount and quality of interpersonal support available from family and friends, the stability of the disabling condition itself, and the presence or absence of a reasonably well-formulated philosophy of life into which the disability experience can be integrated--giving it purpose and meaning. Obviously, with so many causal conditions--and there are many more than I have mentioned--the relationships are never simple. The causal conditions interact so that one can never say, for example, "Aha! This person is only three months post onset and therefore must not have accepted his disability yet!" He just might be one who is very philosophically inclined and is serenely trying to understand God's purpose in bringing him disability so that he can make the best spiritual use of the experience.

Acceptance of disability affects whether a person will be interested in any devices, or in appropriate ones. As noted earlier, one form of denial may lead to total rejection of devices since they would be wasted after "the cure." A less primitive form may lead to demands for devices that will do the impossible and be invisible, because while the disablement itself is recognized as real and permanent, its implications are considered intolerable.

Motivation

This topic encompasses a multitude of interrelated phenomena which I will attempt to untangle and present coherently for the task at hand.

First, let's dispense with the straw man issue of the "unmotivated" client. If the client lives, she or he is motivated. When professionals declare clients, patients, students, etc., "unmotivated," what they mean is, "They're not motivated to play my game my way." The obvious corollary is that they *are* motivated, but to do something else. The professional's responsibility is to figure out what that is and gear rehabilitation planning to it.

To give you a concrete example from my most familiar case study: when I rejected hand rims on my first wheelchair, many rehabilitation professionals would have taken that as clear evidence that I was not really motivated to rehabilitate myself. Nothing could have been further from the truth. I had though it all out and reached what seemed the best decision in view of my specific life goals at that time: no hand rims because a) they would add to the distracting clutter of the wheelchair and I wanted people, especially men, to see *me*, and b) they would suggest that I could propel my own chair, which would interfere with the serene, helpless, graceful image I intended to project. Like a fox is crazy was I unmotivated. This points toward three interrelated aspects of motivation to consider: energy level, depression, and goal directedness.

People with low energy levels, or chronically low levels of activation, are sometimes considered "poorly motivated." They don't do as much, don't seem to think or care as much, as people with high energy levels. They probably *want* as much as anyone, but for varied psychophysiological reasons, they don't have as much energy to go after it. In a way, the central aim of the holistic health/human potential development movement is to help people enhance their energy levels. Such attention may be needed when clients appear to be "poorly motivated" in the sense of having generally less zest for life than you suspect they could have.

One of the most important psychophysiological reasons for low energy is depression—sometimes considered a natural reaction to catastrophic disablement. Temporary sorrow, grief, sadness, mourning, yes; but depression indicates that the natural reactions have gotten out of hand. Depression isn't a primary reaction of extreme sadness, it's a secondary reaction wherein an accumulation of anger is transformed into something that looks like sadness--because of the slowing of thought and behavior, loss of humor, and depletion of energy reserves. Energy isn't lacking in this case, it is being used up--sometimes enormous amounts of it--but inwardly, so that little is left over for reckoning with the outside world.

Reckoning with the outside world is the third aspect of motivation to be considered here: goal directedness. Some people are simply more goal-directed than others, and people who have goals, know what they are, and can state them, are easier for all rehabilitation professionals to work with. A research project I directed several years ago at Rancho Los Amigos Hospital (Wetmore and Kemp, 1969) showed that former spinal cord injury patients who could state specific activity goals (such as "play golf again" or "get a job *teaching* what I used to *do*") had reached much more productive lifestyles ten years after discharge than those who could only state vague, generalized goals (such as "be happy" or "just get along"). The *level* of goal directedness is also affected by energy level and, if present, depression. The *type* of goal directedness has to do with:

Perceived Life Tasks

When I rejected hand rims, it was because they would have interfered with what I perceived as my top priority life task at that time: hooking a good man. Any assistive device that would have helped me with that would have been eagerly accepted.

The clinical folklore in rehabilitation is filled with laments about closets full of orthotic and prosthetic devices which were abandoned because, while they facilitated some function held dear by physicians or therapists, they interfered with other functions held dearer by the disabled people who politely accepted, then abandoned them. The people may not have discovered the disadvantages until after they went home from the hospital. The tenodesis handsplint offers a classic example. Occupational therapists were pleased, and patients too, when they permitted quadriplegics to write. When the patients went home and found they had to constantly take them off, put them on, and take them off again every time they wanted to propel their chairs, they tended to remove them permanently and tuck them away. This happened because wheeling was a more valued activity than writing, and the effort required to do both was greater than the "payoff" was worth. Only if and when the individual got into college, say, and placed writing higher on the life task priority list, would the splint be exhumed from the closet.

It is therefore essential to assess whether the life task priorities of consumers, and those other parties hold out for them, *match*. Part of the match relates to:

Effort-Reward Balance

This was alluded to in the context of handsplints abandoned because the "payoff" of being able to write wasn't worth the effort of continually taking them off and putting them back on. The principle is a broadly applicable one, and the mechanism was explained years ago by the classical learning theorist Clark Hull. Based on rat studies, of course, the observation was that if the rat had to traverse too big a maze or pull too many levers to get too few food pellets, it just didn't do it. Hull hypothesized an intervening variable of "work inhibition" that built up, finally eventuating in discontinuance of effort. I illustrated the principle when I stopped trying to paint until I got a motorized chair because until then, the reward simply was not commensurate with the effort. I mention it here because it relates to motivation. Had I the inner drive to paint felt by Matisse--who, severely disabled by arthritis, painted from his bed in his later years with a brush taped to a long pole--my story might have been different. Clearly, the effort-reward balance must be individually assessed for each person if you want to keep your products out of the closet.

Risk Taking

Individual variation in willingness to take risks accounts for some of the differing reactions designers meet to the same device. To clarify, the following is a passage from a paper on mobility systems:

> There are inter-individual differences in willingness to take risks generally, and there are intra-individual differences to take risks in different realms of life. I can use myself as an example to make this concrete. I'm very willing to take the risk of being the last person to be evacuated from a survivable air crash, because I see a survivable air crash as a very low probability event; and I see losing my job if I were unable to fly as a very high probability event. On the other hand, I am not willing to take the risks of getting caught in the boondocks with a broken-down vehicle, van or auto, because I can fantasize the anxiety I'd go through and I don't need or want to take that chance. Risk-taking willingness will vary with the extent of the risk necessary to support one's chosen lifestyle. As my life is arranged today, I don't need to be able to drive independently to get where I want to go; therefore, the risk has too little payoff. A year from now it might be necessary and the risk would not look so aversive.

Much to my surprise, a few people even find my lift too risky. One nondisabled man said, "There's no way I'd take a chance on being stuck in that thing during a power outage," and urged me to get a generator to avert such a catastrophe. Finding out about such quirks is very important to an assistive device designer. The fact that a device will "work" won't make much difference to a person who harbors irrational fears about some aspect of it. The designer needs to assess two aspects of risk taking: the client's *perception* of the risk involved, and then his or her *willingness* to take it. The client may perceive the type or degree of risk incorrectly, and reject a device on an erroneous basis.

Cosmetic Concerns

People also vary enormously in the extent to which the appearance of assistive devices concerns them. Some may care too much and some may care too little. The fact is, physical appearance has a powerful impact on success in life, whether or not that seems fair, democratic, or reasonable. The seventies saw an outpouring of research findings on the relationships between beauty and success, some of which reached the "pop psych" magazines such as *Psychology Today* and *Human Behavior*. The consensus of findings is clear: the better you look, the better your chances for success in work, love, and life in general. The fact that *attractive* has become a synonym for beauty says it--beauty *attracts*; its opposite repels. Success depends on attracting people--their support, interest, liking, desire to have you around--and sometimes their money.

What this means is that the concern of some disabled people about whether assistive devices will make them look "weird," "freaky," "gross," or comical, is not to be treated lightly or written off as foolish vanity. We already have physical disabilities to contend with; we don't need social handicaps added to them. The Center for Independent Living in Berkeley, California put together a slide show several years ago to demonstrate the fact that people often don't even "see" a disabled person because they are so busy reacting to the clutter of appliances--wheelchairs, braces, crutches, and the like.

Thus, regardless of what the client says about concern for cosmetics, you will be doing him or her a favor if you strive to minimize the clutter associated with the device. Beyond this baseline, you'll begin to deal with individual differences in what is perceived as acceptable by the consumer.

There is a cluster of related terms you have heard many times from psychologists--body image, self image, and self esteem. What everyone wants is self *esteem*--thinking well of yourself, feeling good about yourself. Whether or not you reach that happy state depends in part on your self *image*--what kind of a person you think you are, how you measure up on the traits you value. Your self image, in turn, depends partly on your *body* image--how you see its characteristics and their impact on others. Since almost everything runs in circles these days, you can be sure that body image is, in part, dependent on self esteem. With other psychodynamic forces impinging on all three elements, the match between body image and actual body is seldom perfect. What you see is not necessarily what the client "sees" as his or her body. Often, a disabled person's body image is far less attractive than what others see because it falls short of some idealized standard. The contrast is exaggerated through such processes as generalizing from one flaw to the whole.

What all of this means to the device designer is: after minimizing the clutter, and verifying that the device fits with the person's life tasks, if you are still feeling resistance to cosmetic aspects of the device, you may be dealing with a person who simply cannot integrate it with his or her body image. To illustrate: if I imagine looking down, what I "see" is my lap, my arms and hands, but also my arm rests. Over thirty years' time, I have accepted that as "me." But the first time I saw my legs with their brand-new case of disuse atrophy, I resolved to kill myself if that situation didn't change. Pipestems weren't me. Dancer's calves were me. It took years to acknowledge that pipestems were, indeed, me. In our work, the sooner after onset we see a client, the less likely it is that his or her body image will match what we see; and the more likely it is that certain requests or complaints that don't make sense in terms of what we see, *do* make sense in terms of what she or he "sees" in the mind's eye.

Before leaving the topic of psychological dimensions needing consideration, a few general observations are in order. First, the preferences of people with disabilities are as heterogeneous as those of the general population. There is no such thing as what "the disabled" or "the handicapped" want or like. As is true in the general population, some products will be more popular than others, but there is a stronger tendency to look for unanimity among disabled people than among people in general. The search may as well be abandoned, because uniformity is not likely to be found.

Also, like people-in-general, disabled people vary in terms of the resources they bring to bear on solving problems--both inner and outer resources. By inner resources, I mean such qualities as intelligence, creativity, adaptability, mechanical interests and aptitudes, assertiveness, ability to communicate, and many other traits that will influence how comfortably and effectively they work with rehabilitation professionals and use devices. By outer resources I mean such supports as caring families, mechanically-inclined friends, the money or insurance to pay for devices, and so forth. You need to have an accurate idea of the *resourcefulness* of your clients.

Last, a word on "appropriateness." Some clients seem to want exactly the kinds of help that are deemed "appropriate," "realistic," "sensible"--and others reject what all of the experts agree they need, or demand what seems clearly impossible or counterproductive. It's not easy to know who is the best judge when customers and the experts disagree. A good habit for rehabilitation providers to get into is to temporarily, conceptually, throw out all expert opinion and try to slip into the customer's mocassins long enough to experience how his or her demands make sense. Once you know that, two good things could happen. You might side with the customer, and help explain to the experts why his or her cockamamie ideas make sense. Or, you might side with the experts; but at least you will understand where the customer's demands are issuing from, and you'll be better prepared to explain why his or her wishes can't or shouldn't be met.

Back in the Lab

Psychological factors are as important in designing and building devices as in working directly with their users. In the lab, "human factors" or "human engineering" considerations are of supreme importance. Design features must take into account the human nature of machine operators--in this case, device users. Here, the full range of psychological processes comes into play: sensory and perceptual mechanisms, cognitive and learning mechanisms, volition and emotional reactions. The list looks like the required coursework for an undergraduate degree in psychology.

However, before any of these factors can even matter, the consumer has to be able to afford the device in question. Sometimes public funds or private insurance are available, but often they are not. When this is true, to know that the solution is out there, but unobtainable, may be more frustrating than believing it doesn't exist at all. My lift offers a case in point. I bought it at just over $2000. Soon after, the firm was sold. The new owners are using heavier duty components and selling the sturdier version for about $6000. Few individuals can buy them at that price, and the increase in sturdiness is unnecessary. Mine will handle 500 pounds, and few users will weigh more than that. I am annoyed because I wanted to buy another one for the bedroom. At $2000, I was ready; at $6000, no way.

The point is this: overbuilding for durability, spurious safety margins, or versatility may make costs so prohibitive they remove devices from the reach of individuals. Yet, as disabled affirmative action in employment advances, more and more potential users will have too much income to be eligible for third party assistance, but too little to afford to buy devices independently! This will become an increasingly troublesome "catch 22," so it is important to plan for individual affordability.

As an aside, overbuilding can create other problems, too. In the fifties, one wheelchair manufacturer proudly produced a sturdier manual chair, using a heavier gauge tubing than its predecessors--or successors. Its phantom "advantages," in terms of durability, were not appreciated by family members and others who had to lift them into cars. Designers need to consider the needs of the people who assist devices users, too.

Reliability and Safety

I don't want to leave the impression that I'm so concerned about reducing cost and weight that I've grown cavalier about safety and reliability. I'm concerned about both, and also whether devices *appear* to be safe and reliable to the user. If they don't, they may be rejected or fall into disuse whether or not they are actually safe.

No matter how wonderful a device might be when it's working, if it breaks down too often, the user will get more and more "shell shocked" about trying to use it again. Moreover, the less central it is to survival--literally, or to the continuance of an acceptable lifestyle--the less willing the user will be to take the chance of another breakdown. The trauma of breakdown ranges from rueful embarrassment (e.g., motorized wheelchair breaks down when you are flirting with someone while strolling through the park) to stark terror (e.g., motorized wheelchair breaks down in the middle of a busy street as the light is changing to green for oncoming cars). The non-essential device--one perceived as a quality-of-life nicety--may be abandoned rather quickly.

One thing this means to providers is: if a client seems to be giving up on a device with reliability problems more quickly than others with whom you compare him or her, before concluding anything about the client's strength of character, assess the comparative centrality of the device in his or her life. It also means: design for lay maintenance and repair as much as possible.

Functional Trade-offs

The more devices are meant to do, the more likely they are to break down. Also, the more peculiar they will look, the more they will weigh, and the more they will cost. This requires user and designer to engage in a decision-making process involving functional trade-offs--"What are you willing to put up with to get X?" and "What are you willing to give up to avoid Y?" It is a highly individual matter. Nonetheless, one continually confronts Rube Goldberg nightmares created with no particular individual in mind; rather, "the handicapped" are expected to appreciate a device that will serve as a wheelchair-standingboard-stairclimber-feeder-teethbrusher or some other equally unlikely combination. What really hurts is that the designers are often exceedingly clever people whose gifts are being wasted.

Over twenty years ago, I first heard a rehabilitation psychologist proclaim, "What we need is to get OTs to suppress their cleverness!" This reflected the now-common belief that patients need *facilitation*, to help them arrive at their own solutions, more than they need ready-made solutions handed to them. He was saying that OTs need to resist their urges to use the very cleverness that led them into their field--to solve problems quickly with *their* wits in *their* ways--and swallow hard and wait and facilitate and wait some more while patients grope and falter and grope some more to discover their own ways of doing things. Only when the patient is on the brink of despair should the occupational therapist venture, "Gee, I just thought of something that might work for starters..." This same message is now relevant for device designers. An important role is that of facilitator, not prime actor, in the functional trade-off decision process.

Learning Considerations

Learning to use control systems, reliably and effectively, is the crux of human engineering. Human engineering became an empirical research field after it was apparent that logical deduction doesn't always give good answers. For example, with respect to braking systems on a joy-stick type of control, "logic" may tell one person that braking backwards, matching the direction of intended movement, would be the correct solution. Unfortunately, "logic" may tell another person that braking forward, matching our bracing inclinations, would be the correct solution. Obviously, what appears to be logic is actually intuition, and case-by-case, human factors study is needed to determine when which intuition is correct and for whom.

An important reason for individual differences in response to control systems may be *transfer of training* from previously-used devices. To give a simple example: I have two manual wheelchairs. One brakes forward, one brakes backward. When I change from one chair to the other, it takes a few days to consistently remember which way to brake. When control systems differ, the more similar the devices, the more confusion there will be. Transfer of training effects may be positive or negative. I have described an instance of negative transfer, but previous training of various sorts can also facilitate learning. For this reason, it is important to find out about a client's previous experience with machines, devices, and gadgets in general.

Transfer of training effects may extend beyond learning control systems to learning what equipment can and cannot do. Customers need to have very specific training on the limits of newly purchased equipment, and on the differences between equipment they have used in the past and new varieties, so there will be no negative transfer of training calamities. For example, after years of experience with "brand A" wheelchair--which could take the ramp into a shed in my back yard--I tried it with "brand B." It tipped over and for four days, I experienced what it's like to be aphasic. That was great for building clinical insight, but bad for my disposition, and it could have been serious. I was told by the designer of "brand B" that it could do everything "brand A" could. It wasn't true. After the incident, thinking through the differences in chair design, I could see why it had happened; but the problem didn't come to me intuitively in time. I should have been given accurate information on the limits of the new chair which had not applied to the old one.

Cosmetics Revisited

Some implications of the cosmetic concerns described earlier: 1) simplify as much as possible; but 2) don't try to disguise the purpose or nature of the device; and 3) as much as possible, instrument the task location rather than the person. The issue of simplification is simple--minimize the clutter without introducing structural jeopardy or eliminating feasible functions desired by the prospective user. At the same time, it is neither necessary nor desirable to try to hide what the device is and is for. A rolling overstuffed looks weirder than a normal wheelchair; it will be more distracting, not less, to other people.

One of the worst efforts to cosmetize a device that I ever saw was a prosthetic hook which had been covered with a flesh-colored plastic to make it look more "human." While chrome is a perfectly respectable material, the flesh-colored plastic gave it a rather unearthly, frankly repelling quality that was more *humanoid* than human.

On the last issue, the more you can instrument task locations, and leave the person untrammeled by hardware and clutter when she or he emerges from performing the given functions, the better it will be in terms of social relationships with other people. If the same device is needed in the kitchen, the dressing room, and at work, this proviso might entail too costly duplications. When it is feasible, however, it should be given high priority in device design.

Effort-Reward Balance Revisited

How much effort is a given client willing to put out to feed himself, or transfer herself, or whatever? How much effort would any reasonable person endure? The answers you arrive at to these questions may influence more than *how* you design a device; they may determine *whether* you do so. It's not easy to predict correctly. Several years ago, I bought a food processor--largely because it was the only way I could make a pie crust or slice mushrooms without squashing them. But after the novelty wore off, I said to myself, "So who needs pie crust?" and "Why not squash the mushrooms?" simply because it's more trouble to clean the damn thing than it's worth. (Even my able-bodied housekeeper would rather chop, grate, and slice by hand than clean and reassemble the pieces.) Cooking is a nice-but-not-necessary part of my lifestyle; a more domestic soul might view this effort-reward balance altogether differently. On the other hand, while my lift takes only a minute and a half, I think I'd still prefer it over an attendant if it took fifteen. The point is, the effort-reward balance must be *individually* determined.

These illustrations touch on an important reason why devices are abandoned. People change. The designer didn't do anything wrong, didn't overlook some obvious pitfall or problem; the client just changed his mind, his interests, his direction. How many of you have storerooms or garages filled with assorted tools that were used, perhaps briefly, then put away? Was something wrong with them? No, you just changed your mind about the value of the activity and its goals. No one worries about it; it was your money to "waste" if you chose. However, when the government pays for a device, or grant-supported engineers put their time into it, people do worry. That doesn't mean the underlying process was much different, only the accountability. You are accountable only to yourself; the client is accountable to the taxpayers. Stated differently, the "pathology," if any exists, is in the economics of the situation, not in the psyche of the consumer.

An Engineering Department Looks at Technology for Disabled Persons

Following is the list of participants and their respective affiliations:

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ROBERT MURPHY: My intention is to give you an impression of one role that an engineering school might play in supplying technological expertise to the benefit of the disabled. A better title for the presentation might be "Technology for the Disabled, through the Eyes of a Design Engineering Educator."

This presentation will, I hope, help you understand the difference between what my colleagues and I call gadgeteering as opposed to engineering design and also give you a flavor for the engineering design process. One morphology for engineering design employs the following individual tasks:

- Problem Statement.

- Problem Definition.

- Information Gathering.

- Engineering Feasibility.

- Economic Feasibility.

- Preliminary Design.

This is a logical sequence of steps with a wide variety of applications. To illustrate, let me play the game of applying this morphology to this presentation as well as to the task of an engineering department responding to the technological needs of the disabled population.

A general problem statement that applies here could be put forth as: "Engineering schools are not very responsive to the needs of the disabled." This should be refined to a statement that is more amenable to direct action. This results in the problem definition.

The problem definition could be: "Develop a curriculum adjustment to incorporate the design and construction of technological aids for the disabled individual." This statement permits some direct response and leads us to what could well be the most important step of the process.

During the information gathering process when we assess the needs of the disabled we find a need for clinical-type research involving medical and bioengineering efforts geared toward the fundamental understanding of a wide variety of problems. We also find a need for clinical application or care. This care is primarily medical profession-oriented, but might include technological aids to assist in physical therapy, etc. Finally, we find a strong need in applied engineering. This need consists of applying existing technology to aids for the disabled.

To respond appropriately to these assessed needs one should have a reasonable, if not a complete, listing of what is presently available as a solution (the state-of-the-art, so to speak, in solving the problem definition).

Looking at what's available in the area of engineering schools responding to the technological needs of disabled people we find, generally, a reasonable number of universities responding to the research needs of the disabled. The results of these efforts have the potential for enormous payoff but are generally long-range programs. There are many examples of this type of activity ranging from research efforts in the mechanics of blood flow, exemplified by work done at the University of California at San Diego, to investigations in artificial intelligence and robotics being done at Stanford University and other institutions. Our information gathering would also find a second type of engineering program which involves more of an application of existing technology to the needs of the disabled. This type of program appears to be rarer. One characteristic of this type program is the individualized nature of the resulting devices. Representatives of such programs are the internship program at Stanford, the program at California State University in Sacramento, and the program at Southern Illinois University. Once we understand the nature of the problem we can start working on a solution.

In the engineering feasibility phase we are basically ascertaining if the problem is amenable to a reasonable solution. Relating to our problem definition concerning curriculum we must first consider the various roles of engineering schools in general. The roles might be categorized as:

- Education of Engineering Students.

- Research or Fundamental Studies in Technology

• Service to the Community.

What we (engineering schools) *are* also says a lot about what we are not. We are not, first of all, manufacturing firms in the business of marketing products and secondly, we are not engineering design firms in the business of designing products for manufacture.

What we are, fundamentally, is educational institutions which can respond in limited ways to the technological needs of the disabled community. However limited, these resources can be dramatic and useful in many instances. The net result of the information gathered is that a solution to our problem definition is feasible.

The economic feasibility is possibly the major stumbling block inhibiting the response of an engineering school to the technological needs of the disabled community. To clarify, let me elaborate on the funding sources available to the university: First, we have an educational funding allotment. In California this is primarily the state government. These monies are obviously set aside for educational goals of the university. Past history has shown that there is very little educational money available (or left over) to support assistive device development. Secondly, we find a research allotment. Nationwide, the primary source of this funding has been the federal government. Past history has also shown that the majority of research funding available is designated for more fundamental long-range studies rather than application of existing technology. It has been only relatively recently that monies have become available which permit response in the area of applications of existing technology. Now that I have painted a somewhat gloomy picture, with respect to assistive devices, let me outline the method that our school has used to apply a silver lining.

The Department of Mechanical Engineering at San Diego State University (SDSU) has initiated a program (by no means unique or complete) which we might characterize as our preliminary design solution to the problem of curriculum modification to aid the disabled.

The Department of Mechanical Engineering at SDSU has chosen to respond to both the long-range and the short-range needs of the disabled community. However, I will relay to you only our response to short-term needs, or the application of existing technology.

What we have done is devote, on a semi-formal basis, a portion of approximately four courses, to the production of electro-mechanical aids for the disabled individual. This program starts in the junior year with our *Introduction to Design* course. In this course one of four projects can be devoted to the design solution of a real problem that exists in the disabled community. This device might be for individual use or possible institutional use by trained professionals. Generally, at this level the engineering sophistication of the student is at a relatively low level and the project results in only a paper design but can lead to something more tangible at a later date. Continuing in the junior year our course *Elements of Machine Design* can also incorporate one project in the area of designing technological aids for the disabled. At this level the design, although still only a paper design, is sufficiently defined and developed to permit construction by qualified technicians. It could well be the continuation of a project begun in the previous course. In the senior year we have a two-semester course *Design Engineering: Applications* (or as the students call it, *Senior Projects*), in which we have designated that some number of students (25-30%) will be working on technological aids for the disabled. A requirement in this course is that the end result be a finished product.

In addition we have a senior elective special projects course which permits more extensive involvement in rehabilitative engineering design and is exclusively dedicated to hardware development.

The major limitations of a program such as I have just outlined are: first, it constitutes only 10-25% of the students' academic workload; second, the program functions on a traditional academic schedule; and finally, a critical shortage of funding results, generally, in less than optimal solutions.

At this time I would like to summarize what we in the Department of Mechanical Engineering at SDSU have learned as a result of our involvement in the application of technology for the disabled. With respect to the design morphology we can best summarize by modifying our listing to read:

- Information Gathering: What are the needs? What is available?
- Engineering Feasibility: What can be done? Can we do it?
- Economic Feasibility: What will it cost? Who pays?
- Preliminary Design: Do it.

In a somewhat more meaningful list of learned experiences: First, we have discovered that we must involve clinical professionals to aid in the design process. Second, we must also include members of the disabled community in this process whenever possible. Third, to broaden our economic and physical support, we need to work more closely in a joint effort with private industry and various funding agencies. Fourth, on a positive note, we have learned that engineering schools can have an immediate impact on the local disabled community. The key word here is immediate. Finally, the most valuable contribution of a university engineering program could well be the introduction of the budding engineer to the challenges and rewards of designing technological aids for the disabled.

QUESTION: Do the students in your program go to another school if they are interested in pursuing further training in technological aids for disabled people? Is it an enticing field to them? Is there a lot of public relations?

ROBERT MURPHY: I haven't seen the PR. We have some students who might be able to answer that in a little bit. Yes, if they want to continue on in any depth they can go on. We do not offer a rehabilitation engineering degree. Stanford University, associated with Children's Hospital, has an internship program just for that type of individual. I don't know if any of our students have gone on to that type of program.

QUESTION: That's the only one in California?

ROBERT MURPHY: There's only one person per year in that program. There are programs around the country. The University of Virginia has a fairly large program. It's not a big field right now--for the engineer--as a separate discipline.

QUESTION: In order to generate a lot more of this kind of activity, I wonder if you would think of going to a university that didn't have a program like this and requesting that some students be given special projects with disabled people in the community and work with them on some simple adaptive device that would make their lives easier.

ROBERT MURPHY: I would recommend that if your local engineering school doesn't have a similar program to ours, go to them and ask them if they could respond as you requested. I know that many times engineering design professors are looking for challenging projects and may be interested in the possibilities. Unfortunately, there's a dichotomy there. Many of the devices that the disabled community need don't offer enough of a challenge for the engineering educator and it's difficult to feed it into the curriculum goals of the department. Thus, some accommodation has to be made on both sides and I'm not sure where that balance is. We are responding right now in a form that I have been allocated. Right now, I think I have about six or eight students that I can assign pretty much to any project that I want, so it could be what I would call a "Mickey Mouse" project. It's just that it doesn't have many engineering challenges, but it is something that, as you point out, would be extremely useful to either the professionals in the field or the disabled. But this is the first time since I got into this that I had that leeway, felt that I could take that approach.

QUESTION: I'd like to challenge the question that low tech is not academically respectable. It has to do with the dimension that might be called designs. There has to be a design challenge to make somebody think. The technology is irrelevant and any good engineering program would make that distinction. It's the design that's the challenge, but if it's a ramp going from ground level up two feet, there's little or no design challenge. If you could rephrase it so that it has to be done in some particularly interesting way, like the ramp can't touch the ground at either end, you may have hooked the educators. You may have to get a little inventive to hook them.

ROBERT MURPHY: We were somewhat burned on a project that's going on. One of our students is working on a project and on first look it seemed to be a simple project and so she was assigned only one unit for that project. Well, pretty soon we found out that it's not such an easy project. We make lots of mistakes like that--what appears to be straightforward turns out to be less than straightforward. So, as you say, a good selling job is what's needed, you must really think about what you need, and explain it to us, so that we don't jump to erroneous conclusions.

DAVID USSELL: At Stanford's program, one of the things they emphasized was not to set up a special rehab engineering department. The idea was that if you train someone specifically to be skilled as a mechanical engineer, then you can better apply those skills in the field of rehabilitation engineering rather than design a degree that doesn't really give the student the full engineering background.

From a design viewpoint, when you start to take all of the human factors and all of the constraints into consideration that our last speaker talked about, I've never seen an easy problem--particularly those for daily living; they're very difficult.

I'll try to keep what I have to say brief. I am coordinator of biomedical engineering at Children's Hospital and also I hold the position of Adjunct Professor at San Diego State. I was hired at the hospital because I had a little experience in lasers, cryogenics, optics, video, acoustics, computers, electronics--nothing really in depth, but for the type of program I was hired under, that was really just their cup of tea. They wanted a little of everything, an interface person really, to deal with many different disciplines and sort of pull people together, technologically. I was actually hired to do hardware and software for some evoked potential research. As soon as notification leaked out to others in the hospital (occupational therapists and physical therapists) of some of the things that could be done, I found myself inundated with a tremendous amount of needs. I have limited time and there are many projects that I would like to pursue in depth that I just cannot do. I was very happy to work with evoked potentials--I find that very interesting, but I'm sort of interested in problems of the handicapped and disabled.

In December 1979 there was a Technology for the Handicapped Child Conference held at United Cerebral Palsy and set up by Dr. Sterling and Roger Jeffco. I found it interesting. I didn't understand at the time why there are so few engineers in a meeting like this. It was being conducted by an engineer and, as far as I knew, I was the only one there. I made a fatal error of asking a certain amount of questions that sort of indicated where I came from, and once again I was pounced upon. I just had too many things to do. This experience instantly revealed to me that engineers who had been nice guys in the past were just totally bombed with work and probably got out of it in order to save their family life.

Some of the problems were avertible. They were things I was able to find a source for, something that was already available. Some were too mechanical; it does take a lot of time to create mechanical things. Some were just too involved and couldn't be handled. I was able to handle quite a few of them, but being up rather late one night and feeling totally sick of what I was doing (I didn't feel that that was a good way to be since I had gone in with such a great deal of enthusiasm), I woke a nephew of mine, who incidentally was a mechanical engineering student at San Diego State. Obviously, a thousand Egyptians can move a pyramid in one hour much further than one Egyptian can move a pyramid in a thousand hours. It suddenly occurred to me that I had a large university nearby that had all these students desperately in need of projects. I did indeed go to the university and say I have projects for you.

I have access to a large data base, or group of people who have considerable medical experience and I have some engineering experience. So we presented this to State along with the problems we had; i.e., we didn't have enough time, staff, money, or mechanical expertise. They said, "We've got a little mechanical expertise." So, we were able to match our skills. It was quite a good marriage. The assistance was available, the medical assistance on our side, the mechanical assistance on their side.

State was not only anxious to help us, they had sort of been looking at the situation from the other end. As Dr. Murphy indicated, they had been trying to develop a program, and from time to time, they had students on campus bring them their needs. There wasn't a large body of medical problems. Not every student is interested in designing a device to help in potty training. There are some things that have a little more charisma than others. So in integrating the projects into their program, there were basically four ways that we had to go: First, they had a junior engineering course that Dr. Murphy mentioned which unfortunately does result in paperwork for the most part. The design gets completed. Maybe later, a senior project class will finish it. The second alternative is the senior projects course which not only creates a design but actually manufactures a product. The disadvantage of the course is that it's not very fast. Many times these projects take the full nine months that are allocated for the course and sometimes beyond. The special studies course, the third option, doesn't require quite so much documentation and projects can be cranked out a little more rapidly. For the fastest projects though, we generally use the fourth method: volunteers.

Looking at engineering curriculums today, I was very surprised initially to see how many volunteers we were able to get. We've had several and they've worked on some substantial and worthwhile projects, one of them you're going to hear about today. Initially, we started out in total ignorance, designing things like lap boards, which, although important, are available from many other sources and weren't that challenging. We went into wheelchair modifications. There was a particularly interesting problem with an iron lung which Mitch will talk about later. We worked on wheelchair devices to load wheelchairs into vans. I've got a student right now who is working on a continuous passive motion device for people who have knee replacement and who require some type of exercise after surgery.

It can be frustrating for students to sit in class and work on concocted projects. Some of them are meaningful and some of them aren't. It's frustrating to work on something knowing that it's not going to be used or there's no end in sight. I don't know if anybody here was in the service, but when you walk around empty buildings at three o'clock in the morning guarding it just for the experience, there is a certain sense of frustration. We went to State with real problems, in many cases pressing deadlines. For example, we helped a lady who has a progressive disability. If I had had to put her in the queue of work that I would eventually get to, by the time I would have accomplished the project, she would no longer have needed it. She would have needed something further or the need would have totally disappeared.

I think it's quite good for students to know that they are really working on something that will do actual good for someone. There is a real product that will come out of this that will help someone. Students have the enthusiasm we need and to some extent, time. I'm sure many students would disagree with that, but for one project, this is a good way to channel their energy.

Students get a great deal from working on real world problems. They get, I think, considerably more satisfaction than if it were something that was brought out of a textbook. It brings an awareness of the disabled community's problems that I don't think a lot of students really get anywhere else. Someone mentioned before that people see the chair going across campus. They don't see a person in there. These projects make students realize that they themselves are only temporarily abled. Whether by accident or age, there will come a time when we're really not able-bodied and we will have to depend on others.

There's something else a student gets out of this that I think they need and that's connections. Connections are very important to consider; there's not an engineer in the world worth his salt who cannot come up with something unobtainable through some obscure means. Engineers have to be able to get things that aren't available through normal channels. I think if we look at the financial situation here, our students have done exceedingly well: writing to manufacturers, convincing the right person at the right time that it would be a tremendous benefit to the community if they would donate this piece of equipment which is prohibitively expensive. It works very well, I'm glad to say.

For the engineering experience, it's a tremendous opportunity. The students are able to take a project from conception. They are encouraged to work with the person who will be using the end product, so there is an interactive process; it's not something that's done in a vacuum. They are required therefore to manage their own project. They're responsible for ordering, allocating time, selecting materials, arranging manpower, consulting, researching, documentation, constructing, testing, and, if necessary, software, as some projects are computer-oriented. This has a tendency to stimulate a lot of creativity.

I've encouraged the students to do their own creative thinking. In many cases that has not worked out. Somebody came up with a creative idea last semester. We had a wheelchair with the switch on the side. The switch from high to low was inaccessible to this person. It was on the rear, and it was hard to get. One person measured it and found that it took a fair amount of pressure to push it. To generate a large pressure, he put a little rack-and-pinion and worm gear and got a tremendous torque on it. That's nice, but if the switch fails, if anything goes wrong in this mechanism, it will break the switch right off. It's got too much power. We suggested a cam or something so that if it failed, it would turn it off again. The creativity is there. They're able to come up with some great ideas, but, as Dr. Murphy indicated, at the junior level, there's not a great deal of experience. This is a fantastic way that they can get firsthand experience.

The program has established a very strong belief in Murphy's laws, i.e., Murphy's law in general. The favorite one that I think is conveyed to the students is how long things take to do: you make the absolute best estimate you can of how long it will take and you double it and increase the units by one. Therefore, something that would normally take one week takes two months.

Where do we go from here? As these programs go on, we're hoping to expand them quite a bit. Of course, funds are limited, but there are other ways we can do things, e.g., volunteers who are able to find their own funding sources. We're also adding more electronics--the local IEEE chapter, the Institute of Electrical and Electronic Engineers, has volunteered their help and therefore we're able to put more electronics into the projects that we have.

Recently, Children's Hospital, realizing (1) the need and (2) the fact that they're having trouble, as we all are, finding money from various sources, allowed me to take on more and more rehab projects, many of which are coming from outside. How we are going to fund it I have no idea, but luckily at the moment I don't have to worry about that.

We're attempting to modularize as many of the projects as possible. Nobody wants to reinvent the wheel. We're looking into smaller microprocessor-based systems with the absolute minimum amount of external hardware to make it specific to this person's needs. There are some very nice computer systems on the market geared towards handicapped individuals, e.g., Possum and the TIC system. The biggest problem is they're geared specifically to the handicapped individual. When your volume is low, the costs are high. On the other hand, if someone were to make small modifications with systems like Apple, they could probably sell a small peripheral that goes in there very inexpensively. For instance, an environmental control system, something that will control anything that you can plug in an outlet in your house can be added onto the Apple for the base cost, about \$130. It works with the BSR remote systems and you can add about \$15 per module on top of that. Depending on how many things you want to add, it could be quite inexpensive. (One thing I've got to mention on the Apple, although it is a nice computer and does a lot of good things, the keyboard could cause a problem for a person with any kind of instability at all. Unquestionably the key you hit most on a computer is the return key. It's like the activate key, but it's about a quarter inch away from the reset key which erases everything in the memory of the computer.)

We had someone this morning speak about the Senior Corps of Retired Executives to be tapped, just as we were able to tap off the large student population for projects like this and I know that you're also aware that there is an organization called Telephone Pioneers. There's also a very large group of engineers who've retired without something to do. A lot of them hit the obituary column a short while later for feeling that they're not needed. I talked to Dr. Murphy about that and if we could get a group of retired engineers into the program, they could perhaps work with the students, offering their expertise.

One final note, just to deviate slightly from mechanical engineering, computing in engineering offers a wonderful opportunity for disabled people. There are many ways to get in and out of a computer. Computers are so inexpensive now and there is a tremendous demand for software. It is really an opportunity to take your time, do it at home, do it anywhere you like and create software. Just because a person can't move around as easily as someone else doesn't mean that they ~~can't necessarily~~ think like the dickens and really create super software. There's a very, ~~very big~~ market for it, and I think it's a great opportunity.

One final thing, I'm finding that more and more occupational therapists are bringing me trivial problems. I think it's probably because most of them are female and they've been deprived of a technical education, not necessarily through their own accord. I think in the not-too-distant future we're going to have a workshop to teach some of these people, nurses and people like that, simple things like switches, how they work, and the types that are available. It's very common when you see someone going into a computer store for the first time and they say, "What can it do?" and the salesman says, "Anything you can think of." Well, of course, if you've never seen one before, never worked with one before, you have no idea what it can do. It's ridiculous. So if a person has a basic idea of what switches are available, what can be done, then I think we can go along with that.

QUESTION: In the state university, how did you make the marriage between the electrical, mechanical--and all the other schools of engineering?

DAVID USSELL: We haven't really got together with the electrical yet. I've approached the Institute of Electrical and Electronic Engineers. They have a student chapter on campus and they're willing to work with us on projects. As I said, our program is expanding, but up until now I've been able to handle all the electronic and computers and microelectronic stuff.

QUESTION: I think the use of the computer as a tool is important no matter what the career. You don't have to be a computer programmer if you're using it as a tool.

DAVID USSELL: That's right. In education, some of the computers are being used. A computer has an infinite amount of patience. I don't know if you've ever tried to drum something into someone's head and they just can't get it. A computer will just sit there and try it from different tacks. The computer can also teach a student that there isn't a single straight line between the problem and the solution. There are many ways to that solution and too often students get frustrated, give up, and ask for *the* answer. There isn't *an* answer to anything, there are a number of answers. Some computer systems are quite flexible, e.g., the *Logo* computer system, which enables the computer to learn how a child thinks. It doesn't teach programming to the child. It learns from the child and does what it wants.

Mitch Hart will be our next speaker. He is a student who has actually taken on one of these projects and done quite well.

MITCH HART: I'm Mitch Hart and I'm a chemical engineering student at San Diego State. I'm employed by West Tech Services, which is a geothermal engineering consulting firm downtown that has also recently been handicapped by DOE policy. I'd like to relate my involvement, experience and some thoughts regarding my engineering-oriented interaction with disabled individuals. My initial involvement stemmed from an invitation from Dr. Murphy at an ASME student meeting. He offered individuals wishing engineering experience an opportunity to jump right in and also satisfy altruistic tendencies at the same time. This was about a year ago when I was in electronic sales and attempting to find a job closer to the engineering profession. I volunteered and selected one of the tasks. Simultaneously, I received an offer from the company I'm working for now.

The initial device which I elected to design and construct was for a lady with post-polio who has to give her respiratory system each night off by sleeping in an iron lung. Her physical condition and the height of the lung carriage required her to have assistance in getting on and off of the bed. Basically the device was a lift. It raises her from three-and-a-half to twenty inches and is attached to the lung carriage by means of an aluminum bracket. The lift is required to roll with the carriage, on wheels, in order to allow placement within the carriage track, so that she doesn't have to teeter on the edge as she gets in and out of the lung. Basically, she gets up on the lift with an outward position and the lift is controlled by a li[illegible] switch. The lifting platform itself is about 18 by 12 inches with an 18 [illegible] square stationary surface, providing an additional area for her to step on [illegible]e gets down from the lift. She steps down with her back toward it and ca[illegible]e it. Operation is fairly straightforward. It was kind of a bear to des[illegible]ut it just uses an imported car scissors jack, which raises and lowers t[illegible]form and is guided by the steel rods in each one of the corners. The spr[illegible] the bottom provide an additional momentum from the down to the up positi[illegible]se the jack loses its efficiency when it's all the way compressed. As I s[illegible]lier, the platform is activated by a spring-loaded toggle switch which co[illegible]s a reversible AC motor through some mechanical linkages--it is a Craftsm[illegible] universal socket joint--through the circuitry. The entire electrical system is fused and there are limit switches that control the maximum up and down travel of the platform.

QUESTION: It seems incredibly simple from the photograph, but how much did all the equipment cost?

MITCH HART: I'll give you that at the end. It functions perfectly and it's got a total investment of about $150 and about $100 in time. The majority of this was all accomplished last summer.

In actual operation, the lung is moved in and out of the assembly by her as she gets on the lift. She gets inside and she pedals. She has some difficulty in pedaling both assemblies in and out due to the weight of the assemblies and the rolling resistance. The initial solution, which was to put the entire assembly on a plywood track versus the carpet, was marginally successful, but it still required her to exert more effort cranking the assembly in and out than it did to climb from the ground level to the carriage with somebody else helping her. Another student at State is working on a motorized drive. While it sounds simple, it has to be fail safe, in that if she has a power failure and she's within it, the cranking mechanism still has to enable her to go in and out. She wouldn't want to be trapped inside. This is not being used at the moment until the other drive system, which will either (a) drive one of the wheels or (b) drive the crank mechanism, is complete.

The second item I've been involved with is a switching mechanism to give an individual with muscular dystrophy the capability to control the fast/slow speed selection switch on the wheelchair. Looking at the wheelchairs here today I gather this is probably an old model. I'm not familiar with the state of the art in wheelchairs. The switch is located at the top of this vertical rod. Primarily, the position of the switch and his motor capabilities don't allow him to activate it. Sometimes he can and sometimes he can't, but it's quite a strenuous effort and he doesn't always succeed. The simplest solution of relocating the switch was ruled out because it is a rented wheelchair and it would involve major modifications. It's quite a high current handling switch. So, the final solution was a pair of solonoids triggering the T-bracket mechanism which pivots about the center. It's activated by a switch. It's fairly straightforward in operation and once I got it designed and built, it worked perfectly. Another consideration in designing it was when it does throw the switch, you don't want these solonoids actuated because they continue to draw power from the batteries. As soon as it actuates its switch, the mechanical resistance of the switch keeps the mechanism in position until the other pair of solonoids reverses the direction.

The total investment on this is about $30 and about 40 hours of time. I should also state that this isn't entirely complete yet. This whole device is going to be sealed to keep out any water and dust and insure continuous operation.

DAVID USSELL: I might add something to Mitch's presentation here. One of the driving factors was the cost and availability of parts.

MITCH HART: Hold it, hold it. You're blowing my whole speech. One of the major design influences on both of these has been monetary considerations. Ideal solutions that I came up with were great but the fiscal trade-offs just had to be made. The results of the trade-offs on each one of these is that the platform requires about 14 seconds to go from three-and-a-half to twenty inches, and the switching mechanism on the wheelchair weighs about 11 pounds. Again, this is primarily due to the lack of funds.

But, regardless of the fact that there were drawbacks, both items do accomplish their purposes and the drawbacks were quite small compared to the overall benefits. Regarding the fiscal situation here, I'd like to thank Dave who has personally borne the financial burden for both of these and has also been a big help. If anybody does have any innovative ideas for funding devices of this type, mainly for students, talk to anybody on the panel or raise the question a little later.

QUESTION: Did you go to the parents of these people? Or the woman?

DAVID USSELL: She has no living relatives.

QUESTION: The mother and father of the young man?

MITCH HART: He does have a family. I'm not sure what their financial situation is. I accomplished all the installation work at their house.

QUESTION: Consumers often want to pay for their own devices, if they can afford it. Too often we go for third parties before we ever say anything to the consumer.

DAVID USSELL: Mitch hasn't worried about it too much because he hasn't had to pay for it. Of course, I haven't received my reimbursement yet. I'm still trying to fight and see if I can get the money from MediCal (or Medicare) on the lifting device for the iron lung and the other is trivial by comparison. That's why really nothing has been done.

QUESTION: I think the chair that the fellow with muscular dystrophy is using is great. It's really delightful that you could develop economically a system that makes him able to perform the function that he needed to. But most importantly, is he using the chair that's the most appropriate for his needs? Why isn't there something else happening to provide a fellow with muscular dystrophy a chair that allows him to optimally function in the first place instead of having to jerry rig a device for perhaps an inappropriately prescribed chair?

MITCH HART: I'll agree with everything except jerry rigged. It's a good question. I really don't have an answer for that.

DAVID USSELL: I think part of it has to do with ignorance on our part. We're relatively new in this area.

QUESTION: That's the point I want to get at. It goes back more to the question of developing meaningful ways of getting involvement from disabled people at stages prior to product testing, i.e., at conceptualization, at choice of problems, at ways of dealing with those problems.

DAVID USSELL: You have to consider our bias too. We're not really concerned with whether that is the best chair for him. We see a problem for a student as an opportunity for the student to learn something.

MITCH HART: The way I was introduced to it was that you got a little box, and this box has to do something else, and you can't change the box, you have to modify it.

QUESTION: I don't mean to be difficult, but the way you treat the students is the way they act professionally later on.

DAVID USSELL: All right, to tell you the truth, we didn't think of it. I don't mean to belittle your question at all. It's very valid.

QUESTION: I was curious to know if the members of the student chapter who show an interest just volunteer?

ROBERT MURPHY: If it's truly a volunteer process, it's pretty much divorced from the curriculum or individual departments. It's a one-on-one with the student engineer. It's only if we try to do it in a more formalized fashion through a course that there has to be some approval from the instructor or the department chairman or whoever. To answer your question on how some of this stuff gets fed back into the engineering school, at least in our department, we have done it on a conscious effort. We send the students out looking around for professionals in the field. As soon as the professionals in the field seem to know that we're there, we have no problem getting meaningful problems.

I'd like to answer another comment. One of the things that we do try to teach in this design course through information gathering and problem definition is whether the project is necessary. We have good news and bad news when we ask some people that question. I guess you have to be very diplomatic about who you ask this question. Probably we've gotten burned a couple of times. We make an assessment which is not necessarily always correct and respond more to the engineering challenge than to the human challenge.

Occasionally some of our bad information has come from the disabled community. It's like asking anyone about a technological product that is a new product. "I can't possibly use that" or "it's no use to me." So nobody has all the right answers here, including us.

ROBERT CUNNINGHAM: I'm Robert Cunningham. I'm a student at San Diego State working under Dr. Murphy in the mechanical engineering department. I'm one of the students who is participating in his course and working with rehabilitation engineering. I transferred to San Diego State just this year after undergoing back surgery about two years ago and so I'm approaching this course, engineering and school from a slightly different perspective--as a student and as being disabled. I heard a lot of comments today about people wanting professional engineers, problem-solvers, to go back to the source, the disabled who are having problems. I've talked to people at the disabled students' center at San Diego more as a friend and fellow student and found out that they have had problems for which there were simple solutions that they didn't know about, didn't have access to the information, or didn't realize that they have access to the information. There is equipment that's available that's not very well-publicized, equipment that they could use and that would be very helpful to them. There are binders full of the information right there in the office. The person who needed the equipment was in the office also, yet the two didn't quite come together. I've noticed, in Dr. Murphy's course, that sometimes projects we design are very useful and end up being put into immediate service, and other projects end up down in the basement waiting for a little bit more work by some other student. It's not to say these projects are useless; they need some development but they have a lot of potential.

I'm working on a project with Dr. Murphy for monitoring pressure under people in wheelchairs, to somehow prevent pressure sores. This is a very serious problem and something needs to be done. My project looks like it's going to take many years of work by me and other students that come after me. I'm just beginning this project, and this whole engineering relationship is just beginning; it's not perfect, but I think that it's being developed and I think it's a step in the right direction. We need to focus on talking to the right people, getting the right things done, in the order in which they need to be done. I think we're heading in that direction.

QUESTION: Have you seen any devices that have already been developed to prevent pressure sores?

ROBERT CUNNINGHAM: Yes, I've come across different devices in the literature. I've been to Sharp Rehab and talked to the therapists. They were disappointed with their pneumatic pressure sensing device. It wasn't very accurate or reliable; different people got different measurements and it was questionable. I talked to them about developing some sort of a mapping system that would measure the pressure under people all over rather than in one spot. We've had a lot of problems. It doesn't look like my project will be finished in the foreseeable future, but we're starting, as I said.

ROBERT MURPHY: We're really looking at the material--polyvinyl, flouride, electric plastic--and looking at the applications of that.

ROBERT CUNNINGHAM: The vibrator finger reader uses that material as the vibrating rods. It's worked in a different fashion. It's rolled up like a cigarette in a cylinder and applying voltages to that causes it to vibrate and that's what you read. If you can go that way, you can go in the reverse of that, namely if you put some force on it, it puts out a voltage and so it has some potential uses as a transducer, sensor, feedback sensor, etc. So we're trying to get a better handle on it. There's quite a number of places that are doing work on that same material, e.g., the government, the Naval Ocean Systems Center, and other universities across the country.

Technology for Recreation

CHESTER LAND: The purpose of this panel is to discuss the role of recreation and leisure in the lives of disabled people and to explore ways in which technology can assist disabled and able-bodied people in removing barriers to participation.

Each of us could present our own definition of recreation, and all of our definitions would differ. Our challenge, then, is to present the technologist with a problem to solve in a life area so far-reaching and personal as recreation.

Why does recreation not enjoy a higher meaning in this society? Why is it, when funds are cut, recreation is the first to be eliminated?

During the days of the industrial revolution in the United States, factory workers were given breaks to "recreate" in order to improve production. Soon a connection grew between work and recreation. Recreation followed work; in a sense, recreation was earned by working. What happens if you don't have a job? Have you not earned the right to recreate? If this logic follows then many people in our society are faced with the dilemma: How can I recreate when I haven't earned it? When this attitude prevails, recreation is not viewed as an inherent right, and an attitudinal barrier to participation is created.

We are here today to discuss the interrelationship of recreational activities, rehabilitation, and the quality of life for people with disabilities, and the part that scientific technology can play. The following panel members are involved in work related to recreation and technology. They will participate in a question and answer session and share information in their areas of expertise.

Following is the list of panel members and their respective affiliations:

- Chester Land
  Director, Therapeutic Recreation Program
  Rancho Los Amigos Hospital
  Downey, California

- Peter Axelson
  Rehabilitative Engineer
  Veterans Administration Medical Center
  Research and Development Center
  Palo Alto, California

Marti Hacker
Peer Counselor, Supervisor of Recreation
Community Service Center for the Disabled
San Diego, California

Roy Gash
Manager of the Spoke Shop, Wheelchair Repair Department
Community Service Center for the Disabled
San Diego, California

Marri Taylor
Community Worker
Community Service Center for the Disabled
San Diego, California

QUESTION: What are some of the psychological benefits derived from participating in wheelchair sports and recreation?

ROY GASH: I feel more confident about my physical abilities. Racing has improved my eye/hand coordination. After finishing a race I feel great.

MARRI TAYLOR: I think it's great for people to compete, physically. It's a rewarding experience whether it's playing cards or playing football. Competition is important to everyone, and sports competition is especially important.

MARTI HACKER: Recreation counteracts the all too possible isolating effects of being disabled; it provides a way to meet others and a chance to participate in activities with able-bodied friends. Thus, recreation can eliminate the depression that commonly comes with boredom. Health and good body image are essential ingredients of self-image. Above all, though, recreation can provide *fun*, something that disabled people often fear will forever be missing in their lives.

CHESTER LAND: Everyone owns the right to play, to enjoy playful moments and not feel guilty.

QUESTION: How can technology benefit recreation for disabled people?

MARTI HACKER: One of the most important differences between recreation for able-bodied people and for disabled people is the need for additional manpower to help with setting things up for disabled people's use. Technology can be very useful here, since proper design and mechanical assists can eliminate the need for much extra manpower. From a disabled person's point of view, this is usually a plus, since most of us do not like having to depend on another person any more than necessary. Mechanical adaptations increase feelings of, and indeed our level of, independence.

QUESTION: How did wheelchair sports and the development of special equipment for these sports develop?

ROY GASH: Wheelchair sports have promoted the development of better, lighter and more durable wheelchairs. All of the changes in wheelchair design have come about because of disabled people using available equipment and not being satisfied with it. The men and women who participate in sports and other recreational activities have developed modified wheelchairs to make them lighter, to fit the sport, and to personalize the chair to make it fit the individual.

The use of wheelchairs in basketball, track, tennis and off-road activities has promoted the growth of a new generation of wheelchairs for the active wheelchair user. Wheelchair design has remained basically the same since the 1930s when Everest and Jennings started selling their chair. Until the early to middle seventies, all wheelchairs were copies of this basic design. In the past five years, however, many improvements in wheelchair design have been introduced. These innovations can be traced directly to wheelchair sports; the changes have been made by disabled people thinking about the equipment they use.

All of the chairs which were designed for sports are useful for people with arm and hand weakness. The newer, lighter wheelchairs on the market today can make the difference between a person being dependent and independent--someone with impaired arm strength can push his or her own lightweight chair, whereas it would have been impossible with the older models. This increased independence is directly related to the many hours spent developing a better wheelchair.

Quality wheelchair hubs for everyday use are another result of sports. There are several different hubs being manufactured today. These are a great improvement over the standard wheelchair hub. Many wheelchair users find they greatly improve the way a chair rolls. They, too, are especially helpful for people with weak hands or arms.

Most of the newer equipment on the market today which enables disabled individuals to compete in track, basketball, snow skiing and many other activities is the direct result of a disabled person or group of disabled individuals designing quality equipment for their specific needs.

QUESTION: What are some of the technological adaptations made to wheelchairs for recreation or competitive use?

ROY GASH: The wheelchairs used in basketball were the first to be modified to make the chair more manageable. This was done by adding axle plates to enable the user to change the center of gravity. Negative camber was created by using a camber bracket to spread the frame wider at the bottom than at the top. Excess metal was also cut from the frame. These changes were standard if a person wanted to be competitive while playing the game.

Today the majority of people playing wheelchair basketball use lightweight alloy wheelchairs. These range from Quadra, Quickie or Stainless basketball chairs to locally-made lightweight non-foldable wheelchairs. All of these newer chairs have adjustable rear axle positions, quick-release rear wheels, adjustable front casters and adjustable back heights. They also come in any width desired by the user. These new chairs have improved bearings all around, as well as stronger, improved hubs and front casters. They are also stronger than the old models.

The wheelchairs used in track were originally the basic wheelchair design. The same modifications made to the basketball chair were made to the track chair, except the track chair had more weight cut from it. Some people used sagged or sagging upholstery to lower their center of gravity. Smaller push rims were used to increase speed.

Today race chairs are specifically made for racing. Race equipment is designed for the individual and his or her disability, using the design of the chair to increase speed and muscle groups to their utmost capacity.

My racing chair is long and low. I use 700 centimeter wheels and high-pressure clincher tires. I also use Phil Wood hubs. I use inch-and-a-quarter pneumatics on the front so that I sit about 13 inches off the ground. I have steering handles on the chair because on downhills and curves steering is difficult. These are some of the adaptations that can be made.

QUESTION: What are the benefits of cambered wheels and Phil Wood hubs?

ROY GASH: Cambered wheels help for stability and turns. You can turn quicker and not have the likelihood of turning over. There are chairs now with variable cambers. You can adjust the cambers with a setting, but they're low production chairs. In addition, there are wheels that pop off, just push the button and the wheel comes right off. That helps as far as putting the chairs in cars or other places.

I think it would be hard to improve the Phil Wood hubs. If I took my wheel and spun it, it would spin twice as long as any other wheel in here without a Phil Wood hub. I think they're probably roller bearings, but I don't know for sure what it is. They're waterproof and dirt proof and guaranteed for a lifetime. Even on a very slight incline you just roll right down it, you don't push. Also you don't have one wheel rolling better than the other; they both roll a true straight line.

QUESTION: Where can you get Phil Wood hubs?

ROY GASH: Go to a bike shop. If they carry Phil Wood hubs, they'll string your wheels for $10 or $15.

QUESTION: We see many changes in the manual chairs, but what about the power chairs?

MARRI TAYLOR: I would like to see more technology put into the design of power chairs. I would like to see a chair that can be used in sand, mud, dirt, and any kind of situation. I would like to see wider tires on both the front and back. I would also like to see chairs that are not all chrome, so that they don't have that "hospital look." If wheelchairs could be manufactured so that they could get across any kind of terrain, that would be wonderful. I'd like to help anyone who wants to design that.

QUESTION: Is there a need for more intermediate range power chairs which have the ability to travel several miles daily versus chairs that assist individuals in and out of cars and vans?

MARRI TAYLOR: My chair is a 24-volt and it has the capacity to go about three or four miles in one day.

QUESTION: Is this range sufficient?

MARRI TAYLOR: Sometimes, but not always. It depends on how full a charge the chair has. I would like to invest in waterless batteries and a little beeper that goes off at night to tell me to plug in my chair.

QUESTION: What modifications to the terrain are necessary to make recreation accessible to disabled people?

CHESTER LAND: In Los Angeles, there's an accessible path to the Marina. We constructed a concrete path under the sand and put rails along it that you could move in and out of. If a person wants to go down to the water, there is a chair available so you won't get your chair all sandy and wet. You can transfer to the available chair and move on the concrete path down to the water. If you want to walk and use canes, you can do that. That's one solution that we tried in Los Angeles.

MARRI TAYLOR: Also I've been working with the state Department of Parks and Recreation and they are really willing to make all of the state parks accessible. I'm also working with the county Parks and Recreation Department. The more we can push to have our county parks and state parks accessible, the more disabled people will get out into the public. I've always run into an attitude with people who say, "I've never seen a disabled person here," and I look at the flight of steps or the rocks or whatever and I say, "Well, gee whiz, I wonder why?" It's hopefully up and coming. It's going to take a bit of doing, and unfortunately it's going to take a bit of money, but there is a need.

We're not asking them to pave all their trails. We're asking them to make bathroom facilities accessible, to make drinking fountains accessible, a couple camp sites interspersed throughout the campground that could be made with a little harder-packed dirt or something like that. There's a new combination of asphault and dirt and a couple of other weird things they put into it that can make a hard-pack trail. There is a trail in Northern California--I'm not sure how long it is--but it's a special project and a wheelchair can go the whole distance, but that's unusual. As a disabled person, I'm not asking for total accessibility; that's impossible. If I can't get from here to there, well, that's too bad, but if there's something that can be done easily, I'm all for it. I don't expect the whole world to be ramped; it's just not possible.

QUESTION: How can transportation barriers to recreation be eliminated?

MARTI HACKER: Transportation is truly the first barrier to recreation for disabled people. Because of the expense of specially-adapted vehicles, many disabled people do not drive. There is a tremendous need for inexpensive transportation for disabled people, preferably our own vehicles. Unfortunately, few solutions have been found, although some seem obvious. For example, severely disabled wheelchair users who want to drive have no choice except to use a modified van. Vans cost considerably more than cars, not to mention the cost of gas and upkeep. One possible solution would be a small car with seats removed, allowing the wheelchair user to enter from the back of the car, in the wheelchair, from which he or she would also drive. Such a set-up would also eliminate the need for an expensive lift. In addition to getting to recreational events, driving itself can be a form of recreation. Motorcycles driven from a wheelchair in a sidecar have implemented this idea. Other vehicles, such as street-legal golf carts, double as recreation and transportation for some disabled people. Of course, modified bicycles, either three wheelers or bicycle attachments for wheelchairs, serve the same purpose for short distances.

QUESTION: Peter, why don't you describe the *Para-Bike*?

PETER AXELSON: The *Para-Bike* is a project that started as an idea which I then introduced as a design project for the masters program in mechanical engineering at Stanford University. Two students took the project and I served as a liaison and expressed the needs to them. The result was the *Para-Bike*, the first arm-powered bicycle for the disabled. Four prototypes of the *Para-Bike* have been completed to date. The current version features tilt-away cranks for easier transfer, and multi-functional controlled sidewheels that permit desired lean (including no lean) for cornering while maintaining stability. The results of test riding have demonstrated the potential and desirability of a hand-pedaled bicycle for the disabled person.

QUESTION: What barrier does cost play in prohibiting the availability of chairs and other sports equipment to average consumers?

ROY GASH: Wheelchair sports have helped the development of the wheelchair tremendously. Many individuals are now designing their own chairs, and this is bringing about some excellent technology. Price is still a major barrier. For example, if a wheelchair basketball team purchases ten basketball chairs commercially, the cost can exceed $10,000. However, if they have a welder or a mechanic on the team, they can make all their chairs for $1,000, less the wheels.

QUESTION: What types of ski equipment have been developed for physically disabled individuals?

ROY GASH: There are currently several types of snow skiing equipment on the market. These include snow [illegible] which are compatible w[illegible]. There are several large ski areas which have equipment to loan [illegible] instruction for disabled skiers. Peter, why don't you describe the [illegible]

PETER AXELSON: The *ARROYA* is a [illegible]-like device constructed [illegible] fiberglass. Stainless steel edges on the bottom surface allow for turning and stopping on varying terrain and in various ski conditions. The objective of this research is to continue the development and evaluation of a downhill ski-sledding system for persons who cannot use traditional skiing equipment. Just as important, downhill ski-sledding methodologies must be developed to facilitate the successful integration of this new sport into the existing ski population. The *ARROYA* addresses the neglected recreational needs of disabled persons who would benefit from integration into the whole of society. The responsible application of technology toward ski-sled design development and the establishment of downhill ski-sledding protocal will allow ski programs for the disabled to offer integrative downhill skiing to just about everyone.

QUESTION: How was the *ARROYA* developed?

PETER AXELSON: The Rehabilitative Engineering Research and Development Center at the Veterans Administration Medical Center in Palo Alto, California is responsible for the coordination of development and evaluation of *ARROYA* ski-sled prototypes. RER&D core monies funded the construction of 15 *ARROYA IV* prototypes for the 1979-80 ski season and 10 *ARROYA V* prototypes for the 1980-81 ski season. RER&D also funded three ski-sledding instructor clinics during the 1979-80 ski season to facilitate program evaluation.

During the 1979-80 ski season, the prototype ski-sled, *ARROYA IV*, was field tested at nine ski areas, including Winter Park Ski Area at Winter Park, Colorado and Snoqualmie Ski Summit near Seattle, Washington. Instructor clinics were also held at each of the nine ski areas where ski programs for the disabled are utilizing a total of twenty *ARROYA IV* downhill ski-sleds. These clinics provide instructors, disabled ski program directors and users with knowledge on the safe operation of the ski-sled.

QUESTION: How has the *ARROYA* been received by disabled and non-disabled skiers?

PETER AXELSON: Demonstrations of the *ARROYA* ski-sled at various instructor clinics throughout the United States and in Norway generated very positive publicity. Each clinic received local newspaper coverage and some received television coverage. The objective of this publicity was to make individuals aware of the opportunity for paraplegics to use the *ARROYA* ski-sled, and to increase general public awareness of the disabled community.

Unlike many other sports and recreational activities available to the disabled person, the *ARROYA* allows a ski-sled user to interact naturally with skiers using other types of adaptive equipment (i.e., skies, boots, poles, etc.). This type of interaction between ambulatory and non-ambulatory individuals is not found in "wheelchair sports" (many recreational activities for paraplegics and quadriplegics tend to segregate them from their ambulatory friends). In fact, able-bodied individuals also enjoy skiing in the ski-sled. It is therefore possible that this ski-sled will be used by both ambulatory and non-ambulatory individuals.

One of the things we have had difficulty with is getting outside funding for this kind of work. We have submitted proposals but funding sources don't always recognize the fact that recreation actually needs research. We are going to continue to monitor the evaluation process of the last prototype sled so that we can find a manufacturer that will continue on with the next prototype.

QUESTION: Are disabled people who cannot or do not wish to be involved in competitive sports relegated to physical inactivity?

MARTI HACKER: There are other recreational activities which provide excellent ways of improving muscle tone, coordination, circulation, and cardio-vascular endurance. Most recreational sports are adaptable for many disabled people; the type and degree of disability determine the modifications necessary. Swimming is a sport that can be enjoyed by almost everyone. Adaptations for pools include lifts and sloping access for wheelchairs.

Bowling is another sport that has been adapted for disabled people. A special chute can be used for those who are unable to roll the ball themselves.

Sailing requires help setting up the boat and getting in and out of it--a possibility for technology.

Waterskiing is another sport that has been recently adapted for disabled enthusiasts. In San Diego a ski chair called the *Aquabat* is used. This device consists of a seat attached to two short skis and handlebars. Some type of easily or automatically released hand gripper needs to be designed for those with insufficient hand strength.

These are but a few of the activities which are alternatives to competitive sports. One final word--for wheelchair users, each improvement made in everyday chairs makes participation in recreation easier and more fun.

CHESTER LAND: The disabled community is now beginning to move into the mainstream. How many men as children wanted to be football players but were not big enough, or wanted to be basketball players but were not tall enough? Those were handicapping conditions. The same situation is now beginning to occur among individuals who use wheelchairs. Everyone is not going to be able to play wheelchair sports, but the same leisure feeling can be derived from other recreational sports.

MARRI TAYLOR: For me, fishing is something very individual that makes me feel great. I look upon fishing as a competitive sport as well as basketball or anything else. Whether I am going to get that little fish or not is competition enough for me.

QUESTION: How do individuals who have not been involved in wheelchair sports gain access to communication networks that exist among technology experts?

MARRI TAYLOR: Valuable information exchanges exist among local communities of disabled athletes, sports enthusiasts, and small businesspeople. A major challenge for the future will be to involve small businesspeople in manufacturing innovations as they come out of the wheelchair competitions. *Sports and Spokes* is a valuable publication which contains useful information about wheelchair sports and equipment.

QUESTION: Are there any national centers where individuals with disabilities can receive specific training in sports and recreation?

MARRI TAYLOR: The Vinland National Center in Loretto, Minnesota is a national healthsports center which offers training to disabled and non-disabled individuals. This center provides workshops which focus on skill building in a wide range of physical activities, as well as in the area of health promotion, stress management, disability education, and medical self-care skills. Canoeing; running/jogging; swimming; weight and circuit training; cross country skiing; pulk skiing and ice sledding; archery; wheeling; and poling are some of the skill areas that are addressed by the center. Vinland also publishes *Vin-Lines*, a quarterly newsletter.

<u>Summary</u>

The right to enjoy leisure time through a variety of sports and recreational opportunities is the right of all individuals, including individuals with disabilities. The benefits involved from participation in recreation and leisure pursuits are far-reaching, and include physical, emotional, and psychological benefits.

Wheelchair sports have opened up sports participation to wheelchair users. As the popularity of these sports increases, new developments in wheelchair design are introduced. The popular use of chairs in basketball, track, tennis and other sports has promoted the growth of a new generation of wheelchairs for the active user.

Other forms of sports equipment are being developed by the rehabilitation engineering community. Bicycles and ski equipment are two areas undergoing current research and development. Camping and wilderness activities are also becoming more accessible as national parks and local camping areas begin to make provisions to include persons with disabilities.

As persons with disabilities continue to make their recreation and leisure needs known, advances in technology will continue in this important area. As disabled and non-disabled people continue to play together, technology for recreation will expand and increase access to this life area.

Bibliography of Organizations/Publications
Dealing with Technology for Recreation

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New York, NY 10016
Phone: (212) 481-6359

National Park Service
Division of Special Programs
And Populations
Department of the Interior
Washington, DC 20240

National Therapeutic Recreation
Society (NTRS)
3101 Park Center Drive, 12th Floor
Alexandria, VA 22302
Phone: (703) 820-4940

National Wheelchair Athletic
Association
Templeton Gap Road, Suite C
Colorado Springs, CO 80907
Phone: (303) 632-0698

National Wheelchair Basketball
Association
110 Seaton Center
University of Kentucky
Lexington, KY 40506
Phone: (606) 257-1623

National Wheelchair Softball
Association
P.O. Box 737
Sioux Falls, SD 57101

NHYSRA Lake Tahoe Chapter
Larry Young
Box 1636
Truckee, California 95734
Phone: (916) 587-3911

North American Riding for the
Handicapped Association, Inc.
P.O. Box 100
Ashburn, VA 22011
Phone: (703) 471-1621

Paralyzed Veterans of America
4350 East West Highway, Suite 900
Washington, DC 20814
Phone: (301) 652-2135

Ski for All Foundation
Chris Colb, Executive Director
521 Wall Street, Suite 326A
Seattle, Washington 98121
Phone: (206) 623-2714

Sports and Spokes Magazine
5201 North 19th Avenue, Suite 111
Phoenix, AZ 85015
Phone: (602) 246-9426

United Deaf Skiers Association
Attention: Mr. Gutfran
Two Sunset Hill Road
Simsbury, CT 06070
Phone: (203) 244-3070

U.S. Association of Blind Athletes
55 West California Avenue
Beach Haven, NJ 08008
Phone: (609) 492-1017

United States Wheelchair Sports Fund
c/o Nassau Community College
Garden City, NY 11530
Phone: (516) 222-1245

Vinland National Center
3675 Ihduapi Road
P.O. Box 308
Loretto, MN 55357

Wheelchair Motorcycle Association Inc.
101 Torrey Street
Brockton, MA 02401
Phone: (617) 583-8614

Wilderness Inquiry
2929 4th Avenue South
Minneapolis, MN 55408
Phone: (612) 827-4001

Winter Park Recreational Association
Box 36
Winter Park, CO 80482
Phone: (303) 726-5514, ext. 179

Technology for the Living Environment

RAY LIFCHEZ: In preparing a panel on the subject of technology for the living environment, Cheryl Davis and I sat down and tried to create an overarching theme to this expansive issue. We have selected three central issues which will help us to focus our individual remarks into a coherent framework. The first issue which we will address is the issue of stereotyping when designing, advising, and consulting with disabled clients. Stereotyping is the first barrier to the relationship between the client and the technology professional.

The second issue is closely related to the first. Simply put, this issue is that the means do not always justify the end; you cannot expect clients to accept someone else's concept of what it is to be normal when working with them to solve environmental problems.

The third issue is a double barreled issue which combines the issues of ageism and genderism. These are so deeply rooted in our unconscious, but rarely addressed in teaching or professional work. We have often heard it said about a client or to a client or family, "Well, that's to be expected, after all, he/she is sixty." And as we approach sixty, we realize how ridiculous this statement is.

These interrelated issues will be examined by the following panel members:

- Cheryl Davis
  Consultant in Environmental Issues
  Berkeley, California
- Larry Leifer
  Mechanical Engineer
  Veterans Administration Hospital; and
  Professor of Mechanical Engineering
  Stanford University
  Palo Alto, California
- Heidi Pendleton
  Occupational Therapist
  Project Threshold
  Rancho Los Amigos Rehabilitation Center
  Long Beach, California

• Ray Lifchez
Professor of Architecture
University of California, Berkeley
Berkeley, California

The following remarks summarize major points of discussion about technology for the living environment. Transcription of the question and answer session is not included.

CHERYL DAVIS: I feel that a lack of communication between the designer and the disabled consumer is a major problem. I would like to use a personal anecdote to illustrate this point.

Recently in an airport I visited a restroom which displayed the international symbol of access on the door. The toilet had a foot activated flusher, and as I approached the sink to wash my hands I found that technology had tricked me again. The new improved foot activated sink led me to the realization that there is a definite breakdown in communication between consumer and designer. It is clear that there has been a failure to think through the various ways in which a disabled person moves through and uses a facility.

If an architect or an airport manager had been told, "use the facilities without standing up and without reaching very far," or "assume that you are quadriplegic and can't raise your elbows above your shoulder," then perhaps it would have been fairly evident that a problem existed with the foot activators.

This incident suggests that technical matters are more than technical matters. There is a very necessary grounding in subjective experience and the failure to communicate sufficiently with a client in order to elicit that subjective experience can lead the designer to a very limited definition of the problem. A solution to a problem is based on the problem. Those other factors that aren't taken into consideration will never materialize in the evidence of the solution.

Therefore, the major concern is the establishment of strong lines of communication between the client and the designer. We need to find ways to involve the consumer more fully in the design process. Although this was the primary sentiment during the International Year of Disabled Persons, this sentiment has not been translated fully into action. Consequently, two things occur. First, the disabled client often feels very insignificant, and second, the designer often feels that the client is not very articulate, intelligent, or capable of giving information.

In working with clients to help them modify their environments I learned through experience that there is a particular approach that works best. First the client has to know what is possible. One can involve the client in developing a "wish list" by asking him/her, "If you knew that there were a way to *x*, would you like to do it, or would you prefer *y*?" I found that if you simply said, "What would you like to do?" absolutely no image would come to mind, particularly to people who weren't moving out in the world yet. To elicit meaningful feedback, one must help the client to develop images.

The importance of involving disabled clients in the design process prior to testing and evaluation is critical. When this does not occur, money is often spent for something which turns out to be remarkably inappropriate.

Another important issue that we are examining is age. Most of the devices for living actively in the community are not thought of as appropriate for older people or there is simply no impetus to make them available to older people. This limits the market and limits the mobility of older adults. Many elderly people are deprived cognitively and sensorally because they are isolated from society.

A colleague of mine knew an older woman who was given a power chair for demonstration purposes for a period of several months. At the end of this time she didn't want to give it back. She cried because she had begun to do things again which had not been possible for many years.

Age stereotyping limits a client's potential and promotes a rigid, categorical way of thinking. To say that one device is suitable for people aged 20-40 while another is only suitable for those over 65 places restrictions and limitations on people as individuals, regardless of age.

I noticed in Europe the permobile, for example, has a wide variety of models, including of all things a trainer for children. It can be controlled by someone accompanying the person until they're responsible enough to operate it themselves. That's marvelous. That's a very foreign way of thinking about devices in this country and I do feel that it comes from not involving the disabled people themselves enough, or the parents enough. It may be very difficult for the parents of disabled, severely disabled children to realize that in a few years when you can no longer lift this cute little tyke up in your arms and carry him up the stairs, you're going to want to think a good deal more about modifying the environment and also having the appropriate devices for that person. It's very difficult to reach those people and get them thinking about it but I think, again, it affects the market and it has some manufacturing implications, also.

Sexual stereotypes constitute another formidable area of concern. First there is a very common assumption that women are less physically active than men. Until several years ago women were not so involved in motorcycling, mountain climbing and other high risk activities. Consequently, there have been more males than females who are traumatic quadriplegics. However, now that women are more active, one can expect the proportions to change. Unfortunately, women who are not involved in wheelchair athletics often do not know the options for manual wheelchairs. Women tend not to find out about the new technology partly because it is simply not passed on to them. There needs to be more attention to the human interface. The process of consumer education is too slow, too accidental, and too contingent on the area in which the disabled person lives, his/her sex or age.

As disabled people find more and more effective ways of working with designers, more disabled people may learn to define their own needs more clearly, more concisely, and more articulately. This can only be accomplished through constant communication between consumer and designer. As communication increases, so will solutions.

HEIDI PENDLETON: I work for Project Threshold, a program which addresses some of the problems of the physically handicapped, and I would like to address some of the issues of this program as they relate to my program. Project Threshold is a resource that was developed in a rehabilitative engineering center at Rancho Los Amigos Hospital. This program, which is funded by the California State Department of Rehabilitation, is structured to assist the client in meeting individual needs in the areas of independent living, going back to the classroom, or returning to work.

Our project operates according to a team approach involving a core staff as well as rehabilitation engineers, and community consultants: occupational therapists, physical therapists, speech pathologists and nurses.

Figure 1. Greg Sanders: the carpenter-craftsman. Credit: Ken Okuno

Figure 2. The antikick device, used when ripping lumber to keep the sawed half from flying off the machine, is also useful as a convenient handle for guiding the blade of the saw when there is limited finger function. Credit: Ken Okuno

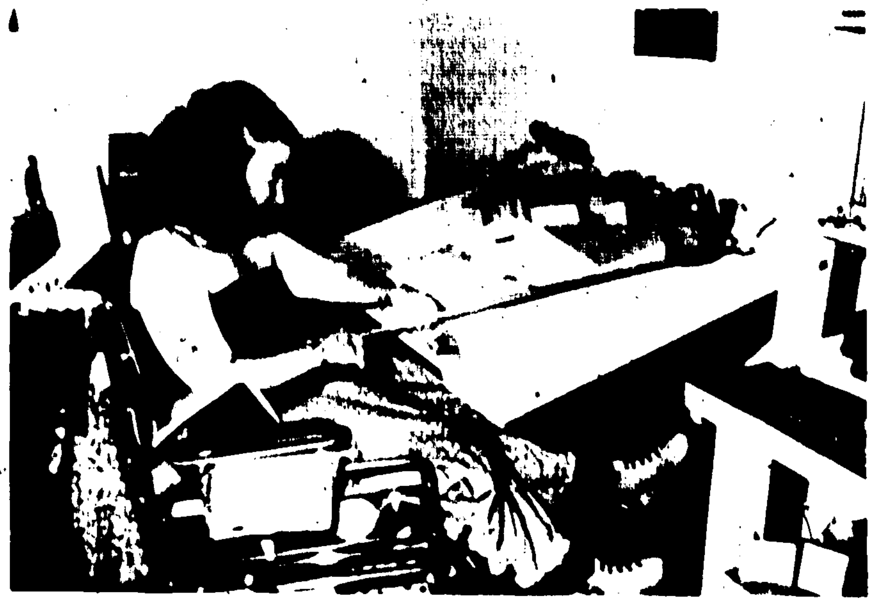


Figure 3. Tools that extend the reach can greatly increase the amount accom- [illegible] without assistance. This device both lifts and pulls and is carried as [illegible] attachment attached to the wheelchair. Credit: Multimedia [illegible] of Optometry, U of CA, Berkeley.

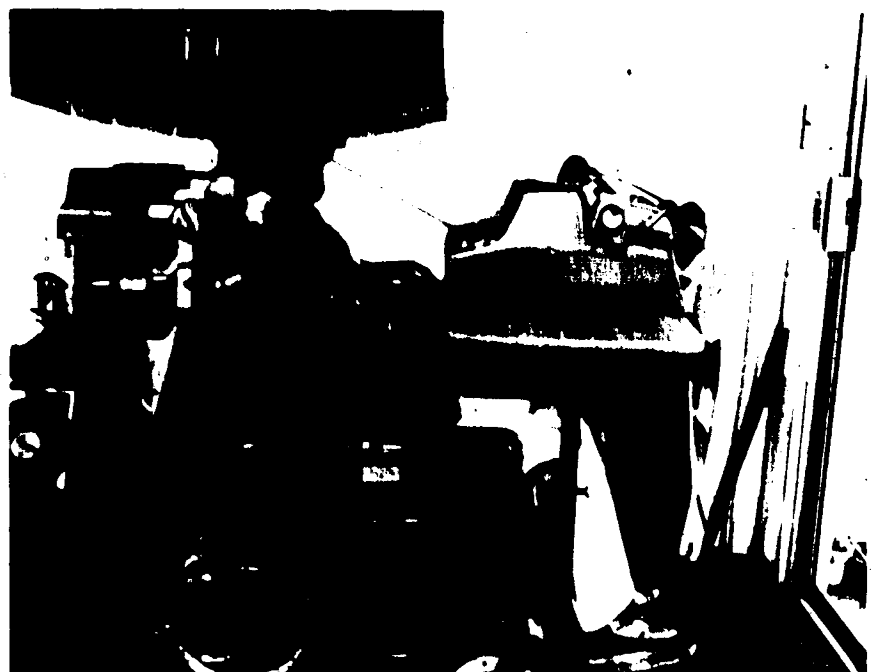


Figure [illegible] A light-touch typewriter equipped with an extra-long sheet of paper [illegible] typing with a mouth wand with a special weighted tip. Credit: Multi- [illegible] Optometry, U of CA, Berkeley.

The first step in our program is to interview the individual client comprehensively. In accomplishing this assessment, we go through the person's day, review their independent living skills, and look at the ways in which they would like to increase their independence. Then this information is taken to a team intake meeting and the team discusses what services are appropriate for the client.

The next step is evaluation which takes place in a model home which our program uses. This is a large building equipped with a kitchen, living room, bedroom, and bathroom. It is stocked with numerous assistive devices and moveable furniture which enables the client to draw floor plans and simulate realistic situations with the equipment and adaptive behavior. Our policy is to try to find the most cost effective solutions to problems. We begin by looking at adaptive behavior and changing the way a person might do an activity. If adaptive behavior is not sufficient, the second solution is to offer commercially available assistive devices. If we're still unable to find a solution then we contact engineers to custom design and fabricate equipment.

The most important consideration in working with clients is to involve the individual in the problem solving processes from the beginning. In the initial interview it is important to tell the client why you are asking certain questions, involve them in the problem solving process, listen attentively, and allow the client to direct some of the process. Often the client gains the skill of using his/her own problem solving process, initiating action, taking control, and furthering independence as day to day problems surface.

Not all solutions to daily living problems are elaborate. Cost effective solutions can often be accomplished by looking at problems creatively. In most of the cases the goal is to create simple ways of creating access. In the 118 cases that we saw last year, we were able to come up with either adaptive behavior or commercially available equipment in 65% of the cases. The average cost amounted to $447 per case, whereas in 28% of the cases we needed to seek engineering input which resulted in an average rate of $1,500 per case. Using this type of client-centered approach results in a cost effective method of accessing simple solutions.

Finally, I'd like to emphasize again, that it is the consumer's responsibility to express his/her desires. The consumer may need to modify those desires as practical implications become evident, but the consumer should be involved and at least talk through his/her needs and desires.

LARRY LEIFER: My work and my concern is with human interface. It is a very complicated task to match a person, the most extraordinary machine in the universe, with a machine made by my own hands and my own intellect. It is important to make certain that we start with the person as an individual, try to understand his/her abilities and disabilities and how the individual wants to be living five or ten years from now.

Today we have talked a great deal about mobility and relatively little about communication. A new class of aids that are just becoming possible for us to even think about building are manipulation aids. These aids create a new opportunity for relationship with the world: instead of having a one-on-one relationship we now have a three point interaction with the world. I'd like to describe a problem in involving disabled people in the task of developing these devices. We begin the process of developing the device by establishing some goal. In essence, I begin with a hypothesis. Then I test my hypothesis by taking a step and checking to see where I am. I am, then, free to change my goals.

I've been concerned with getting disabled people into the design process. By and large, disabled people receive whatever's being done--from the time they enter the medical environment with a disabling condition they begin to receive

Figure 5. A meat fork with a special fitting for the hand allows independence in meal preparation. Credit: Ken Okuno.

Figure 6. An attendant has arranged the kitchen so this blind person can manage alone. Credit: Jane Scherr.

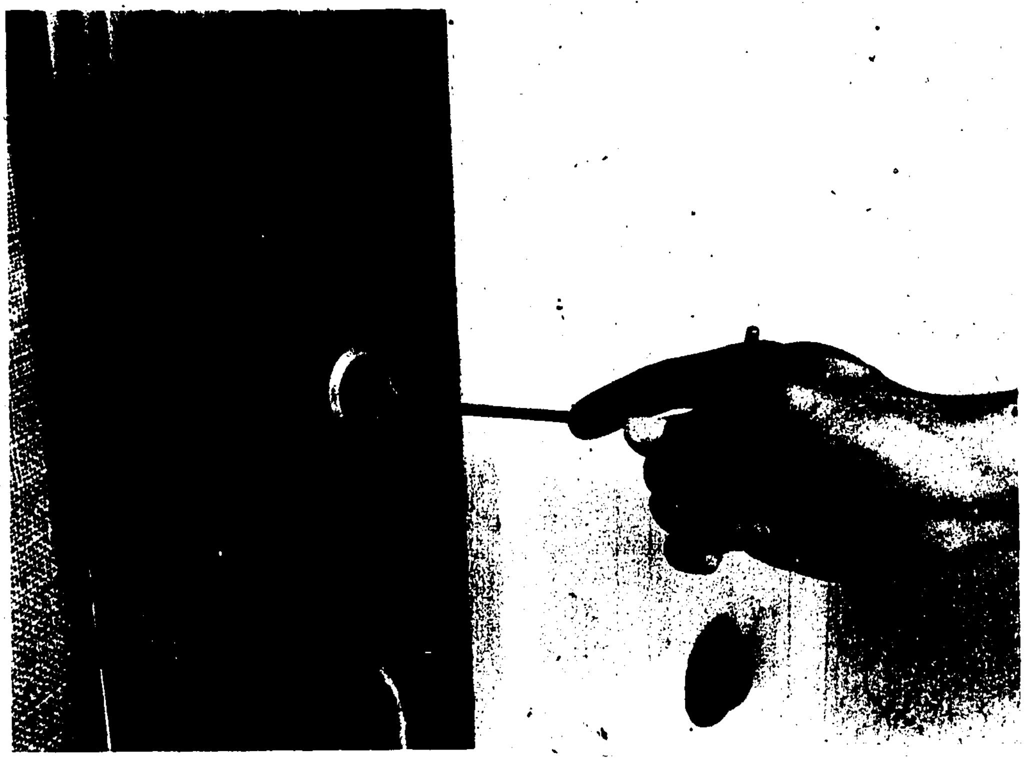


Figure 7. The metal extender bolted to this key makes it possible to unlock or lock this door with limited finger function. Credit: Multimedia Center, School of Optometry, U of CA, Berkeley.

The photographs (credits noted by each) are from *Design for Independent Living: The Environment and Disabled People* by Raymond Lifchez and Barbara Winslow, Berkeley: University of California Press, 1982 (paperback). New York: The Whitney Library of Design, 1979 (cloth).

medical attention and are rarely consulted as to whether or not they want to be made better. That environment's tough in terms of never asking you what you believe about it. We deli[illegible] the disabled person into a rehabilitation/engineering environment and so[illegible]es up and says, "Oh, you need a wheelchair, don't you?" The user just [illegible]d doesn't influence the goal.

It is relatively [illegible]rticipate in the supervisory loop of the process. Becoming a kind of a[illegible]hatever scale allows you to supervise and influence the goals set. [illegible]ougher and what concerns me in particular is how to get people into [illegible] loop. I believe that is connected with education, becoming aware of [illegible] be done and how to formulate your needs in a way that technologically [illegible]eople can interact with. In the extreme, to have control means going bac[illegible]hool. If you don't like the wheelchairs being designed, you could go [illegible]h an engineering curriculum some place and get yourself trained as an engineer and then do the design yourself instead of trying to supervise somebody else who is doing it for you.

Current trends in assist[illegible] devices are delivering an array of materials. Some have bells and whistles; others have rollers and treads. I hope that our objective will come back to the human scale so that we can begin to carefully decide what remains in the h[illegible] dimension to be solved, and what can be appropriately solved by machines. The important questions when planning for and with disabled clients still remain: "Where would you like to live? What sort of an environment do you prefer?" When these questions are addressed first, then a living environment can unfold in which assistive devices have a role. Our mission is to design an environment in which both the assisting devices and ourselves can cohabitate, a place where devices can enhance our lives.

RAY LIFCHEZ: I am interested in trying to get a more complete picture of people in their environments--people at several environmental levels. The intimate level, or intimate environment level, can be defined basically as the body. The wheelchair and clothing are self expressive ways of telling people who we are. The next level, the dwelling environment, could be the home or the workplace. The dwelling place is a place where we have control over our setting. The third level of the environment is the public realm of which we have very little control.

The interview process is a very workable scheme for finding out how people relate to their environment, and how to avoid stereotyping. Choosing authentic sites for interviews is of primary importance. If we wanted to talk to a person about the work setting we would simply say, "Can we join you at lunch at your work setting?" or "Can we sit next to you at your desk?" If we wanted to find out what it was like to be in a public place we would simply say, "Where would you like to meet for a drink?" The interview-in-place is a very useful technique which helps disabled clients and designers to understand their own experience in a place and to evaluate the working and non-working aspects of the environment so that plans for modifications can be realized.

The best way to let vendors of state services find out whether or not their facilities are accessible is to talk to the people using the facilities and let them participate as "user consultants." Too often corps of consultants are rushed into a facility when valuable information is available from individuals at the site. This approach was used very successfully in Sacramento, California, in a project to help state services comply to the code of access. One result of the project was a guide called *Getting There*, a publication consisting of sets of diagrams which can be used by designers and persons with disabilities. The format of *Getting There* is in the style of cartoons which create visual images of accessible and non-accessible environments.

In helping people in the area of access it is necessary to go beyond specific technical assistance information. Building a ramp or locating a light switch are design problems which can be solved easily. The more difficult mission is discerning how the disabled individual feels about his/her environment. This can only be accomplished through continued and consistent partnership of interaction between designers and individuals with disabilities.

2 Issues in Technology for Education

Dorothy Tombaugh

Low-Budget Ideas for the Visually Impaired in Science

There are a number of low-cost or no-cost techniques to aid the visually impaired to fully participate in the science laboratory. When the term "laboratory observation" is used the tendency is to think primarily of visual observations. However, tactile, auditory, olfactory, and thermal observations are able to bring considerable information to the visually-impaired student in science. An array of instruments add quantitative measurements for the observer.

Tactile Observations

Braille paintings and raised-line drawings are particularly important for a biology program but are needed at some time for all courses. Raised-line drawings are made by drawing on braille paper placed on a rubber or plastic mat. The tools for such drawings may be any instrument which does not poke a hold in the paper. Among these tools are a tracing wheel, "popsickle sticks," nails with rounded tips and blunt ends of pens. Braille paintings are first sketched in pencil on cardboard. This is outlined with glue. String, rope, buttons, wire, sandpaper and bits of cloth are among the variety of items added to the glue to vary the texture. Multiple copies of these braille paintings are made by making a model as above using heat-resistant glue. This model is usable in the *American Thermoform Brailon Duplicator* for making multiple copies of the paintings. The goal of these braille paintings and raised-line drawings is to convey scientific information, not to be a work of art for display.

Tactile observations are used for examining most equipment and material in the laboratory. A crayfish may be immobilized by restraining its claws with small rubber bands. Details of internal structures of earthworms, insects, snails and other small animals require models, raised-line drawings and braille paintings to clarify the study. Animals as large as a bull frog are readily observed manually. The use of tactile observations may require that specimens in preservative be removed from containers, washed and put on trays. Human anatomy can best be learned from models, skeletons and observing one's own muscles.

The weight of material placed on a centigram balance is read manually. The position of the weights on the beams is determined by counting the grooves. For the beam with no grooves, a braille ruler is calibrated so a unit of length is equated to a determined number of milligrams. A narrow band of clear nail polish may be painted on the midpoint of the scale to enable a blind person to determine when the pointer is at the center point.

Models of protozoa may be fashioned from jello. The jello is poured into a plastic bag which is restricted in shape while cooling. Threads, rope, raisins, slices of dowel rod and other items are used to represent cellular inclusions. The colloidal nature of jello gives a realistic model of cytoplasm.

A *3M Braille Labeler* turns label tape quickly into readable material for blind persons who read braille. It is not necessary for the sighted person using is to read braille as it has dials in both print and braille. The *3M Large Print Labeler* will likewise produce large raised letters for the benefit of the visually impaired with limited sight. Reagents, shelves, and directions on equipment all need suitable markings. With braille labels and a tracing wheel, wax pencil or narrow tape, lines on graphs and markings on maps are easily identified.

Plastic syringes are available in a wide range of sizes. By notching the plunger at suitable intervals, they serve as a "braille syringe" for use in measuring liquids.

The visually-handicapped student and a sighted person need a common mode for sharing problem solving and balancing equations. A child's metal *Slant Board* with magnetic plastic letters and numbers allows the non-sighted person to go over the problem with his fingertips. Another way is to use a *Braille Scrabble Board* for which letters have both print and braille letters. With the addition of numbers made with print and braille labelers which are placed on wooden squares similar to the letters, the materials are then available to work series of equations. Graphs can be shared when pieces of pegboard, golf tees and string are used to make them. This also serves for a lecture demonstration model for the ~~sighted members of the class.~~

Many details of plant growth, vigor, appearance and identification are available through manual observation. Blind students have shown competence in grafting tomatoes and potato plants.

Unless an odor is pleasantly perfumed or noticeably unpleasant the sighted person pays scant heed to olfactory stimuli. The visually impaired employ such stimuli as additional clues for identifying items in their environment. In chemistry laboratory the technique of wafting an odor is learned. On biology field trips the identification of plants is aided by breaking the stem or leaf to examine its odor. The odor of soils give clues to add to tactile observations in their identity.

Auditory Observations

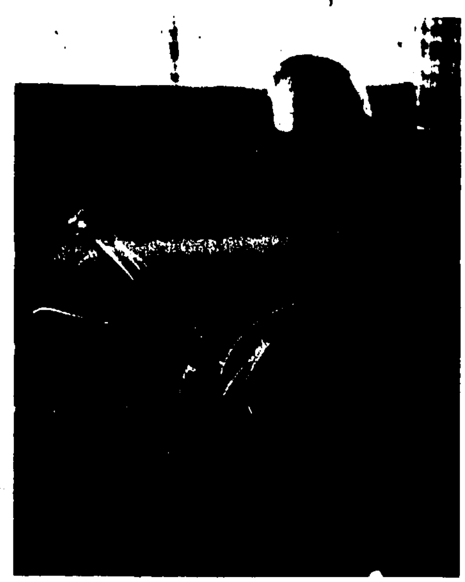
If instructors verbalize as they write or draw on the blackboard or as they present material on the overhead projector, they will not only aid the visually impaired but they will also reinforce the learning of all students. When quizzes are given on material presented via movies, the blind students often have superior scores because they have listened intently to the sound track. Taping lectures and then editing the tapes to preserve only important information needed for recall gives the visually-impaired student class notes of excellent quality.

A number of instruments are now available with auditory signals or voice output to give the visually impaired greater competence and independence in the laboratory. The light sensor is one of the most versatile of these instruments. It is small enough to be held in the hand and carried in a pocket. There are several versions on the market but all involve a photoelectric cell to detect light and a sound source which increases in pitch with an increase in the intensity of light. They also can be used for simple non-scientific tasks such as determining the location of heading on stationery and whether the necktie or scarf at hand is striped, plain-colored or printed.

Figure 1. Student at Evergreen College, Olympia, Washington demonstrates lowered chemistry lab bench built for her. They planned to build a "larsen" chair with oak chair (after seeing the model demonstrated by the Tombaughs) for her to use with NMR equipment where metal wheelchair could not be used.

Figure 2. Kathy Cotman demonstrating adapted laboratory equipment at Euclid (Ohio) High School. Kathy, a biologist, works at the Cleveland Clinic Tumor Registrar.

Figure 3. Roy Tombaugh building adaptive lab equipment in his van "workshop."



In chemistry laboratories the light sensor detects the formation of a precipitate and the occurrence of a chemical change indicated by a change in color. It will locate the meniscus in a colorless solution in a buret, a graduated cylinder, or a volumetric flask. By placing a finger on the buret at the point where the tone of the light sensor changed, the lines etched on the glass can be "read" by counting the lines with a fingernail or plastic card. Accuracy is dependent on the individual's experience, hearing and manual dexterity. More sophisticated instrumentation for precise professional work is available at greater cost.

In microbiology the light sensor will detect growth as shown by a change in the transmission of light through a broth solution and certain of the solid media. A change in pH is detected by the change in the color of the indicator and a comparison of standard media with that of the test material. The presence of gas in a culture is shown likewise by a change in the passage of light through the medium.

In genetics the light sensor may be used to differentiate between green and albino corn. It can be used to indicate color difference (but not what color) in genetic corn. For counting kernels of yellow and purple corn the user of the light sensor soon learns the higher pitch indicates yellow and the lower one is purple. Tactile sense differentiates between smooth and rough surfaces. Color differences in fur coats of animals is readily detected. Fruit flies are too small for examination by visually-impaired persons with present instruments.

In physics labs the light sensor will announce the swing of the pendulum. It will detect the presence of light and its relative intensity. It senses the approximate position of the needle of a light meter and other instruments.

For geology the light sensor will indicate differences between colors of soils, rocks and minerals. It will indicate color changes in testing for ions in solutions. It detects not only the difference between black and white but also shades of grays on maps. The light sensor will function best if there is a steady light illuminating the area. A fluorescent tube mounted vertically behind ground glass is a suitable light source for many investigations. The light sensor should be available in all science laboratories as an aid in making a wide variety of observations.

The *Audicator*, the sound source used with light sensor from Science for the Blind Products, can also be used with other accessories such as the *Liquid Level Indicator*. This comes in two sizes, one for use in volumetric flasks and cylinders and the other usable with coffee cups. *Clip leads* are an additional accessory available for checking electrical circuits.

Another type of instrument with an audio output is the *Aud-A-Mometer*, a braille thermometer. This operates with a continuous tone which is reduced to no tone when a pointer on the Null indicator is turned to the temperature reading comparable to that registered by the stainless steel probe attached. *Aud-A-Match*, a Null indicator, can be connected to other equipment such as impedance bridges, laboratory potentiometer circuits or to resistance-measuring bridges allowing a blind person to tell by tone when the circuit is balanced.

The addition of talking capacity to instruments is bringing greater independence in the laboratory for persons who are blind. The *Talking Calculator* was the first instrument to emit voice output as the numbers were punched into it and when the computation was ended. These calculators have the same competence as others. Additionally they may be used with an earphone so they can be used during tests without disturbing others or giving out information.

This last year marked the introduction of a talking thermometer, *ThermoVoice*, by American Foundation for the Blind. The unit is housed in a plastic case which may be worn on a cord about the user's neck. The thermo-probe rests in a niche of its own in the case when it is not in use. The laboratory probe has a range of 10° to 110° C and registers with an accuracy of ±0.1° C. An additional probe in a higher range is also available. This is primarily for cooking but it will find a place in organic chemistry as well. The probes stabilize in seconds after immersion in the material to be tested. The voice may be heard via an earphone also.

Additional Aids

For visually-impaired students who have some vision, one of the prime considerations should be correct lighting for their work. Because of individual differences in eye disorders there is a wide variance in lighting needs for these students. This should be discussed with the student early in the year so this can be adjusted to the best use. A plastic lens is available at low cost to enlarge an area. It substitutes for a dissecting microscope and may be used for reading as well.

Many items of equipment purchased for the use of sighted students have raised markings as on the plastic beakers and cylinders. Timing devices, maple meter sticks and rulers frequently have lines depressed sufficiently to be read with the fingers. Geology and geography departments often have models and relief maps which need only the addition of braille or large print labels for them to be usable by the visually impaired.

Mainstreaming visually-impaired students in science presents no major problems. There is little need for expensive equipment for beginning courses. Improved techniques, a little extra consideration on the part of all and a sense of ~~team participation will~~ benefit not just the handicapped but all the members of the class.

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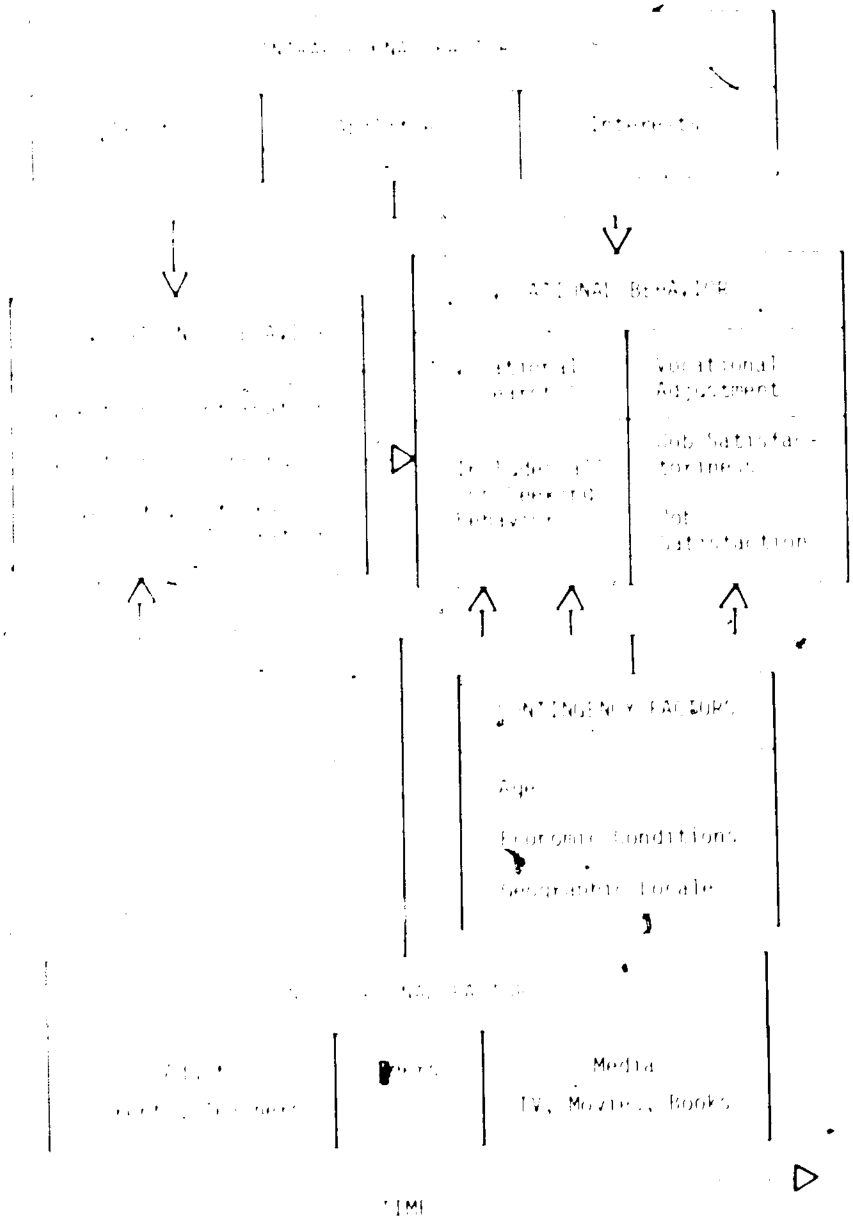

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Table 1: Rank Order Matrix of Positions for NTID Co-op Students at Ford Motor Company Car Engineering Division, Dearborn, Michigan.

	NTID Student - Major		
Rank Order	Electrical Engineering BSEE	Mechanical Engineering BSME	Computer Science BTCS
First Assignment	Ignition Laboratory Support Services	Mechanical Systems Laboratory	Computer Graphics Department (Programming)
Second Assignment	Electric Engine Control	Electric Engine Control	Electric Engine Control (Programming)
Third Assignment	Special Test Engineering		Special Test Engineering (Programming)
Not Recommended At This Time		Vehicle Engineering Program Control & Chassis Section	

equipment is not practical if it is limited to the use of one student or one experiment. The best alternative is the homemade "tin can and rubber band" method. These homemade items are disposable and easily replaced at little or no cost. This method provides the students with hands-on experience, the opportunity to create something while learning the principles behind the creation. Such an experience also encourages the students to use their own creativity and imagination in problem solving--a skill that will prove useful later in life, in higher education and on the job. This approach also permits a sense of accomplishment--the students are able to take their projects home and show them to parents and friends.

Although adaptations to science programs are necessary to accommodate disabled students, of primary importance is the students' interest in the program. Figure 1 diagrams the major components of vocational awareness. Of those components, the Interpersonal Factors are often overlooked by teachers. Handicapped students need role models with whom they can identify. Too often, these roles are absent or of a stereotypical nature leading the students to limit their career decisions to either stereotypical vocational roles or no career planning at all. When developing a program in science for the handicapped student, the inclusion of the role model is essential.

With this purpose in mind, a videotape, *We Know We Can,* was developed at the National Technical Institute for the Deaf. The videotape uses role models from scientific professions and thereby encourages students to explore all career options.

Finally, we must not conclude that the modifications for handicapped students end with their formal education. We must also consider the employment of these individuals and determine what modifications are needed in the work place. This is actually a joint responsibility of educators and employers. Educators need to know of the career opportunities that exist so as to inform their students. The employers need to be aware of modifications that may be necessary and entry level positions that are most suitable for a handicapped employee. To facilitate this process, NTID's National Center for Employment of the Deaf has developed a Job Analysis Model, which matches abilities with opportunities, helping both the employer and the job seeker. As shown in Table 1, a job analysis shows several entry level positions as well as career steps. No position is stated as *unsuitable* for a deaf person, although we may not recommend a particular position due to lack of experience or training.

There is no limit to the potential for handicapped persons seeking a career in science--if the interest exists and the right approach is taken.

David Lunney and Robert C. Morrison

Talking and Voice Entry Computers for the Chemistry Lab

At East Carolina University we are developing a microcomputer-based *Universal Laboratory Training and Research Aid (ULTRA)* for handicapped students in undergraduate chemistry laboratories. The primary goals are to enable blind students and students with upper limb disabilities to obtain meaningful laboratory experience in undergraduate chemistry laboratories, to provide a personal computer that is usable by handicapped students, and to develop an open-ended professional tool for handicapped students who plan to enter scientific or technical careers.

The *ULTRA* system is designed around the popular *Zilog Z80* microcomputer, which is available as a set of assembled industrial quality circuit boards. Wherever possible, we use commercially available modules and subsystems to permit relatively easy manufacture of the final system. The software will be available on disks and microcartridge tapes. Some of the software routines will be permanently stored in erasable read only memory in the *ULTRA* system.

The *ULTRA* system will have two *Z80* microprocessors (master and slave), a mixture of random access memory (RAM) and erasable programmable read only memory (EPROM), and both digital and analog input/output capabilities. The master microprocessor will be used for data acquisition and performing calculations. The slave microprocessor will be used to interact with the handicapped user. Two versions of the *ULTRA* system will be available: one for blind students and the other for students with upper limb disabilities. In the version for blind students, the slave processor will function as a talking computer terminal with keyboard entry and synthesized speech output. In the version for students with upper limb disabilities, the slave microprocessor will act like a voice-entry terminal with speech input and a video screen for output.

The *ULTRA* system can be interfaced to a wide variety of instruments and sensors used in undergraduate chemistry laboratories. The system contains electronic circuits for conditioning electrical signals from these instruments so they may be safely and accurately read by the computer system. Typical devices that are being interfaced to the *ULTRA* system are pH electrodes, visible spectrophotometers, infrared spectrophotometers, gas chromatographs, analytical balances, temperature sensors, titration devices, and others.

The talking terminal consists of a *Z80* microcomputer, a keyboard, and a *Votrax SC-01* voice synthesizer. The software for the talking terminal uses letter-to-sound rules to generate phonemes (phonetic elements) for construction of words. An appropriate sequence of phoneme codes is sent to the voice synthesizer for spoken output. Although the talking terminal is contained in the portable *ULTRA* system, it can be connected to any host computer; for example, it could be connected to a central computer over a telephone line. This feature gives the blind student unlimited access to computer programs that are available on central computer systems.

The voice-entry terminal uses an *Interstate Electronics VOTERM* voice recognition module (VRM) for speech recognition, a video screen for displaying output and a *Z80* microcomputer to handle the communication between the VRM, the host (*ULTRA*) computer, and a mass storage device (tape or disk). The VRM is capable of recognizing up to 100 individual spoken words. A user trains the VRM for each word in a vocabulary by saying the word several times. The VRM stores voice patterns for each spoken word in its memory and is capable of recognizing these voice patterns when they are spoken by the user in a subsequent recognition step. Each user must train the VRM for his or her voice patterns for every word in the vocabulary he or she intends to use. After the VRM has been trained by a user, the voice patterns for the various vocabularies can be stored on a disk file to be used later. The software for the *Z80* displays vocabulary word lists currently being used, displays information that is being sent by the host computer, and can switch vocabularies between a mass storage file and the VRM. The user can have vocabularies much larger than 100 words by saving voice patterns for vocabulary words on a disk file and loading them on the VRM when they are needed.

Most of the experiment-oriented software routines run with a program that functions as a scientific calculator. This allows a student to collect and store data from an instrument that is making measurements in an experiment and to perform scientific calculations using the data before making his or her laboratory report. Thus a handicapped student is able to have laboratory experience that parallels the laboratory experience of other students. That is, he or she runs the experiment, collects the data, performs calculations, and makes a report. The calculator program can also be run by itself, without running an experiment. Thus, a student can have a talking or a voice-entry calculator for solving normal scientific problems.

The *ULTRA* system enables blind students to perform chemical experiments independently in the laboratory. With appropriate equipment they can mix solutions, perform titrations, measure pH's, weigh samples, etc. Students with upper limb disabilities will still need an assistant to manipulate equipment and glassware. However, these handicapped students will be able to control data collection and to perform the calculations independently.

The *ULTRA* should be available for the handicapped students in two to three years. With the help of the Office of Special Education marketing division we hope to find a manufacturer capable of producing the *ULTRA* system at a reasonable cost (about $8,000).

Larry J. Leifer

Robotic Manipulation Aids in Rehabilitation

Abstract

It has been hypothesized that industrial robotics technology can be adapted to the manipulation needs of people with severe physical impairment. Initial tests with programmable manipulators were encouraging while demonstrating the limited usefulness of preprogrammed motion sequences. It was clear that interactive command and control of manipulation would be required for relatively unstructured domestic environments. In pursuit of this objective, the Stanford Robotic Aid incorporates: 1) a voice actuated real-time programming command language to direct the manipulation task; 2) a non-contact two-degree-of-freedom head motion tracker to "pilot" the manipulator; 3) a tactile sensing gripper to perform semi-autonomous grasping functions; and 4) a unified command/control system to manage the dynamic interaction between a human user and his/her "program directed" assistive device. Our concerns touch upon the issues of: 1) knowledge representation; 2) computational models of the spatial environment; 3) human perception of space and time; and 4) the interaction between natural body language and its verbal representation. Our experience and findings are relevant to rehabilitation and industrial robotics.

Context

The number of disabled people in the U.S.A. is estimated at 15-45 million or seven to 21% of the total population (Office of Technology Assessment, 1982). The higher figure is indicative of people with all degrees of impairment, and the lower figure is indicative of people with severe impairment. While all the estimates are rough, the magnitude is significant. The incidence and type of severe disability occurring in the United States are presented in Table 1.

The accepted international classification of impairment, disability and handicap is as follows (Wood, 1980):

Impairment: any loss or abnormality of psychological, physiological, or anatomical structure or function.

Disability: any restriction or lack of ability (resulting) from an impairment to perform an activity in the manner or within the range considered normal for a human being.

Handicap: a disadvantage for a given individual, resulting from an impairment or a disability, that limits or prevents the

Table 1

ESTIMATED NUMBER OF PEOPLE WITH IMPAIRMENTS ACCORDING TO ETIOLOGICAL (NOT FUNCTIONAL) CLASSIFICATION

Data are for the United States (after LeBlanc, 1973)

IMPAIRMENT	ESTIMATED POPULATION
Paralysis/Paresis (both upper limbs)	172,000
Paralysis/Paresis (both lower limbs)	330,000
Hemiplegia/Hemiparesis (both limbs on one side)	340,000
Paraplegia (both lower limbs)	77,000 - 200,000
Quadriplegia (both upper and lower limbs)	38,000
Cerebral Palsy	153,000 - 750,000
Spina Bifida	27,500
Multiple Sclerosis	500,000
Muscular Dystrophy	200,000
Osteogenesis Imperfecta	10,000 - 30,000
Parkinson's Disease	1,000,000
Disabling Arthritis	2,201,000
Upper-Limb Deformity	819,999
Lower-Limb Deformity	2,916,000
Spinal Deformity	1,135,000
Upper-Limb Amputation	90,000
Lower-Limb Amputation	210,000

fulfillment of a role that is normal (depending on age, sex, social and cultural factors) for that individual.

Thus, a lower-limb amputation is an impairment. The disability could be that the person cannot walk. The handicap could be that the person cannot get to work. Many people with severe impairments are, in fact, severely disabled and in turn severely handicapped in the use of their environment. Ideally, assistive technology supports independent living by reducing disability or removing the associated handicap. The economic potential of independence is considerable. Bowe (1980) estimates that every dollar spent for rehabilitation research returns $11.00 in cost benefit to society.

The Need To Manipulate

The evolution of humankind can be measured in terms of our mastery of tools. Tools allow us to control our environment in ways quite beyond our native ability. Hand tools have become machine tools and now machine tools have evolved hands. We are building general purpose programmable machines (Robots) whose primary function is to manipulate other machines (manually). It is fitting that those people who have lost the ability to directly manipulate their own personal space be among the first to receive the benefits of this evolving technology.

A severely disabled individual is cut off from direct control of his or her own personal space. This individual is unable to use the vast array of gadgets which most of us depend upon for our personal and vocational well being. Quadriplegia, paralysis of four limbs, is one disability that impairs the power to manipulate. It is typically the result of a traumatic spinal cord injury in which neural tissue of the spinal column is disrupted. When this happens at the level of the neck, the person will have neither sensation or muscle control in their trunk and legs. Depending on the injury, little muscle control or sensation will be available in the arms. Grasp function is almost always lost. Respiratory function, because it is controlled from higher in the brain stem, is usually intact. In spite of an overwhelming loss of body function these individuals have no impairment of their mental facilities and, with good medical treatment, have a normal life expectancy. This injury occurs with increasing frequency, is seven times more likely to happen to males than females and is most likely to happen in the age range from 18-22. While statistical data are sparse, it has been estimated by Kalsbeek, et al. (1980) that the average net cost in one year (44% direct medical costs; 56% indirect costs) for serious new head and spinal cord injury cases is $2,400,000,000 (in 1980 dollars). There are an estimated 6,000 serious spinal cord injury cases per year in the United States of which about 1,000 result in quadriplegia. At a minimum, costs of this magnitude would seem to warrant the search for good care at lower cost to the individual and society. There are also compelling psycho-social reasons to help the disabled achieve full and productive lives.

Design Philosoply

The design philosophy of the "robotic aid" research and development community is based on the assertion that a disabled individual is best served by a single, general purpose system, rather than a collection of special purpose devices. The disabled, surrounded by a proliferation of rehabilitative gadgets, will otherwise be further isolated from the general populace and public spaces. It is important to note that the typically diadic relationship between an individual and his/her environment must be replaced by the triadic union of environment, robot and usar (Figure 1).

While it is premature to make definitive statements regarding Robotic Aid economics, it is clear that those forces which propel development of industrial manipulators, especially labor costs, are also experienced by severely disabled individuals who may have to pay for 24-hour attendant care. For comparison, one may speculate that a widely available robotic manipulation aid would cost about as much as a personal automobile and come in an equivalent variety of models.

Function versus Anatomy

Before reviewing the evolution of rehabilitative robotics, it will help to examine the concept of rehabilitation as it is manifest in the development of assistive devices. The dominant philosophy, implicit and explicit, has been to replace lost or damaged anatomy. Functional considerations are consistently built upon the assumption that the missing limb must be replaced. This approach places severe constraints on the control, size, weight, power and geometry of potential solutions. At this time, there is a negative correlation between the degree of anatomical fidelity in a manipulator and the degree to which functional performance criteria can be achieved. In exploring the possibility that industrial manipulators may be used to satisfy the manipulation needs of disabled people one does not pretend that the aid is part of the user's body. Typically, there is no physical contact with the user beyond that needed at the command/control interface. While a robotic aid should be worthy of inclusion in one's living quarters, problems associated with cosmesis are far less critical.

Interactive Robotics

A Robotic Manipulation Aid must be interactive because it serves the constantly shifting attention of its user. It does not operate in the industrial context of repetitious tasks. With an emphasis on flexibility, it must operate in largely unstructured environments where effective use of tactile sensation is required. Also unlike industrial robotics, the manipulator must be programmed in real-time using information entry channels other than traditional keyboards. Interactive robotics research and development grow out of disparate origins in artificial intelligence and master/slave telemanipulation (Figure 2).

Statement of the Problem

An interactive robotic manipulation aid should include the following basic features. It must have one or more electro-mechanical manipulators (arms) which can be moved about the environment and are capable of bringing an end effector (hand) to any position and orientation within a prescribed working volume. Each mechanical arm must have an end-effector (hand) which incorporates tactile sensors and can provide the user with functional information about object location and grasp quality. Each manipulator and end-effector must be under the control of one or more computers (microprocessors) to perform complex behaviors upon receipt of task specific commands. The user needs to have one or more input interfaces to have complete command and control of the robotic system. To have comprehensive awareness of the actions and knowledge of the robot the user must have one or more feedback interfaces (e.g., displays, voice output).

There are five primary application areas where it has been suggested that robotic manipulation aids will be superior to other means for supporting independent living by persons with severe physical impairment:

1. ACTIVITIES OF DAILY LIVING: food preparation; food service; personal hygiene.

2. MEDICAL THERAPY: limited physical therapy; some forms of diagnostic testing.

3. PERSONAL CLERICAL TASKS: calculator and computer operation; use of commercial telecommunication devices; appliance control; office materials handling.

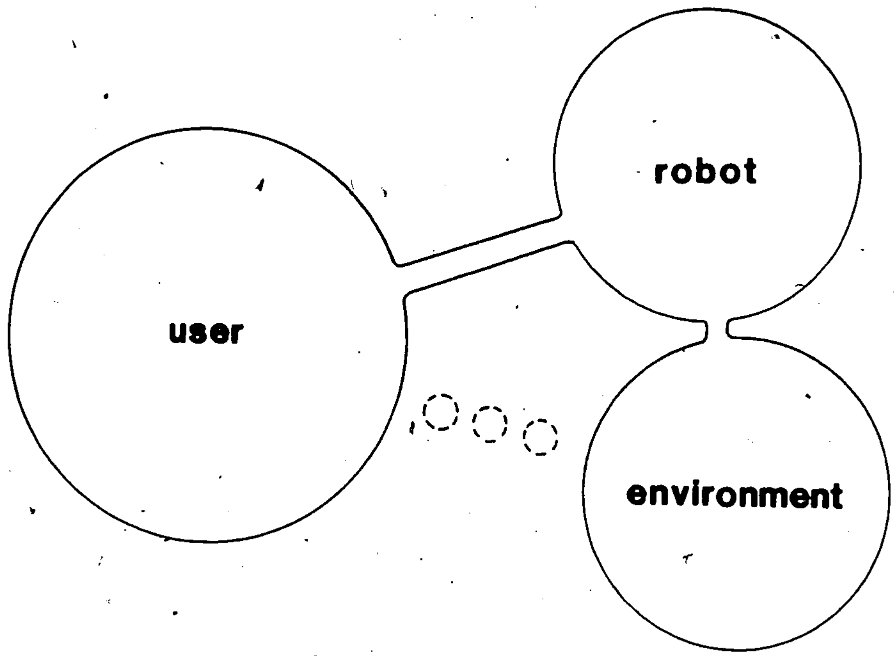

Figure 1. The USER-ROBOT-ENVIRONMENT triad illustrates that the robot (manipulation aid) is intended to give the user physical control of an environment which is otherwise only the subject of wishful thinking. However, direct user <---> environment interaction is replaced by a two-stage pathway (user <---> robot <---> environment). The command and control linkage between the user and the robot is crucial to effective implementation of the operator's wishes. Development of this information transmission channel is limited by our understanding of human information processing and our technology; the robot <---> environment channel is only limited by our technology.

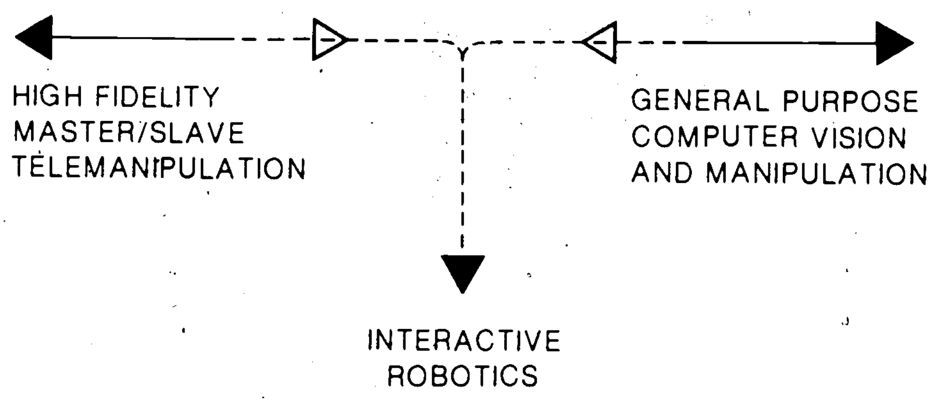

Figure 2. INTERACTIVE ROBOTICS research draws knowledge and technology from both Robotics and Telemanipulation. While Interactive Robotics includes a human operator and machine intelligence, the robotics field tends to exclude the possibility of a human operator and the telemanipulation field tends to neglect the potential of machine intelligence.

4. VOCATIONAL TASKS: supervision of industrial automation systems; computer and manipulator programming; assembly and inspection; secretarial work; switchboard operation.

5. RECREATION: control of electronic games; manipulation in physical games such as chess and monopoly; avocational work; painting.

There are three conditions which must be met by a robotic manipulation aid before it can be an economically feasible partial substitute for human caretaking. Its manipulative capability must be sufficiently good to make it an attractive alternative to some classes of human assistance. It must be reliable enough that the user and attendants will be encouraged to use it. Savings (and/or earnings) derived from using the Robotic Manipulation Aid must pay for its initial and maintenance costs.

Key Questions

There are four classical technical questions and two global value questions which must be considered at each step in the evolution of robotic manipulation aids. What is the natural language used by people to conceive of, structure, and implement manipulation tasks? What physical communications interface(s) will best transmit input command and control information needed by the manipulation aid? What control structure should the robot have to process multiple (and potentially conflicting) inputs in the context of ongoing activity and its knowledge of the surrounding environment such that the result is a smooth manipulative sequence? What feedback channels can best be used to let the user know what the robot knows and what it can do at any given moment? How does one clinically evaluate a robotic manipulation aid to assess the costs and benefits derived from its use? Who will pay for and maintain the manipulation aid?

Key Considerations

Even when the prospective user has no upper limb function there are a variety of command and control input channels available. Command, usually accomplished with a keyboard, refers to a discrete item of information which specifies a task, operating mode, datum, or label. Control, typically done with a joystick or steering wheel is typically used for continuous input functions such as those required to pilot a vehicle. In most man-machine interfaces the human hand is used to perform both command and control functions. For the quadriplegic individual this is not feasible. Alternative channels are poorly understood. Head displacements are limited in range and their precision has not been evaluated. While the human voice is capable of making thousands of utterances, only one or two can be machine recognized per second (a high information band-width with a low temporal band-width). The physiological signal channels (electromyogram and electroencephalogram) are conceptually elegant but unreliable. In the case of eye movement command/control, it is important that we not defeat the normal function of an already vital information channel. It is also important to note that fatigue is usually proportional to the degree to which conscious attention is required in the control task. Accordingly, input modes should be amenable to subconscious performance. It is hypothesized that an interactive manipulator interface should incorporate a variety of command/control channels such that the operator may choose between them on a moment to moment task specific basis.

Information transfer between man and machine must be carefully managed. Every physical disability reduces our capacity to transmit, receive, or process information. Accordingly, the user should specify goals and the system should attempt to achieve those goals while the user supervises the operation. The exact division of labor between man and computer will necessarily vary according to the task.

The inadequacy of sensory feedback from artificial limbs has severely limited their usefulness. Without sensory feedback the control of limb movements is performed open-loop. Visual feedback of gross limb displacements is not equivalent to kinesthetic feedback. Unlike muscle, tendon, and joint sensations, visual feedback requires constant attention. This high attention state leads to fatigue and diminishes the user's ability to attend to other stimuli. We are, at the performance feedback interface, in a position similar to the one encountered at the command input interface. Human channel band-widths are limited and poorly understood. At this time we can best proceed by minimizing the amount of information processing required of the user.

Clinical evaluation of robotic manipulation aids is important and should be an integral part of the development plan. With a history of rehabilitative devices that have been developed, delivered to the patient and then neglected, it is imperative that technical people establish and maintain a constructively critical dialogue with prospective users of their product.

Orthotic Telemanipulation

An orthosis is an exoskeletal structure which supports and moves the user's arm. While related to exoskeletal bracing, the term seems to have achieved wide acceptance only at about the same time that external power was first applied to drive the supporting structure. This line of development produced the first computerized manipulator system at Case Institute of Technology during the early 1960's. This four degree-of-freedom (4 DF) externally powered exoskeleton carried the paralyzed user's arm through a variety of manipulation sequences initiated by the user by directing a head mounted light beam at photo-receptors mounted on selected objects (Reswick and Mergler, 1962; Corell and Wijnschenk, 1964). This was a milestone project in many respects. The technology employed and the concept of computer augmented manipulation were not to achieve comparable sophistication for more than ten years.

The Rancho Los Amigos "Golden Arm" was designed as an orthosis with seven degrees-of-freedom (Karchak and Allen, 1968). It followed the design philosophy of the Case system but did not incorporate any computer augmentation. Direct current servo motors were used at each joint and were individually controlled by a variety of ingenious switch arrays. Several similar versions of this system were built. At least one version was wheelchair mounted and battery powered.

Extensive clinical trials with the Rancho Arm confirmed that joint specific control was not feasible. This finding confirmed results from the Case group and underlined the need for computer augmentation. Moe and Schwartz (1969) computerized the Rancho Arm to provide coordinated joint displacement and proportional control while Freedy, Hull and Lyman (1971) studied the feasibility of using a computer to adaptively aid the user in controlling the manipulator. However, these efforts could not overcome the inherent limitations of an orthosis which attempted to animate the paralyzed human arm.

Remote Manipulators

In the late sixties and early seventies work began with manipulators which were physically isolated from the user and made no pretext of being limb replacements. The designer was now free to follow the dictates of efficient machine design for computer control.

Roesler and Paeslack (1974), at the University of Heidelberg, were the first to use an industrial manipulator and a highly structured work environment. The electromechanical manipulator had five degrees-of-freedom plus grasp. The manipulator was about 1.3 times human scale and occupied a fixed location within a highly structured work station. A minicomputer performed cylindrical coordinate transformations; stored intermediate points; and integrated the use of

F[illegible]gure 4 [illegible] working with the Stanford Robotic Manipulation Aid are (from left to r[illegible] [illegible] Page, [illegible] Roger Awad, Evaluation Team Member, and Frances [illegible] Staff Consultant. The system is shown with one of the clin[illegible] [illegible] anticipated [illegible] in the continuing series [illegible] special environment adaptations (a modified telephone, special typewriter, a four mouth stick keyboard, motorized parts bin, and a three degree-of-freedom mouth manipulandum. The user invoked and controlled all motions of the manipulator.

A conceptually similar manipulator work station has been developed by investigators at the Johns Hopkins University Applied Physics Laboratory (Seamone, et al., 1978, Schneider, et al., 1981). Their four degree-of-freedom manipulator (plus grasp) is human scale, evolved from a prosthesis for shoulder level amputees and has been adapted to microprocessor control. The arm is mounted on a translation table which provides one additional degree-of-freedom to enlarge the working volume of the manipulator. Preprogrammed manipulation sequences are used for standard tasks such as book retrieval from predefined storage bins and food service from predefined serving bowl locations.

Mason (1980), at the VA New York Prosthetics Center, was the first to use a prismatic shoulder joint in a rehabilitation manipulator. The principal design objective was to reach the floor and/or overhead shelves for object retrieval. The earliest version had four degrees-of-freedom plus grasp and is best referred to as a powered reacher. The device was used in both table and wheelchair mounted configurations. It was controlled by mechanical switches and a chin manipulandum. Analog electronics were used to obtain cartesian velocity control and there was no programming capability. The design was used as a basis for several second generation telescoping manipulators. Experiments with a second generation powered reacher were carried out at the NASA Jet Propulsion Laboratory (JPL) where a manipulator with three additional degrees of freedom at the wrist was mounted on an electric powered wheelchair with a minicomputer based voice recognition system (Heer, et al., 1975).

The Spartacus Project in France was the first to use a computer-augmented nuclear industry master-slave manipulator for rehabilitative purposes. The manipulator had six degrees-of-freedom plus grasp (Guittet, et al., 1979). Control modes included discrete mechanical switches, a three-degree-of-freedom manipulandum, mechanical head motion instrumentation, and laryngophone input. There was the first robotic aid with optical proximity detectors on the terminal device. Computer augmentation was accomplished with a minicomputer and included end point control. The system had primitive "reflexes" for object localization, and grasp. The manipulator was programmable in a high level language and capable of repeating preprogrammed motion sequences. The project is noteworthy for its pioneering work with sensors, control reflexes, and high level software.

The VA supported Stanford Robotic Aid is the most recent project in the evolution of a robotic manipulation aid (Leiter, et al., 1980, 1981, 1982). It is the first system to incorporate a human scale industrial manipulator (Unimation PUMA-250), a standard microprocessor based voiced command unit, and mixed mode hierarchical control software running in five independent microcomputers (Figure 3). The first version of this system is being used in clinical pretesting. The six degree-of-freedom PUMA-250 is DC torque motor driven with incremental optical encoders in an all digital position servo. Manipulation is controlled in the background while user interactions are monitored in the foreground of a BASIC like operating system (VAL). The VAL operating system is used to write user programs and perform coordinate transformations. The arm controller is supervised by an executive microcomputer which integrates voice and sensor inputs with arm and voice outputs. A two fingered hand incorporates optical proximity sensors. In response to voice commands the system can perform preprogrammed manipulation tasks, interactive movement control and deferred command sequences. This project has been designed to test the hypothesis that robotic aids can make a valuable contribution to the rehabilitation of severely disabled individuals (Figure 4).

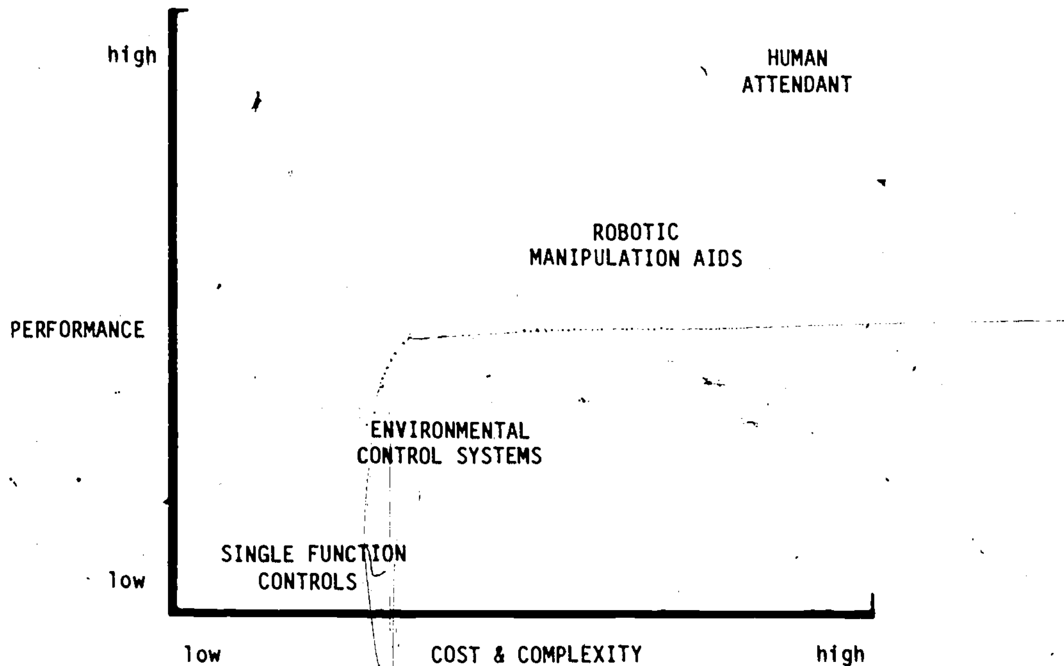

Figure 5. The disabled individual (like all of us) has a spectrum of environment manipulation needs. As represented above, the assistive technology that can be applied to service these needs can be mapped to delimit the cost and complexity associated with increasing manipulation performance specifications. It is most probable that there will be a continuing need for the full range of assistive devices and people.

The specifications for a robotic manipulation aid have been outlined, the design philosophy has been examined, and their evolution has been briefly reviewed. Though designed specifically to aid the physically disabled, the features of an interactive robotic system have important implications for the entire field of robotics.

Control of One's Personal Environment

Will robotic manipulation aids replace environmental control systems? Will environmental control systems replace single function switches? These and similar questions suggest the need for a comprehensive model for the relationship between our selves and our environment. This can be shown, as in Figure 5, to visualize performance versus cost and complexity. Each of these assistive technologies occupies a rather unique "market nitch" and there is good reason to believe that the different technologies will coexist indefinitely.

An interesting aspect of technology utilization has to do with its impact on the user's own self image. This is particularly true for persons with physical disability. Assistive devices become a part of one's personal space and body image. In spite of possible inconveniences, the user of a wheelchair wants his or her style of dress to be typical for the social and physical surroundings. It is imperative that environmental control systems and robotic manipulation aids "suit" the user.

Issues Related To Choice

Trained animals provide one of the interesting alternatives to environmental control systems and robotic manipulation aids. Like the case for "seeing eye dogs," one can imagine that a monkey could be trained to perform essential manual tasks. However, it is noteworthy that only about three percent of blind persons use seeing eye dogs and that this percentage has been stable over the last 30 years. It can be surmised that a roughly equivalent percentage of paralyzed persons will want to live with monkeys. While animals clearly have a place on the farm, they are conspicuously absent from the kitchen and office.

Recent trends in social expectations regarding computer usage and the practicality of industrial robotics will make it easier to introduce the concept of a personal robotic aid. Growing awareness that human-computer-interaction quality is a major determinant of overall system performance (Ketil Bo, 1982) will lead to a better understanding of human information processing and task planning. This general knowledge can, with care and attention, be used to facilitate computer access by the disabled.

Evolution and Robotic Aids

With the advent of effective manipulation aids it will be appropriate to extend the concept by making the aid mobile. This freedom of movement extends the user's sphere of influence while reducing his or her need for personal mobility. In other circumstances it may be preferable to mount the manipulator on the user's wheelchair. In combination with improved telemetry technology and techniques for extracting intention information from bioelectric signals we can envisage a symbiotic relationship between man and machine.

Acknowledgements

A more complete and pictorial review of the evolution of rehabilitative robotics may be found in Leifer (1981). A more comprehensive review of the Stanford Robotic Manipulation Aid Project and rationale may be found in Leifer (1982). As in all such undertakings, many individuals have contributed to the circumstances which make this paper possible. Though fully cited elsewhere;

we wish once again to register our appreciation for the team of which we are a part. This work is supported by the Veterans Administration.

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Diane Merchant

Disabled Educators Project

Disabled people are moving into the education profession in increasing numbers. They are serving as teachers, college professors, administrators--and in a host of other educational roles. Though barriers to training and employment persist, many disabled persons are prevailing to make unique and valuable contributions in the classroom.

These and other statements are supported by a study done by the American Association of Colleges for Teacher Education (AACTE) as part of its project, "Opportunities for Disabled Individuals in the Education Profession." The project has sought to increase opportunities for disabled persons in teacher education programs and within schools, colleges and departments of education; to identify disabled educators and record their experiences; and to encourage the education profession to recognize and use the assets of the disabled population. AACTE's project is part of Project HEATH (Higher Education and the Handicapped). HEATH is a consortium of higher education organizations involved in promoting greater access for disabled students to postsecondary education.

The inspiration for AACTE's work with disabled educators came from the Project on the Handicapped in Science of the American Association for the Advancement of Science (AAAS). AACTE saw that it was at least as important for educators who are disabled to receive the same encouragement and support that disabled scientists have received through AAAS. With increasing numbers of handicapped children in the regular classroom, handicapped teachers are valuable assets to schools. Disabled teachers have a first-hand knowledge of a disability and may often have insights into educating handicapped children. They are a positive example of success and thus good role models for handicapped children and their parents, colleagues, and nonhandicapped children. It is often said that attitudinal prejudice is the most difficult to erase. AACTE's project is based on a belief that the classroom is one of the best places to begin to show young minds that disabled persons can be and are successful persons.

Using the AAAS model, AACTE located disabled educators through announcements about the project in education journals and disability publications. The individuals who agreed to participate in the project completed and returned a detailed survey instrument that gathered a wealth of information, including experiences of disabled individuals in teacher training programs, in becoming employed, and advancing in the profession. Many persons volunteered the strategies that they had used to cope with a disability and to be a fully productive professional. Some told of technological aids that were of use to them.

The first apparent fact that the survey results showed is that there are more people with disabilities who work in education than anyone would have imagined. Letters from people from all areas of the country poured in and the number received surely represents only a fraction of persons who could have responded.

Project participants identified the major barriers that they believe restrict the full participation of disabled persons in the education field. Survey results show that while many of the barriers are not as formidable today as they were 20 or even 10 years ago, obstacles persist and those obstacles are similar regardless of the disability.

It will come as little surprise to handicapped persons that the barriers most often cited were attitudinal ones--particularly attitudes held by prospective employers that disabled persons could not effectively do the job. Even those disabled educators who reported a good college experience often encountered skepticism or outright refusal by persons in a position to hire them. Those who were looking for their first job 20 years ago and had to write that they had a disability on the application form never even got called for an interview. The disabled educators in the AACTE study felt that employers could discriminate without *appearing* to discriminate and that it is to the advantage of the disabled applicant to allay unspoken doubts and fears as they are being considered for a position. They suggested that the reality may be that it is harder to land the first job if you are disabled and believed that direct communication about one's limitations as well as an explanation of the ways that one has learned to perform the job in question may be helpful in the job interview. Some thought that taking steps to improve employment prospects while still a student, such as attending professional meetings and making contacts, would pay off.

Sometimes disabled persons themselves had internalized a defeatist attitude. One young blind woman expressed an interest in teaching but felt that even if she managed to get certified to teach, that, of course, she would be restricted to teaching blind children. She did not realize that numerous blind persons are working very well in classrooms with sighted children.

The number two barrier, according to educators with disabilities, is admission to teacher education programs. One illustrative case is that of Olympic-bound skier Jill Kinmont Boothe, whose story was dramatized in the movie "The Other Side of the Mountain." She wrote that after a skiing accident left her quadriplegic she decided to go back to school and major in education. The California university that she chose, however, refused her admission because she could not negotiate the few steps into the education building from a wheelchair. She was also refused aid from the state office of vocational rehabilitation on the grounds that she was too severely disabled for them to help her with her education. About half of the project respondents said that they also faced difficulties with counselors who discouraged them often because of the counselors' lack of knowledge that education could be a viable career for a disabled person, their lack of exposure to role models, and general lowered expectation for their clients.

Happily, the stories of outright discrimination seem to be mainly in the past. The majority, though not all, of current students or recent graduates of teacher education programs report very good experiences with supportive counselors and college faculty.

Part of the increased support stems, no doubt, from federal laws such as Section 504 of the Rehabilitation Act of 1973. Section 504 prohibits discrimination against handicapped persons in federally assisted programs or activities. The AACTE data shows that students are receiving the accommodations they need much more easily today than a decade ago. The kinds of accommodations students often cited were provision of interpreters, willingness by faculty to let them tape assignments or take tests in a slightly different manner, or classes

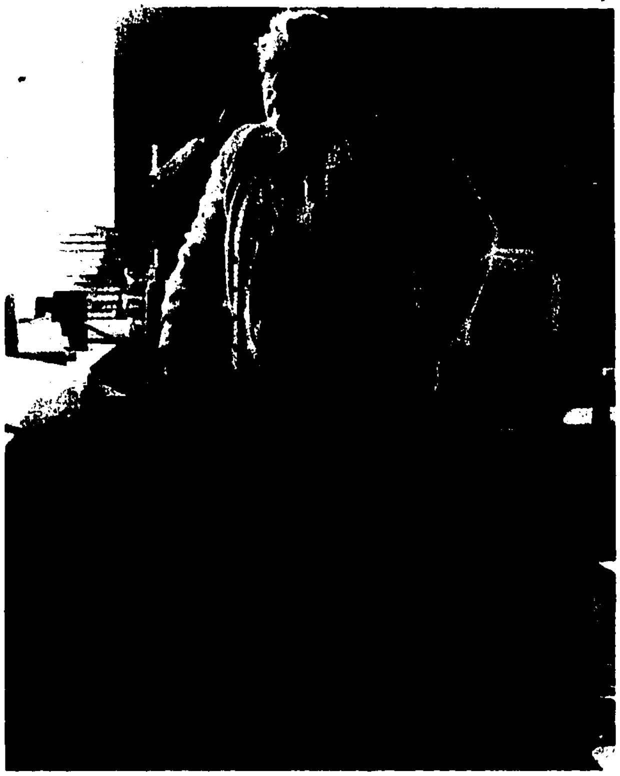


Figure 1. Veteran teacher Jim Benson sees himself as a role model for other handicapped students who have minor physical handicaps and learning disabilities. Credit: Ohio Schools.

Figure 2. Terri Seitz, once told by a principal that he would never hire a handicapped teacher, today successfully instructs a receptive student at her barrier-free elementary school. Credit: National Education Association.

Figure 3. Despite his blindness, Richard Stolper prepares his junior high science students to use a telescope. Credit: American Foundation for the Blind. Photographer: Sally Di Martini.

Figure 4. Carol Ann Moore stimulates class participation and support among her education students at the University of North Colorado. Photographer: Eric Lundberg.

scheduled in accessible facilities. Sometimes one course was substituted for another. A blind student reported taking a two-dimensional sculpture class instead of another required art course. An art education major in a wheelchair had his easel tilted toward him and his tools put in a place easy to reach. One teacher educator who is herself disabled stressed the responsibility that disabled students have to determine solutions to their own problems first before asking for accommodations. She believes that they will need these problem-solving skills later on the job when they will function to an even greater degree on their own.

Just as educators are accepting children with different learning styles, they also must begin to accept teachers who do the job in a slightly different way. Simply because a teacher in a wheelchair cannot physically reach the classroom windows to open and close them or a blind teacher cannot write on the blackboard, that person is not disqualified for the job.

Some graduates take positions in nontraditional education settings. One recent graduate from the AACTE study did not go into the classroom, but instead directs education programs for a rehabilitation center in her hometown. Some people undertake educational research, and some team teach. A disability that may be restrictive in one setting may not be a handicap at all in another.

Student teaching is an important part of the degree program according to respondents in the AACTE study. Student teaching and other field experiences afforded a time to work out one's own classroom strategies. Difficulties most often associated with student teaching were inaccessibility of schools and sometimes attitudes of cooperating teachers.

Some educators reported completing degree programs with no particular problems, only to face discriminatory certification standards. Virginia, for example, still has a statement on the books that certification may be denied a person with a "disqualifying handicap." Also contrary to Section 504 is a New York City requirement that physically disabled candidates perform a demonstration lesson prior to being certified. A disabled education student in a wheelchair has filed a class action suit challenging this discriminatory requirement.

After attitudinal barriers and barriers to admission into teacher education programs, the next most often mentioned obstacle for a disabled educator was a general lack of role models. Not only did the participants in the AACTE study feel that disabled persons in education had to be more persistent and try harder, but that they also had to do it without the comfort or knowledge of others who had gone before them.

While the project did not include a direct study of the technological aids used by disabled educators, some listed them in the course of describing the strategies with which they coped with a disability while performing as a professional.

Among the technological aids used by visually handicapped educators were taped textbook materials, recording equipment and optical aids, braille writers, *Optacons*, and a talking computer terminal to aid in teaching and research. One blind science and math teacher reported using a braille calculator as well as a pegboard with a surface painted like a chalkboard. Another math teacher describes a modified overhead projector with raised lines that he can feel and the students can see. He also makes use of a brailled calculus text. Another teacher who is blind has etched lines onto the blackboard to help him write on the board more legibly.

A deaf high school teacher writes that he uses such standard devices as a teletypewriter (TTD) and a telephone amplifier as well as a TV/phone system that is set up throughout the campus. According to several deaf educators, their buildings are equipped with a strobe light in addition to a fire alarm. Some hearing-impaired educators report very good success with the audio loop amplification system.

One professor who lost some of his voice in reaction to the swine flu vaccine continues to lecture with the aid of that technological standby, the microphone. Many disabled educators report using overhead projectors or slide projectors in the classroom. Learning disabled educators have taken advantage of tape recorders to record classes and work materials. One quadriplegic graduate of a teacher training program teaches independent living skills. She uses technological devices such as hand controls on her transportation vehicle, and a special typewriter and speaker box phone in the office. A classroom teacher with severe arthritis says she uses a device called *The Helping Hand* to reach and grip objects.

In the absence of technological aids, many persons drew on other sources of aid, such as other people. A number of teachers with disabilities performed duties for able-bodied teachers in exchange for help with things they could not do. For example, a teacher without full use of her hands supervised another's class for a short time in exchange for help in running off papers on the ditto machine.

Disabled teachers often enlisted the aid of students. One teacher who is physically handicapped cannot lead certain activities on the playground, but her students can, and all clamor to be the leader. She believes that the added responsibility is of positive value to her students. A blind former teacher in Massachusetts agrees. He says that his junior high aged students learned at an earlier age that they bear some of the responsibility for creating the learning environment. Another blind teacher feels that his blindness helps to build a better rapport in the classroom, since his students realize that he has to trust their work. A teacher who is in a wheelchair in Memphis has high praise for her students. Although she reports some difficulty in being accepted by colleagues, she says that her students categorized as "slow learners" clean up and wash the blackboards without being asked, when they realize that she feels too weak to do the job herself.

Each disabled educator who participated in the AACTE project is listed in a resource directory entitled *Educators with Disabilities: A Resource Guide*. Copies may be obtained under stock number 065-000-00104-7 for $5.50 each from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Roy Nord

Creating Accessible Programs: Some Guidelines for Identifying Needs and Selecting Assistive Devices for Handicapped College Students

The task of responding rationally, effectively, and compassionately to the needs of handicapped students in higher education is, needless to say, a complex and multi-faceted one. Most importantly, it is a task that is very difficult to generalize about.

This is true for two reasons. In the first place, the "needs" of handicapped students are essentially *individual* needs. An attempt to define those needs for whole categories of individuals by reliance on clinical descriptions of the type and severity of the handicap is likely to lead to highly unsatisfactory results. In the second place, the kind of assistance and support required to make college programs both effective for and accessible to a student with a disability is determined not only by the capabilities and desires of that student, but also by the academic, physical, and institutional context of the particular college in which he or she is enrolled.

The purpose of these introductory remarks is not primarily to provide in advance an excuse for the failings of the discussion to follow, but rather to emphasize the point that there can be no precise "recipe" for a successful program to accommodate handicapped students. By far the most important ingredients in any program are the creativity of the people involved and their willingness and ability to communicate effectively with each other. The most important and difficult job of providers of services for handicapped students is to cultivate these skills and abilities in themselves and elicit them from others.

Organization and Purposes

The remainder of this paper will focus on a number of other, perhaps less important ingredients in the process of determining whether or not an assistive device is the most appropriate means to bypass, eliminate, or overcome a barrier, and then selecting the aid or device which will most satisfactorily meet the needs of the handicapped student as well as those of his or her classmates and those of the institution as a whole.

I have identified and will discuss briefly seven components of this process:

- Identification of the activities which must be made accessible.
- Clarification of institutional and governmental policies which may constrain funding and/or service options.

institutions can, if they so desire, take advantage of this fact to evade responsibility themselves. Furthermore, again based on observations made during the HEATH project site visits, few campuses have established the explicit policies which are needed to clarify institutional goals and objectives in the area of handicapped student services.

Given this situation, the third purpose of a "policy and funding source inventory" may be the most important--that is to clarify for the service provider the areas in which precise information does exist and alert both the provider and institutional policy-makers to the need to address those questions in which needed policies do not exist.

If properly carried out, this stage of the process should at least provide a list of "cans," "can'ts," and "maybes" which will avoid unnecessary ambiguities in response to student requests for funds or assistance.

Definition of Program Goals

The definition of the *essential* goals of programs to be made accessible may be the single most important step in this process. In order to achieve the basic objectives of making the educational experience *accessible* to the handicapped student without diminishing the *effectiveness* of educational programs, it is first necessary to develop a standard by which the "effectiveness" of alternative approaches to the learning experience can be measured. That standard must be defined in terms of the fundamental purposes of the activity being evaluated. Perhaps the most frequent error made in the process of defining these purposes is to confuse form with substance. It is of considerable importance that the question "What are you trying to teach?" be answered before the question "What must a student do to learn?" is asked. If this is not done, the functional "requirements" for participation in a course are likely to be defined in terms of *how* the material is currently being taught, rather than *what* are the basic intellectual goals of the course.

Such confusion between form and substance is likely to lead to one of two undesirable results. Either students who are capable of performing the essential functions prerequisite to learning the material will be excluded because of a false understanding of what those essential functions are, or course requirements which truly are essential will be eliminated to provide access at the cost of effectiveness. Furthermore, even if these consequences are avoided, the solution arrived at may be unnecessarily costly, cumbersome, or disruptive.

The performance of the research and evaluation necessary to define purposes must, of course, involve the responsible faculty member or program director. Properly presented, the request that these people undertake the analysis of their own goals and objectives should not be unwelcome. The required exercise in program assessment could be enormously useful to both faculty and the institution above and beyond its importance in arriving at an optimal strategy for accommodating handicapped students.

Identification of Functional Requirements

This component really involves two distinct tasks: first, a simple survey of the functions which are conventionally required by the course or other activity, and second, an evaluation of these functions to determine (a) which ones can be eliminated without compromising the basic purposes of the activity, (b) which ones are amenable to "substitution"--that is, which ones can be effectively carried out by relying on a different physical capability than that conventionally required, and (c) which ones can be performed or substituted for by using either an assistive device or a human helper.

In order to carry out these tasks as well as possible, a tendency which most of us have inherited from our own educational experiences must be overcome. That is the tendency to assume that the only way to solve problems is to attack them head-on. We are used to being given problems and then asked to "solve" them by applying some standard method or technique.

There are, however, other and sometimes better ways to "solve" problems. Redefinition of the problem can sometimes eliminate it. That is essentially the approach which allows functions to be discarded as superfluous. "Going around" problems is another alternative--the one which results in the "substitution" solution. Direct assault is the third approach, and the one which leads to the kinds of solutions requiring the use of an assistive device or a human helper. While this approach is, in many cases, either the only or the most satisfactory one, it should not be presumed to be either.

As noted earlier, the preceding four stages, if completed carefully, will provide the basis for either a timely and effective response to the needs of students requesting assistance or for rational and cost-effective preparation for anticipated needs. The level of formality with which they are carried out will depend on time and staff constraints, but, in one way or another they must be done.

Evaluation

I will abbreviate my comments on the remaining three steps. They are obviously important, but perhaps because of that fact, they are more frequently the focus of attention on campuses and therefore less in need of clarification.

Evaluation of Student Capabilities

The most important thing to say about this task is that, if at all possible, it should be undertaken as a cooperative effort among the service provider, the student, and the faculty members or administrators involved. If the students for whom accommodations are being made are not available, others with relevant experience, preferably as students with similar disabilities should be consulted.

This task also offers the opportunity to encourage a mutually-productive approach to accessibility among all of the concerned parties. Students, faculty members, and college administrators frequently operate under the misconception that theirs is an adversary relationship. It is not, and one of the more fruitful accomplishments of a handicapped student service provider can be to dispell this misconception.

Evaluation of Alternative Accommodation Strategies

I will say very little about this task other than (a) it is closely linked with the task of assessing functional requirements discussed under number four above; and (b) cost-effectiveness is, at this stage, a preeminently legitimate consideration. The task of identifying functional requirements may be made considerably easier if input from interested students is solicited. Once these requirements, and the goals and capabilities of the student are known, the primary consideration becomes that of selecting the approach which will most efficiently meet the needs of the current and future population of both handicapped and non-handicapped students within the fiscal constraints under which the institution must operate.

Implementation

Evaluation of Alternative Devices

There are, as you undoubtedly know, a wide variety of catalogs, computer data bases, and directories to sources of assistive devices, of which the "Assistive Devices Directory" in the soon-to-be-published NACUBO report, *Managing Accessibility in Higher Education* is one. What that directory attempted--and to a limited extent succeeded in doing--was to compile some general information about the generic types of devices which have potential application to the needs of college students, and to organize that information according to general classes of functional requirements within college and university programs. While this directory is, by itself, not an exhaustive source of information, the organizational approach it uses may be a useful tool for application by handicapped student service providers. Such an application could be accomplished in two stages: first, by establishing contact with manufacturers and other sources of assistive devices using the lists of addresses available in the NACUBO directory and/or other directories such as the one recently issued by the Wisconsin Vocational Studies Center in Madison; and second, by reviewing the materials received on an annual or semiannual basis and organizing the relevant information from those documents according to its major functional applications. Such an effort need not be comprehensive or exhaustive to be useful, nor would it replace the usefulness of the computer data bases which are being developed for those institutions with the capacity to take advantage of them. However it is accomplished, a well-organized and up-to-date information base on multiple sources for devices is necessary to allow timely and cost-effective response to those student needs which can be best met by assistive devices.

Listed below are a few considerations and criteria which may be useful in selecting among alternative sources:

- If possible, see the product before purchasing it. Pictures and specifications can be deceptive.
- Apply a functional approach to evaluation of the product. Make sure it will fit in the space where it is to be used; that it is quiet enough to avoid disrupting classes or libraries; and that it will perform the functions identified as necessary in steps four and six.
- Consider the adaptibility of the device to uses and users other than those for which or for whom it is specifically purchased.
- Consider "do-it-yourself" solutions but do not assume that such solutions will necessarily be more cost-effective; sometimes they are not.
- Apply creativity to the selection process. In many cases, items not specifically designed as assistive devices can be creatively applied to produce inexpensive solutions.
- If at all possible, consider products from more than one manufacturer. Prices for similar equipment vary widely, and such variations do not always reflect differences in quality or capabilities.
- Use common sense. Investigate both the product and the source to determine reliability. Businesses that sell products for the handicapped are neither more nor less reliable than are other businesses.

As I said at the outset, the most important ingredients in a successful program are the sensitivity and creativity of the people involved, and I have not yet come across a prescription for producing these capabilities.

Donald G. Sims

Computer-Assisted Lipreading Training for the Deaf Using The Dynamic Audio Video Interactive Device (DAVID)

Hickey (1974), Bukoski (1975), Vinsonhaler and Bass (1972), and Jamison, et al. (1974) have given ample evidence of the effectiveness of computer-assisted instruction (CAI). CAI allows increased efficiency in terms of time and personnel needed to achieve generally guaranteed levels of student-paced learning performance. CAI with the deaf is only now becoming a more frequent occurrence, according to a national survey taken by VonFeldt (1977). Boothroyd (1975) and Nickerson, et al. (1976) have reported use of CAI and graphic real time displays for training speech-prosodic feature production. Arcanin (1979) has a large project underway at the California School for the Deaf for teaching language and elementary math concepts. However, little systemic research on a long-term ecological basis has been done, according to a review by Hertzog and Braverman (1978).

Current auditory training and speechreading instruction at the National Technical Institute for the Deaf (NTID) involves a significant amount of drill and practice. This is as it should be insofar as improving speech recognition in the visual and/or auditory modalities is a matter of time spend on the tasks. That is, the more time the student practices these receptive skills, the greater the skill he or she will acquire.

Programmed self-instruction (PSI) is the mode of learning best suited to this drill and practice requirement because of its efficiency in terms of teacher time. Clearly, we could not afford a one-on-one drill and practice method of teaching for very many students.

However, current drill and practice PSI in use at NTID does not use some of the typical advantages of PSI because of some of the limitations of the medium that is used to present it.

Let me explain this by describing a typical speechreading drill lesson as it is done now without computer assistance.

Current Speechreading Drill Methods

At the risk of over-generalizing and not taking individual instructors' modifications into account, the typical videotape drill lesson begins with familiarization of the vocabulary used within the next unit of instruction. The student reads the definition of the important and/or often misunderstood words. This is followed by a word-to-definition matching exercise and a "use the word in a sentence" exercise.

A unit of instruction consists of one videotape with 25 sentences recorded in sequence. The sentences are made up by instructors in various technical program majors, such as architecture or printing, or from what is called "survival" materials (e.g., going to the bank, going to the post office, etc.). The sentences on the tape are said twice, then a period of blank tape follows to allow the student to respond in one of several manners. Then the sentence is said again with the caption shown of what is being said.

The student views and responds to each of the sentences twice. The first time, the student's response task is usually to identify the target sentence on a multiple choice answer paper (see Figure 1). The captioned version of the sentence which follows on the tape is used by the student to correct the answer. The tape continues to roll and the next sentence in the unit is shown and so on through the unit of 25 sentences.

Then, depending on the instructor's evaluation of the student's ability, the tape is played again and a more difficult response task is assigned. Typically, the student may be asked to write the sentences this time with a key word advanced organizer given on the answer sheet (see Figure 2). The first pass through the unit is to familiarize the student with the unit materials and the second pass is to give the student a challenging drill and practice exercise. Again, the student is responsible for grading himself by watching the captions. Usually, two passes of the tape for a particular unit are required. Some instructors require that students demonstrate an arbitrary proficiency level of, for example, 80% correct sentence identification or 80% correct word identification of the unit sentences before the student can go on to the next unit.

Deficiencies

This paradigm of drill does not take advantage of a number of features of programmed instruction. First, the instruction does not proceed at the student's own pace. The tape continues to roll and students rarely stop it unless they need more time to write. Occasionally students miss the target sentence because they are still writing when it is played. Also, it is a well-known psychophysical fact that a perceptual set of readiness can facilitate performance. That is, when the stimulus is given only when the student is in a state of readiness, his performance is enhanced. The conventional presentation has no practical way of controlling the onset of the drill stimulus.

The second feature of PSI not fully used is branching. This concept involves changing the instructional content or response mode when the student encounters difficulty. As I said before, the tape rolls on--mainly because it is very difficult to stop, reposition and repeat an individual sentence (it requires at least 20 seconds). Thus the student is left with essentially memorizing the written representation of the difficult sentence so he can reach proficiency rather than concentrating on the difficult visual elements of the sentence.

The above discussion brings us to the third feature of mastery: proficiency or criterion-referenced learning. PSI is very amenable to the requirement that a student learn the given material to a specified level of proficiency, such as 90% correct. However, with the conventional videotape medium it is often difficult to require a student to watch the entire unit more than twice without a loss of student interest and motivation. Thus, students may not master the more difficult content of the unit.

By placing the videotape player under computer control we reasoned that we could access the training stimuli according to the best principles of PSI. That is, the stimuli could be presented when the student was ready and at the pace preferred by that student. Further, we would have the capacity to randomly access the sentences allowing, for example, a review of the sentences with which the student had difficulty until a set level of mastery is achieved.

Name ____________________ Date ____________________

Please Check: With Sound ____________ Without Sound ____________

Course: Speechreading

Lesson: Survival Sentences Sentences 151-175

Worksheet I: - Multiple Choice Sentences

Instructions:

1. The speaker will say a sentence twice.
2. Watch closely. Circle the letter by the sentence you think the speaker said.
3. Look quickly back at the screen for the written caption.
4. Check ✓ if right, X if wrong.
5. The speaker will repeat the sentence a third time. Watch the lip movements again.
6. Say each sentence that you speechread. Speaking strengthens speechreading.
7. If you need more time to write, stop the tape.

Number:	Multiple Choice Sentences:
151.	a. What is your Social Security number? b. What is your student number? c. What is your I.D. number? d. Your Social Security number is your student number.
152.	a. What is your home address? b. Please give me your home address? c. Please give me your school address? d. Where do you live?
153.	a. How do you spell your last name? b. How is that spelled? c. How do you spell your first name? d. Is that the correct spelling?
154.	a. What is your middle name? b. How do you spell your middle name? c. Do you have a middle name? d. What is your first name?

Figure 1

Name ______________________ Date ______________

Please Check: With Sound __________ Without Sound __________

Course: Advanced Speechreading

Topic: Survival Sentences 151-175

Worksheet III: Key Words

Instructions:

1. The speaker will say a sentence twice.
2. Write what you think the speaker said. Look quickly at the screen for the written caption.
3. Circle mistakes. DO NOT ERASE mistakes when you correct your answer.
4. The speaker will repeat the sentence a third time when the caption is shown. Say each sentence that you speechread. SPEAKING STRENGTHENS SPEECHREADING.
5. If you need more time to write, stop the tape.

Key Word(s)		Sentences
Topic: Student Information		
151. student number	151.	________________________________
152. home address	152.	________________________________
153. spell	153.	________________________________
154. name	154.	________________________________
155. resident advisor	155.	________________________________

Figure 2

Management of Instruction

A separate yet equally important area of the educational process is management of instruction. Obviously, computer assistance would be helpful in handling the file cabinets full of speechreading materials and the subsequent scoring and grading of these instructional materials. Teachers now must rely on students grading their own drill work because it is impractical to do otherwise. It is also difficult for students to follow the complex series of instructions necessary to adapt the drill to their own needs. Finally, teachers who are new to this curriculum do not always know which units and/or speakers are more or less difficult to speechread. Thus, even with prompt teacher guidance, proper sequencing of drills from easy to difficult may not be accomplished. In fact, I don't see how it would be possible for data to be gathered relative to unit and item difficulty within units without computer assistance. CAI, for example, can keep track of the response time required for each sentence stimulus. If a particular sentence has a high latency of response for nearly all students, it can be eliminated from the unit. Similarly, if all students get an item correct very quickly, it too can be eliminated. Thus the instructional efficiency of each unit can be enhanced.

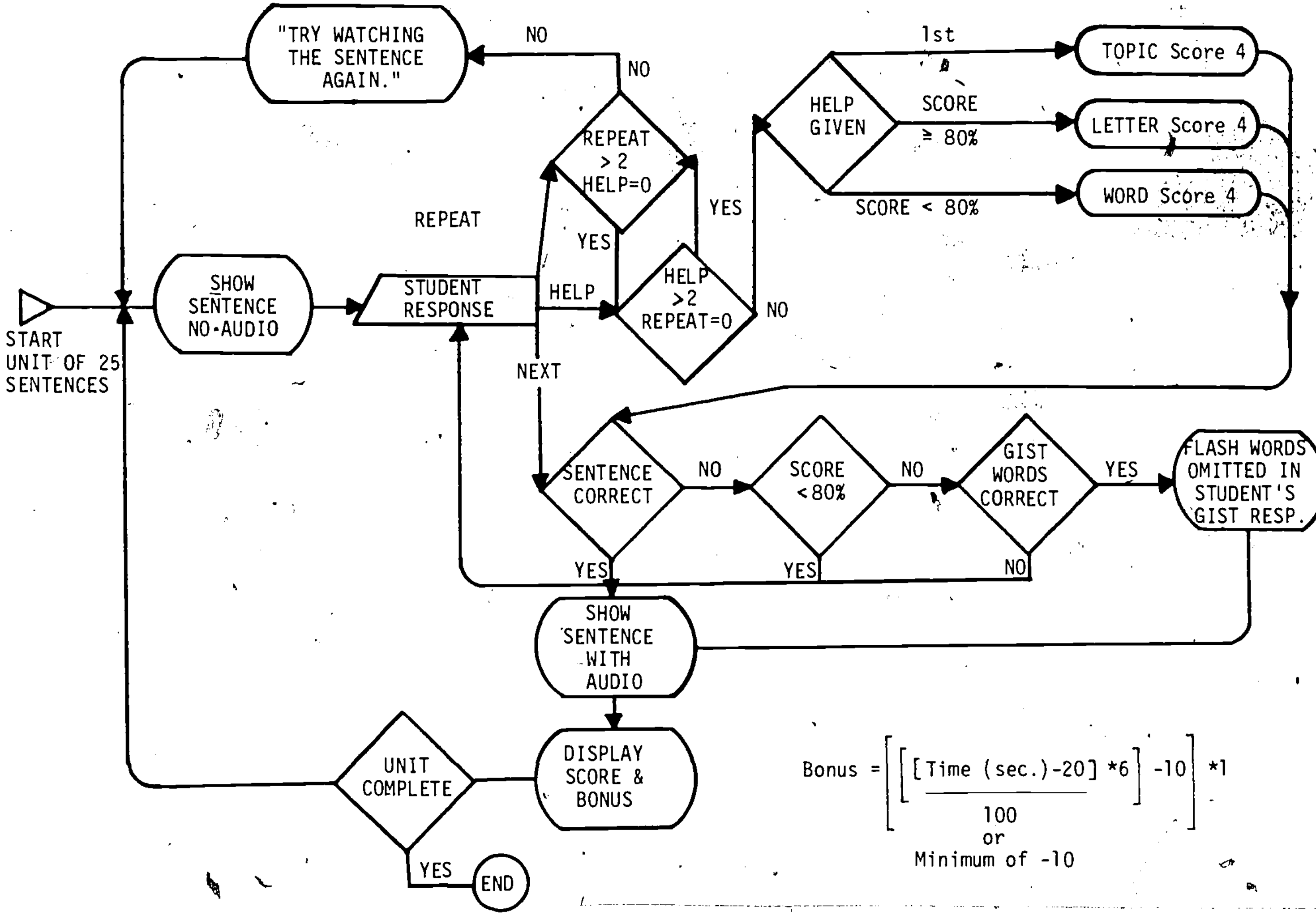
Lastly, with regard to CAI management, histories of individual or group student attendance, achievement, and lesson trajectories can be easily retrieved for the teacher. History with CAI has shown that there is usually much more data available to the teacher than is routinely used.

DAVID Lessons

Eight different computer-assisted drill methods for speechreading have been programmed on the *Dynamic Audio Video Interactive Device (DAVID)*. They are all variations on four methods designed by Jacobs (1981) and still in use with the videotapes in the learning labs. We have added to the current computer drill the capacity to help the student (under his control) with: first, a short description of what the sentence is about; second, the letter(s) that is missing or incorrect; and third, the word(s) that is missing or incorrect. The student can use this help by pressing the HELP key. Each time the HELP key is used some points are taken off the student's score. The score for each sentence is derived by a formula that takes the number of helps, repeats and the latency for the correct response. If the student uses 12 or more helps and/or repeats or uses a great amount of time (e.g., more than two or three minutes to respond correctly), he or she must review the sentence at the end of the unit drill. The student can use two successive helps before being forced to repeat watching the sentence. The student can watch the target sentence again at any time by using the repeat key.

The response in this drill is to type all the words of the target into the computer. The computer screen provides a blank line broken according to the number of words and the number of letters within each word of the target sentence. This response mode was chosen after observing a number of students of varying ability use the system, so that its difficulty level was appropriate for most students.

A final feature of the *DAVID* lesson is gist scoring. If the student is able to get the major-content words of the sentence (even out of order), the sentence will be called correct and the missing words will be added and blinked. This allows the very good speechreader to focus on getting the message as quickly as possible, or the very poor speechreader with poor language usage to make progress. We therefore also have the ability to score the students' responses by gist or exact words correctly identified. The flow chart of the current *DAVID* lesson is seen in Figure 3.



$$\text{Bonus} = \left[\left[\frac{[\text{Time (sec.)} - 20] * 6}{100} \right] - 10 \right] * 1$$

or

Minimum of -10

Figure 3. Flow Chart of *DAVID* Lesson for Speechreading Drill

Our assumption in designing the *DAVID* research has been that the above advantages of computer-assisted instruction do not need further research but that the use of CAI methodology within the context of speechreading drill with the deaf should be compared with currently used lab drill methods. This comparison should be made in terms of what the students learn and their attitudes toward the mode of instruction. In this way I am hopeful that the viability of the *DAVID* instructional medium will be established and the system will be put into routine use. Following that, further research into the most effective and efficient use of *DAVID* for speechreading can be accomplished. Additionally, there is a great need to begin a systematic study of drill and practice methodologies and sequencing in general. It is hoped that having computer assistance will facilitate this process.

Currently, we are collecting data from a conventional videotape drill control group and a *DAVID* experimental group. We will accumulate 30 subjects in each group. We hope to demonstrate improved pre- to post-test gains in retention of key words taken from the drill sentences and placed in novel contexts. We will also attempt to demonstrate improved student effectiveness with this type of instruction.

The *DAVID* system to date has been based on a Wang mini-computer. We are now programming for the Apple II+ computer which will add color graphics and reduce costs from the prototype version by a factor of eight. The new system will use the Panasonic VHS videotape player which adds still-frame and variable-speed playback, i.e., slow motion even to one-by-one frames of 1/30th of a second time resolution. We are using Applesoft Basic language with some extensions to the language written in Assembler. These extensions function as basic commands and allow quicker answer string analysis and correction.

Future Lesson Development

First a word about what kind of programs of instruction should use *DAVID*. In essence, if what is to be mastered involves a dynamic sequence of motions that must be seen to be learned, then one has the material that would lend itself to *DAVID* instruction. Also, there may be a very good reason to add *DAVID* control to an existing instructional television program. That is, *DAVID* can add student interaction in the form of checking for content mastery within an instructional TV program. It can be used for simulation and gaming where the consequences of various alternative actions can be viewed without penalty, for example in interpersonal training, job interviewing, or communication strategy training such as is used in speechreading.

We are planning a demonstration sign language expressive and receptive drill lesson. This lesson would be in a "watch - record - compare" format. The student would watch a signed sentence, repeating it as often as necessary to master it, then he or she would record their own production of that sentence with a small TV camera attached to the videotape recorder. Finally, the student could then compare his recording to the model stimulus. After the student has accumulated a hundred or so recordings, the computer could randomly choose some of the student's productions and give a receptive sign language test. This format would also be useful in training teachers of the deaf and oral interpreters to articulate in the most visually distinct manner.

Summary

A review of the rationale for use of CAI with the current programmed self-instruction has been presented. Current and future activities with the *DAVID* system have been described. As Dr. Barry Cronin (1979) said, "the *DAVID* represents a totally new instructional media combining the color, motion and sound of television with the interactive capacities of computer-assisted instruction."

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Robert H. Murray

Closed Captioning of Motion Picture Film for Use on National Television and for Delayed Broadcast by Affiliates

Over 75% of all prime time network shows originate on film. Half of these shows are broadcast from the original film. The system devised by the Public Broadcasting Service (PBS) for closed captioning requires that broadcast be made from TV tape. It was therefore desirable to devise a means for encoding caption data onto motion picture film to permit direct TV broadcast from film.

In 1978 PBS contracted with Rochester Institute of Technology (RIT) to accomplish a feasibility study to determine how motion picture film could be used to carry the caption information in coded form. The project was directed by Robert H. Murray. Of 25 methods suggested, four were chosen for intensive investigation. From the four, one was selected for development. This has resulted in proposed recommended practices for the TV and motion picture industry which are now in the final stages of circulation for acceptance. Hardware has been developed to optically encode and decode a data track for both 16mm and 35mm release prints. One of the major networks will shortly begin broadcasting closed captions directly from film.

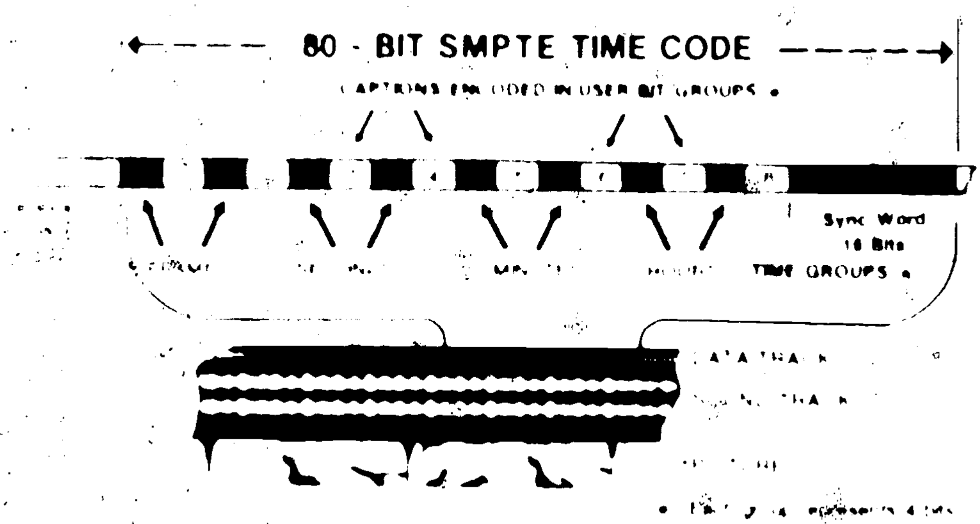
Criteria for the System

Figure 1 shows the criteria that were established during the feasibility study by consultation with both motion picture and TV industry representatives. Heavy emphasis was placed upon the need for a time code to identify each frame of picture with its one unique address (points 6 and 7). The majority of the group also felt it imperative that the captions be self-editing, if the film was edited to insert commercials, for example.

Early tests using an optical data track exposed onto 16mm film confirmed that the SMPTE (Society of Motion Picture and Television Engineers) time code for television could be encoded and decoded with error rates low enough to provide the basis for a caption data system.

Fortunately, the committee that designed the SMPTE time code had the foresight to include some 32 "user bits" within the 80 bits that make up each time code. These "user bits" are unassigned; they may be used for any purpose by a potential "user" without interfering with the time code. The 32 bits are divided into eight groups (see Figure 2). It was proposed and accepted that these user bits be utilized to carry the data stream for captions on motion picture release prints.

CRITERIA FOR
A DATA TRACK ON MOTION PICTURE FILM



Relation of Time Code to Picture

Each frame of picture has its own unique and complete time code immediately adjacent to it. No offset is involved.

The time code hours are used as an identification for film reel numbers: [illegible] reel one, hour two reel two, etc. For reel one the time code [illegible] to fall alongside the start frame of picture. This provides eight seconds of time code prior to the first frame of picture.

Relation of Caption Data to Picture and Sound

For reasons that will be explained later, the data track is read (reproduced) [illegible] one half seconds early. To accomplish this, the data reproducing device, [illegible] 16mm and 35mm film, is located 36 frames above the projector aperture [illegible] the supply reel).

The two principal reasons for locating the data reproduction head to read the data track "early" are to make it possible for the captions to be self-editing. A third consideration was the physical configurations of the telecine projectors [illegible] majority use today for TV broadcast.

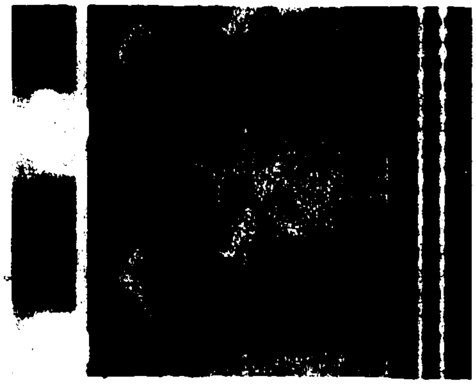
Any [illegible] or splicing of the film will cause a discontinuity in the time code. This must be detected prior to the splice reaching the projector aperture [illegible] for timely action to be taken. The electronics that separate the captions encoded in the user bits from the time code also check the time code for continuity. If discontinuity is detected, a command code is generated and transmitted to the viewer's caption decoder which removes the caption from the viewer's screen. There was much concern about having a program caption carry over into a material that had been edited into the film. The early detection and caption removal fulfills this primary consideration.

The second reason for locating the data read device "early" has to do with the manner in which captions are transmitted and displayed: an entire caption must appear on the viewer's screen all at once and not the two characters or letters at a time as they are transmitted. A caption cannot be displayed until the last character is transmitted and the command signal is given to display the caption at the viewer's home decoder. Thus a caption encoded in the data track [illegible] the event. The greater the number of words a caption contains, the [illegible] the data must start to be transmitted. This is *unlike* the picture sound [illegible] a continuous process.

The illustration in Figure 6 may serve as an example. An explosion has just [illegible], the picture aperture shows the intense "flash"; later pictures show the [illegible] and debris. The picture sound head has just started to pick up the "boom," [illegible] continue (subsiding) over the next dozen frames. The data read head [illegible] collected (and sent for transmission) all the characters "B-O-O-M!" [illegible] transmitted the display caption command.

Instead of the explosion, imagine an actor *just starting* to utter a long [illegible]. The sound track would just be starting to pass point B where the sound [illegible] read. The sound track of the sentence would continue (to the left in [illegible]) well past the picture aperture and even the data read position (C). [illegible] caption data tracks starting point will move further to the right as the caption length increases. For average captions the data starting point will lie between A and B. In this way a caption is "protected" from edits by the picture [illegible] the sound track. Incidentally, if a caption data track is partly edited [illegible] caption will not display at all. You might note in Figure 6 that if an edit [illegible] immediately after (to the left) our "flash," the sound would be completely [illegible] "Boom!" caption might display except for the fact that the edit had

Figure 3. Enlargement from 16mm test film frame showing the optical data track containing the SMPTE time code.



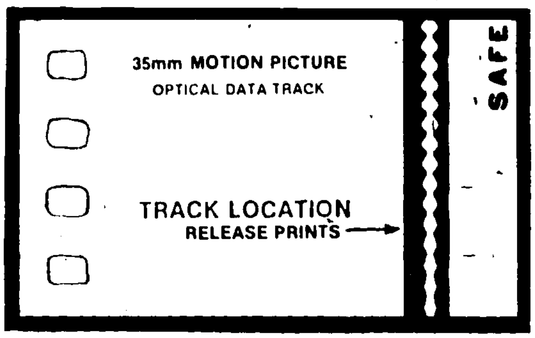


Figure 4. Frame of 35mm test film showing data track alongside the normal sound track.

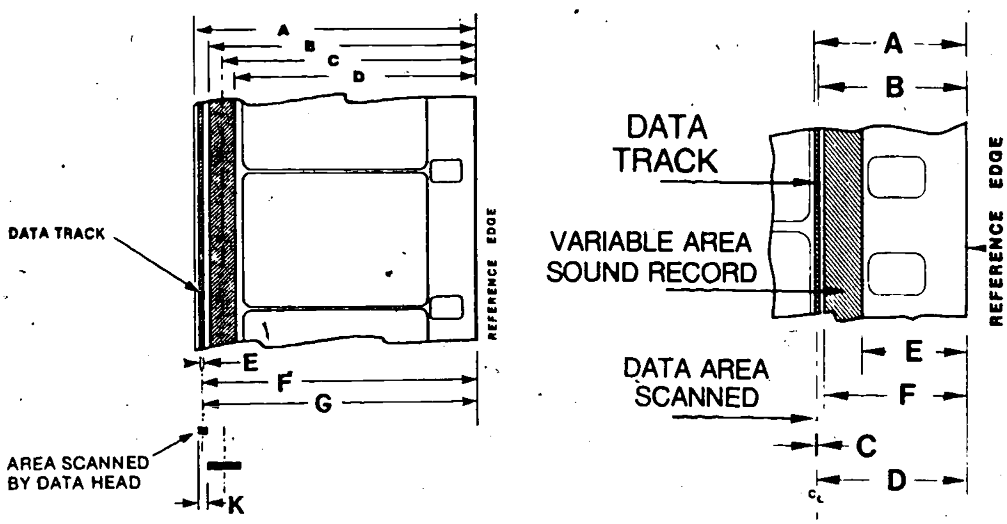


Figure 5. Locations of photographic data records on (left) 16mm and (right) 35mm motion picture release prints.

already been detected by the data reproduce head and the dump caption command sent at the appropriate time.

Data Track Reproduction Devices

The data track read heads for both 16mm and 35mm scan an area .005-inch wide down the center of the .010-inch wide data track. Film is pulled through the device by the telecine projectors existing constant speed drive rollers. The devices incorporate means to stabilize the film's lateral movement in relation to the film's reference edge. Adjustments are incorporated for focus and for lateral displacement of the area scanned. Azimuth adjustment is not incorporated since the area scanned is so narrow.

The data read heads pictured in Figures 7 and 8 were developed--in consultation with the author--by Harbeck Manufacturing Company, 170 South Avenue, Webster, NY 14580. They both are available for purchase. The 16mm *Data Track Reproducer* was designed to install on the *RCA-TP66* projector with only one tapped hole required for installation. The 35mm read head was designed for installation on the *RCA-FR35* projector. It mounts in the already existing holes provided for a magnetic read head. A magnetic read head and the data track reproducer cannot be used at the same time. Both models of the read heads provide for the film to bypass the units if desired. Both have open threading paths for the film.

Error Rates and Redundant Encoding

Film is not perfect. It is subject to dirt, scratches and other abuse. Considerable testing has been accomplished. The results indicate that at least 98% correct data recovery can be expected. A number of the tests were in excess of 99½% data recovery. This is not sufficiently error-free to form a system without error correction in decoding. Rather than elaborate error correction codes, the decision was reached to encode each portion of data twice--100% redundancy. Four frames separate redundant blocks of data. Well over ten million film frames of time code data have been tested and nowhere was it observed (except for splices) that four consecutive frames were in error. It is perhaps interesting to note that one test loop used to set up the test equipment made in excess of 4,000 passes through the read head and although it shows considerable wear the data recovery was still in excess of 98.6%. Even with 100% redundancy there is sufficient capacity to encode captions in two languages on the same film and still have additional capacity remaining.

Operational Logistics

Time code recorded on the optical data track can be used in two ways, depending on whether the captions are ready when the optical track is made. If they are ready, the caption data can be merged into the time code user bits and then be recorded on the film. This would lead to a single-system composite motion picture print containing all the information needed to broadcast in the closed caption mode. If the captions are not ready in time, the time code can be recorded on the data track without captions. Later the time code will be used during network broadcast to synchronize the caption data which will have been recorded on a computer storage device called a floppy disk.

Operational requirements for implementation of the system involve only a few additional steps in the production process.

When the final-cut work print of a film has been completed and sent to the network for preview, a picture and-sound transfer to a three-quarter-inch videotape cassette is normally made by the network. This is done by playing the work print on a telecine chain interlocked with the full coat magnetic film sound track.

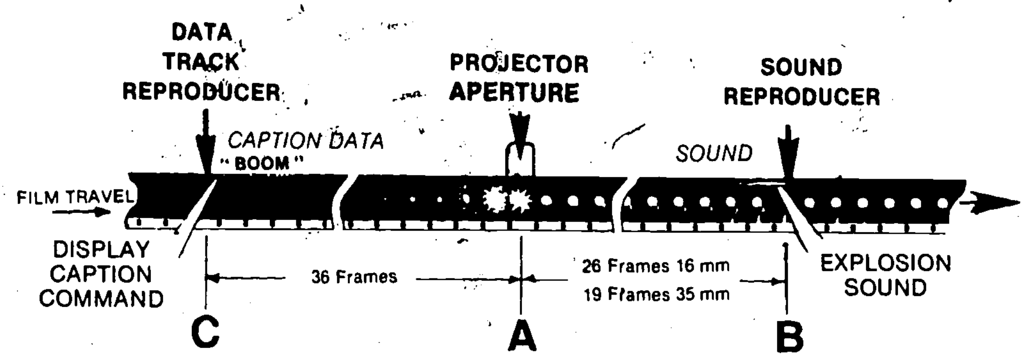


Figure 6. Relationships on film of picture, sound track and the data track (see text).

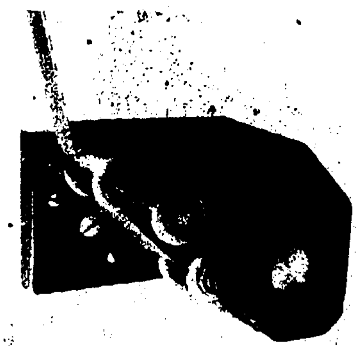


Figure 7. The 16mm *Data Track Reproducer* designed for installation on the *RCA-TP66* telecine projector.

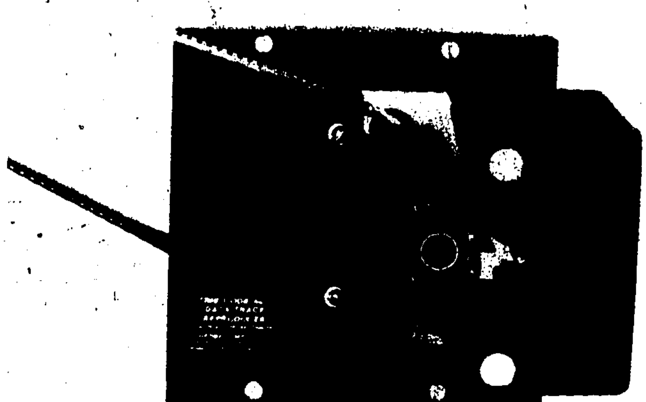


Figure 8. 35mm version of the *Data Track Reproducer* designed for installing on the *RCA-FR35* telecine projector.

If a magnetic film of the SMPTE time code is also interlocked, along with the work print and picture sound when the video cassette is made, then the time code can be recorded into the second audio track of the three-quarter-inch video cassette. Master 16mm magnetic film recordings of the SMPTE time code are available to the networks from the SMPTE Working Group Committee on Proposed Location of Optical Data Tracks.

The videotape cassette and a script of the film (if available) is then sent to the National Captioning Institute (NCI) where the captions will be composed and timed. NCI then will produce a magnetic floppy disk which contains the caption data along with an "address" for each caption. (The SMPTE time code was obtained from the videotape cassette.)

A duplicate master of the SMPTE time code on magnetic film is used in conjunction with the floppy disk to merge the caption data into the user-bit groups and create the final magnetic film record. This magnetic film then contains the time code and the caption data combined on one track. This data recording is sent to the sound studio that will be making the optical sound track master for the program.

The sound studio, in creating the optical sound and caption data tracks, runs the program sound in interlock with the magnetic film record of the merged captions and time code. The exposure of both tracks will then be produced simultaneously on one negative. The negative with these optical tracks will then be printed with the picture in the normal fashion. All release prints will have the captions already encoded.

If the magnetic film recording of the merged captions and time code is not available from the network when the master optical sound tracks are made, the sound studio will record only time code on the optical data track.

The time code will be obtained from master magnetic film recordings of the SMPTE time code identical to those referred to earlier. Subsequently, when the floppy disk record of captions is completed, it will be sent to the broadcaster where it will be played back and synchronized with the film by means of the time code recorded in the data track of the motion picture film.

A film containing the time code and captions may be played on any standard projector without the data track interfering with the picture or the normal sound. No closed captions will be transmitted unless the projector has been fitted with the equipment to scan and reproduce the caption data track. Such equipment has been developed and will soon be made available to broadcasters as a retrofit kit for existing projectors. Its cost is expected to be moderate.

The system described for closed captioning of film has had limited field testing. Several steps must be completed before the system becomes fully operational:

- A recommended practice for an optical data track to record time code on 16mm and 35mm film should be adopted by the SMPTE. Toward that end, the committee mentioned earlier has been formed within SMPTE and has made proposals for recommended practice standards for data track locations on both 16mm and 35mm films as well as a 24 frames per second time code.
- Production models of the reproducing devices, for both 16mm and 35mm, have been constructed and confirm the workability of the concept. Interface electronics to transfer the caption data to the line 21 encoder have been constructed and are presently undergoing field testing. This field testing will need to be completed and modifications made to reflect the results.

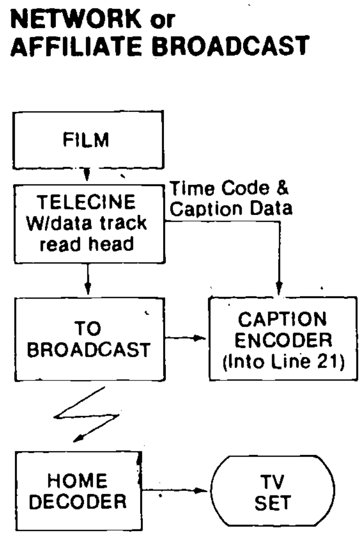


Figure 9. Illustrates the data flow when captions have been incorporated within the time code of the films data track. Local TV stations can use this system for delayed broadcast of syndicated film programs.

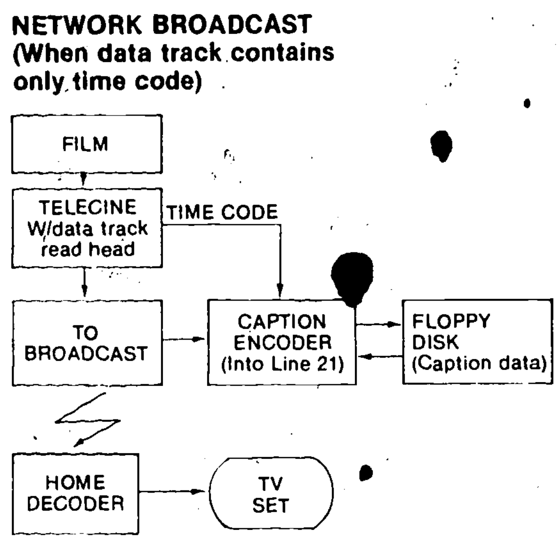


Figure 10. Shows the data flow when time code without captions has been placed in the film's data track. This system would only be used by the TV networks since the caption data is obtained from a second source: the floppy disk.

- Manufacturers have been located to produce retrofit kits so that broadcast telecine projectors can be equipped to read the optical data track. Advertising the availability of the equipment will be needed.

A system for time coding film fulfills a long-standing need of the film industry irrespective of its application to captioning. Film producers and other interested parties can help in achieving this in several ways. Industry acceptance will be needed for adoption of the recommended practice standard. Help from those in a position to expedite this process would be an important contribution.

With adoption of the standard, producers and sound studios will be urged to apply time code to all release films whether scheduled for immediate captioning or not. Finally, film producers are urged to join with the National Captioning Institute in providing, to the maximum extent possible, the benefits of this new technology for the hearing impaired.

Comments--In-Camera Recording of Time Code

Considerable interest has been generated both in the U.S. and in Europe regarding in-camera exposure of time code to identify each frame of picture. This is a direct result of the SMPTE committee's study and efforts in working to achieve a data track on release prints.

From the outset, the committee was mindful of the industry's need for a code system that would identify each individual frame and be machine-readable. They were equally cognizant that much film is used for television and that any code should be compatible, and should, if possible, make use of already existing hardware such as the SMPTE time-code readers already in use in the TV industry. This strongly influenced the committee's recommendation to adapt the SMPTE time code for television for film use.

Individual committee members (and others) have made in-camera exposure tests of the time code and have demonstrated the feasibility of utilizing such a system. Indeed, work is progressing in more than one camera manufacturer's labs for incorporating the means for exposing a time-code data track and modification of editing tables to read the data track (both 16mm and 35mm).

The SMPTE committee has drafted recommendations for the in-camera data tracks location: in 16mm it is identical to that proposed for release prints; and on 35mm film the proposed location is a .020-inch track located just inside the sprocket holes with a center line .201 inches from the reference edge. This location was chosen for a number of reasons: 1) to permit a maximum area for image--it encroaches only slightly on a full aperture image (a reduced aperture mask would have to be used), and there is no encroachment at all for type B and C apertures; and 2) the wider track makes allowance for film weave at high speeds through editing equipment and also permits reading the data track with present optical reproducers with only slight modification (masking a portion of the normal read area.)

Equipment already exists in Europe for interpreting the user bits as well as the time code and printing this information in man-readable form at selected intervals onto the film.

From work presently going on, the future looks bright for mechanizing the synchronizing of multi-camera dailies, negative cutting and electronic editing of film that has been transferred to TV tape for that purpose.

A major change in the way an industry handles film appears to be on the threshold. Conversion will not be immediate. Some will never make the change (they never have to since the system is fully compatible with present practices). From my perspective, I believe we are about to witness a major change that will reach both far and wide into the future of filmmaking and its compatibility with television. I feel proud to be playing a part in it!

Judith Braeges

The Use of Speech Displays with the Hearing Impaired

Speech displays are devices which detect and display information about the speech code. This information can be used either to supplement a hearing-impaired person's speech reception capabilities, or to facilitate the learning of speech production skills.

A speech display's usefulness is determined by the phonetic distinctions it can show clearly and consistently. The perception and production of meaningful phonetic distinctions are the bases of the understanding and the intelligible production of speech. For example, in English /d/ and /t/ are different meaningful phonemes. If a speaker says "den" for "ten," the intended meaning is not clear. Normally, the distinction between such visually alike phonemes is learned through the auditory monitoring of one's own speech and that of others. But, because many of the meaningful distinctions of the speech code are not readily perceivable by a person with a limited auditory monitoring ability, such a person must often rely on external monitors to learn the necessary distinctions. Traditionally, the teacher acts as the external monitor, but a speech display capable of showing such distinctions could also be used.

The development of such a useful speech display has been the goal of applied speech science since the 1920s. More than 100 different aids have been developed to aid speech reception and/or speech production. The focus of this discussion will be on the application of these aids to the task of speech production training.

It is common to organize the large array of aids on the basis of how the signal is delivered to the user. The two primary groups are Tactile Aids and Visual Aids.

Tactile aids display information to the skin by the vibration of an oscillator. Single channel (one point of vibration) tactile aids are restricted in the information they can deliver due to the limitations of the skin's response. For example, the skin's ability to detect frequency deteriorates rapidly above 200 Hertz. The information in the speech signal necessary to make the majority of important phonetic distinctions is located above 200 Hertz and is therefore not available to a user of a single channel tactile aid.

One effort to overcome the skin's limitations is the *Teletactor* belt developed by Dr. Frank Saunders.[1] This is a multi-point electro-tactile display which is worn around the stomach. High-frequency components of the acoustic signal are felt as a tickling sensation (low-level electrical stimulation) from those electrodes on the right of the belt; mid-frequencies in the middle; low frequencies on the left. In this way, the user can simultaneously receive information about many sounds which have different spectral characteristics.

Visual displays present the information to the user's eye. The *Visipitch*[2] uses a line tracing on an oscilloscopic display to show selected parameters of speech (e.g., pitch, intensity). The *Speech Spectrographic Display (SSD)*[3] instantaneously records a spectrogram of a speech sample. A spectrogram is a very detailed representation of the speech signal which shows the frequencies of the utterance as they change in time. Both the *Visipitch* and the *SSD* are able to store the recorded speech signal on a screen for analysis and study. This storage capability, which is common in visual aids, but rare in tactile aids, is very useful in the analysis of errors and in production instruction.

Speech displays potentially can be used to assist each of the three major components of speech production training: *1. Error analysis; 2. Production instruction;* and *3. Stabilizing drill.*

Error analysis is the basis of the corrective directions given to the student. The teacher must determine if the production was correct or incorrect, and just what was wrong with any incorrect attempts. Because of the fleeting nature of speech, the ambiguity of some deaf productions and the auditory fatigue caused by repeated listening trials, a speech display which stores a speech segment for analysis and study can be of substantial assistance.

Production instruction is that phase of speech development in which the teacher tells the student how to produce the target. A speech display which shows the speech signal changing in time can be used to communicate information about the articulatory dynamics of the target. In addition, the instantaniety of a speech display may play a major role in the development of the student's tactile-proprioceptive and/or auditory self-monitoring.

Stabilizing drill normally takes up a large part of the time in speech training sessions. Once the student is able to produce a target at some low level of consistency, its production is stabilized through many trials with feedback. Usually, the teacher provides this feedback, but a speech display which clearly and consistently displays a distinction between correct productions and errors could fill this role also. At the Rochester School for the Deaf, three *SSD*s are used to provide visual feedback to students who work relatively independently with the speech displays.[4] A therapist writes a program of drill work for the student, trains the student to make the simple judgment to distinguish his correct productions from his errors, and monitors three children at one time as they work alone. This results in a tripling of the amount of drill delivered to students and an efficient, cost-effective use of the teacher's time.

Speech displays clearly offer benefits to the teaching of speech production skills. But what basis can be used to compare and rate the various aids which are available? One objective measure is the number of correct/error distinctions which an aid can display clearly and consistently. An aid is only useful for developing those phonetic distinctions which it can distinguish.

Because there are over 600 correct/error pairs in the speech of the deaf, it is not possible to test all the pairs. But these 600 errors can be divided into 30 groups on the basis of their distinguishing features. We tested the ability of three representative aids to clearly and consistently distinguish elements of these 30 groups in order to demonstrate a method of objectively comparing aids.[5] The results of this evaluation are shown in Table 1.

In summary, speech displays have a role to play in speech production training with the deaf. They can be powerful assistance tools, not able to solve the problems alone, but able to substantially assist in the task. By rating aids objectively, as on the basis of the number and importance of the phonetic

Table 1

# and %age of Errors Discriminated	Single Channel Vibrotactile Display	Pitch and Intensity Visual Display with Storage	Visual Spectrographic Display
Consonants	$\frac{143}{500}$ = 29%	$\frac{257}{500}$ = 51%	$\frac{500}{500}$ = 100%
Vowels and Diphthongs	$\frac{2}{70}$ = 3%	$\frac{17}{70}$ = 24%	$\frac{47}{70}$ = 67%
Suprasegmentals and Quality	$\frac{19}{26}$ = 73%	$\frac{23}{26}$ = 88%	$\frac{22}{26}$ = 85%
Totals	$\frac{168}{596}$ = 28%	$\frac{297}{596}$ = 50%	$\frac{569}{596}$ = 95%

distinctions each can display, speech display instrumentation can be "demystified" and realistic expectations and programs for their use can be developed.

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Technology for Employment

[illegible] Crewe

[illegible] Choosing Technology for the [illegible]

[illegible]

[illegible] equipment, transportation, [illegible] and working

Of the special kinds of equipment, by far the most common was an ordinary desk raised on blocks to accommodate a wheelchair. Other kinds of working surfaces that we encountered in our study or found reported in the literature included adjustable workbenches, an operating table that could be lowered for a surgeon, an adjustable examining table for a veterinarian, and a movable pulpit.

Rehabilitation engineers have indicated that virtually any kind of equipment that can be operated with a switch can be adapted for a quadriplegic. Breath-operated or voice-operated controls are available, and plates, knobs, and levers can be built at various angles to respond to any kind of touch.

One of our subjects used a tractor that was operated with hand controls. The tractor had power steering and an automatic starter, and was mounted with the use of a hoist. Portable hoists were also found to be helpful to other workers, such as mechanics.

Some adaptations were extremely simple, for example, a rubber thimble that was used to turn pages and move papers around a desk. The telephone company has a wide range of useful equipment including head sets, speaker phones, telephones with adjustable volume, etc.

Electrically powered tools represent another kind of adapted equipment. Many of them are commonly used by able-bodied people, including typewriters, recorders, and dictating machines.

Transportation adaptations were infrequently mentioned in our study, probably because respondents were focusing on the job setting itself rather than on the process of arriving at work. A few of the individuals did have special vans or motorized wheelchairs. One individual lived in a nursing home and traveled around the community in a chair that was equipped with headlights. He managed a catering business and also served on the City Council.

When work adaptations are mentioned, architectural modifications are often the first thing to come to mind. Employers often assume that they will be expensive, but this is not borne out by experience. In our study, bathroom modifications were the most frequent, and they were made for 6 of the 56 workers. Some of these were as simple as replacing a door with a curtain. Occasionally, more extensive modifications were needed. Other architectural changes included removal of carpeting, and the widening of doors and aisles. We did not encounter any elevator construction, although one person did need to get special clearance to use the freight elevator. One other person had his office moved to the first floor after he was injured.

In some circumstances, severely disabled individuals may need a full-time attendant or interpreter. In those instances, the assistant is ordinarily paid by the individual or a rehabilitation agency. In other examples, assistants function more like a typical secretary to increase the efficiency of the worker. In these cases, the assistant is usually paid by the employer.

Family involvement represents another kind of special assistance. Our study included one couple who served together as receptionists for a veterinarian. A more common arrangement is when one spouse is self-employed and the other assists in the business. Sometimes the disabled individual helps with aspects of a family business. In other cases, the disabled individual may have a business, for example an insurance agency, with which the spouse assists.

Mallik[2] has indicated that when equipment and environmental modifications are not cost effective, then job restructuring is recommended as a form of accommodation. Our study identified several instances of duty modification. One is specialized division of labor. For example, a paraplegic veterinarian stayed in the clinic while his partner went out and took care of large animals. A spinal cord injured manager of an automobile distributorship also did the inside tasks.

Such agreements are easiest to reach for a person who is self-employed and can choose an agreeable partner, but with a willing employer they can be reached in other situations too. For example, a paraplegic automobile mechanic was given the work he could do from a wheelchair, from a crawler, or sitting on a fender.

Sometimes usual duties can be eliminated from a job definition. For example, travel may be eliminated or drastically reduced. An architect was not required to supervise construction or to check compliance as he usually would have done. An elementary teacher was excused from supervising recess or field trips. An insurance salesman who had difficulty with constant travel took an office job that involved training new salesmen.

Special arrangements were sometimes made for working hours as well. Some individuals chose to work part-time, and others needed periodic rest breaks, time out for personal cares, or special hours to avoid rush hour commuting.

Two main conclusions can be drawn from our study of job adaptations. First, for the most part, solutions to work-related problems were simple and inexpensive. Secondly, a strong relationship existed between return to a previous job and more complex solutions. This would be expected, because when an individual returns to a previous job, both the employer and the individual have a special investment in working problems out. They also have a better knowledge of the possibilities, and creativity is a function of knowledge as well as imagination.

What are the criteria to be used in choosing appropriate technology for a disabled worker? At least seven criteria occurred to me. One is *function*, that is, will the adaptation meet the need? Will it do what it was expected to do? The second is *adaptability*. Will the modification impair the usefulness of equipment by nondisabled co-workers? Closely related are the attitudes of co-workers and union rules regarding the adaptation. Rather frequently, an adaptation provided for a disabled worker has been envied by all of the able-bodied workers, and this can cause strained feelings on the job.

Availability is another criterion, and a closely related one is *cost*. First of all, can money be found to pay for the adaptation, and secondly, is the adaptation cost-effective? In other words, can the piece of equipment be obtained at any price, and if so, will it pay for itself?

Maintainability is another criterion. Little needs to be said about the frustration involved in trying to use a complex piece of equipment that repeatedly breaks down. Generally the simpler the device, the smaller the problem of upkeep.

The sixth criterion is *comparability*, meaning simply, is this adaptation better than the available alternatives? There is another important criterion--that of *acceptability*. In other words, can the individual live with this adaptation, and will he or she use it? Professor Zola of Brandeis University has warned that technology can do too much for people with disabilities.[3] Machines or devices created by technology may be so complete and efficient that they rob people of their integrity by making them feel useless. He observed that many disabled people invent an addition to their device or alter its use to suit their purposes. For many years he assumed this was simply a way of correcting faults in the equipment, but he recently recognized that more was at stake. People make changes in order to make their devices more personal and more a part of themselves. He suggested that adaptive devices need not do everything, and in fact, it may even be better to encourage people to invent ways to improve their equipment and to make it more their own.

Professor Zola also indicated that there are other ways in which technology may go too far, particularly with regard to replacement of bodily parts and functions with equipment. Recognizing the value of transplants and prostheses, they are nevertheless a mixed blessing. As the body rejects foreign substances, so may the psychological person reject parts that seem alien. They will often feel extremely conspicuous about, for example, a slight audible click in the motion of a prosthesis, and many people will resist using even a cane in public. For example, Franklin D. Roosevelt was extremely reluctant to be photographed in a wheelchair. One man in our spinal cord injury follow-up study had stayed in the house for seven years to avoid being seen. Undoubtedly, this response is caused not only by a rejection of devices, but also by rejection of the disability itself. Still, the matter of devices alone is not trivial. How many people leave rehabilitation centers, armed to the teeth with fancy equipment, and proceed to store it all in the front closet? And how often can they demonstrate a simple, inexpensive substitute for a complex and costly device? I would certainly not argue against the use of high technology when that is the only good solution to a problem, but all of the criteria, including *cost, availability,* and *maintenance* favor *simplicity*.

In deciding upon what technology to use, involvement of the disabled individual in the planning and design of adaptive equipment may be an even more important consideration. This sounds obvious, but there is still a frequent assumption that such matters belong in the hands of the professionals. A recent training manual, for example, set out to explode the myth that disabled people are the best judges of their capabilities and limitations. Conversely, Peter Drucker noted, "My greatest strength as a consultant is to be ignorant and ask a few questions." With the many challenges that have yet to be met, it is important that the professional and consumer, the able-bodied and the disabled, pool their knowledge and imagination in order to avoid getting into the situation of the patent office director who could see "nothing more left to invent."

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Jiri Vasa and Ian Hofford

Skid Loader Modifications for a Quadriplegic Farmer

Introduction

One of our latest projects at Queen's University, Kingston, Canada, was the modification of a skid loader for a disabled farmer. Mr. Hofford, user of the machine, reported on its various features at this meeting. I would like to supplement his report and respond to some questions from the audience.

As the name of this meeting suggests, the concern of the participants is centered around employment for the disabled. I will, therefore, describe only very briefly construction aspects of the modification and will try to convey in more detail our thoughts regarding the impact of this kind of project on the problems of employment of disabled people.

Modification

Requirements

Mr. Hofford needed a machine which would enable him to work on the family farm. He envisioned working for up to eight hours a day, independently, for a greater part of the year.

In the very early stage of the project he was considering, as an alternative, a vehicle which would just transport him around the farm to enable him to do supervisory work. This alternative was very soon abandoned in favor of a tractor-like machine which would be capable of a variety of work as required on the farm.

A mechanism which would transport Mr. Hofford in and out of the machine was needed. It was to be self-contained and located on the machine, so it would be available in the field. The operation of the system was to be such that Mr. Hofford's young children could assist in transfers whenever it was necessary.

Only movements of Mr. Hofford's elbows were to be used to operate the machine. No attachments to Mr. Hofford's body were to be considered.

Machine

The machine was selected, after a considerable search, because it could do all that Mr. Hofford intended to do on the farm and it was easier to modify than other candidates, such as standard tractors.

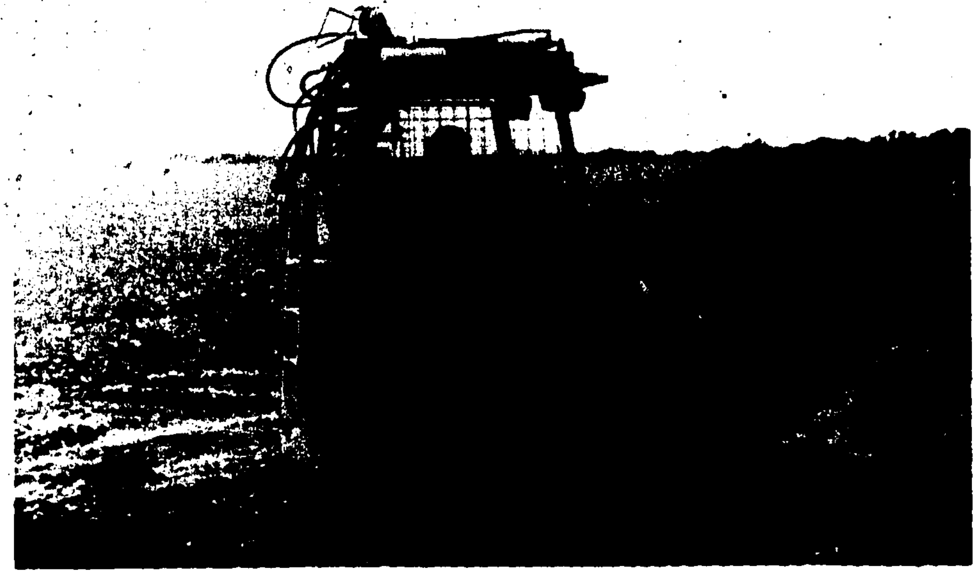


Figure 1. Side view of the loader. The hoist, in "stored" position, is visible on the roof of the protective cage. The electric winch is above the hoist; the cylinder under the winch is the hydraulic fluid reservoir. The hydraulic hoses, behind the protective cage, are of correct length to allow the hoist to fully extend for transfers. The ladder stored on the back of the machine has been designed and constructed on the farm by a friend of the family. It is used by an assistant for transfers.

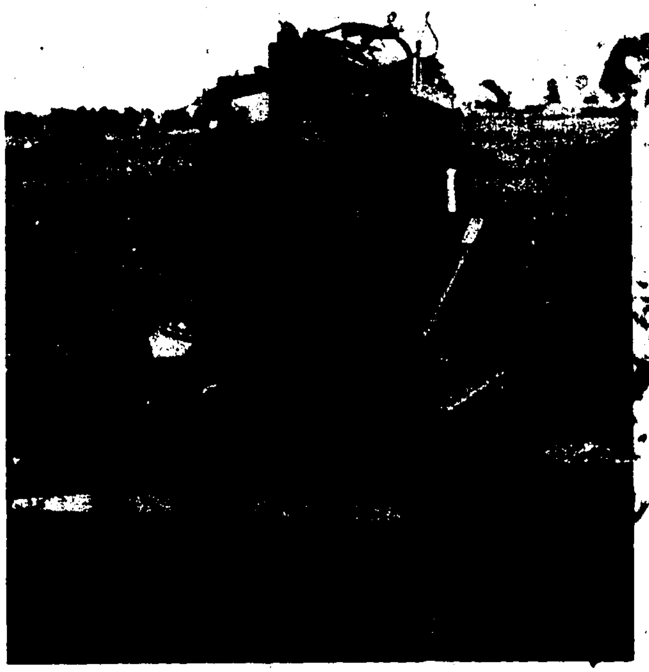


Figure 2. Front view of the machine. Mr. Hofford has his left elbow in the left bracket to control driving; he is in the process of transferring his right elbow to the below-the-bar position in the right bracket to operate the bucket. Rear-view mirrors, visible beside the lights under the roof of the protective cage, are used when the machine is operated in reverse.

There are two main features which make the machine suitable for modification:

- The propulsion is by hydraulic motors with the pump powered by a regular internal combustion motor. This combination can develop considerable power at low speed and does not employ a conventional transmission or a clutch.

- The steering is not, as on standard tractors, performed by turning a set of wheels, but by speeding up, slowing down, stopping or reversing the left or right hand pair of wheels to cause "skidding" to one side or the other. The complete control of the machine's movements can thus be accomplished via two levers with NEUTRAL, FORWARD and REVERSE positions.

The modified machine is operated via seventeen switches located in two elbow brackets. The functions are allocated as follows:

- Two switches start the motor (both of them must be depressed simultaneously).

- Two switches stop the motor (depressing any one of them is sufficient).

- Two switches are used for THROTTLE OPEN and THROTTLE CLOSE.

- Two switches operate BRAKE ON and BRAKE OFF.

- Two switches control ARM UP and ARM DOWN functions.

- Two more switches are used for BUCKET UP and BUCKET DOWN.

- Two switches on either side control that side's wheels' direction and speed.

- The last switch operates a siren provided for potential emergency situations.

Hoist

The hoist represents almost half of the overall effort. It was essential for easy and dependable transfer of the user from the wheelchair into the driver's seat and back.

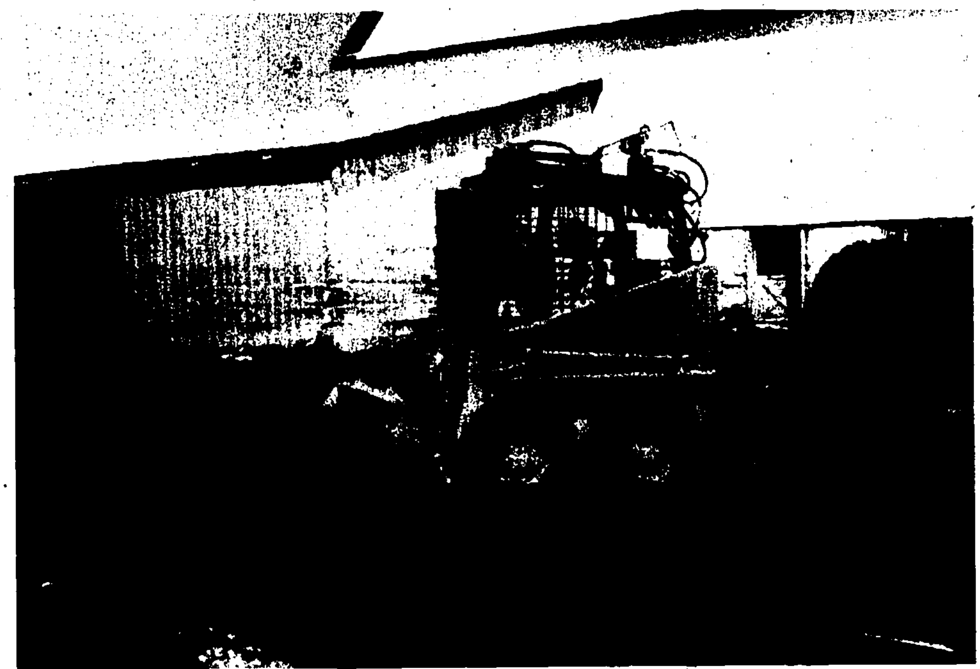
It had to be compact enough for storage on top of the protective cage; extended, it had to reach from the middle of the driver's seat beyond the middle of the bucket where the wheelchair would be located. Although to a great extent hydraulically-powered, it does not share the machine's hydraulic circuit. To ensure its functioning even in case of failure of the machine's main motor, the hoist has its own, battery-powered hydraulic pump as well as an independent winch.

Project Rationale

When the project was in its proposal state, the two most commonly asked questions were:

"Is it possible to modify the machine successfully?" and
"Will the results justify the cost?"

The first question has been answered. The second is still being asked and has been asked at this meeting. I would like to present here several thoughts which may contribute to finding the answer.



Figures 3 and 4. A working sequence from Mr. Hofford's daily activities. The manure spreader is, at the present, emptied periodically by a member of the family. Mr. Hofford is impatient with the delays and would like to be able to perform that operation, too, by himself.

Universality of the System

We are convinced, as I will show later, that the project is easily justifiable even for an isolated case of one person needing a specialized machine. But this is not the case here. The system was developed with universality very much in mind. It can be used, with minor modifications, by persons with a wide range of disabilities; it is unlikely that a person more disabled than Mr. Hofford would contemplate employment in this field and for all others it would be easier to use the system than for Mr. Hofford.

The modification is also suitable for a wide range of machines. Most types of loaders, of all sizes, can be modified; other machines, such as bulldozers, would accept the system and could be made available to disabled operators. Consequently, the application of the system is not limited to farming only. Other areas such as the construction industry, excavating and material handling in general are equally well-suited for the use of modified machines.

As I already mentioned, Mr. Hofford's machine can be controlled not only directly from the driver's seat, but also remotely, via a cable, from a control panel outside the machine. With this remote control capability the system has further potential applications in dangerous environments, such as in demolition work and in inexpensive machines for use in police and army applications.

Farm Application: Special Appeal

I have to admit that we are biased in favor of farmers. Despite the generally harder conditions for a disabled person living on a farm in comparison with his counterpart in the city, the disabled farmer is generally less bitter about his plight and very often continues working, ignoring his disability, without the benefit of any aid at all. When we investigated a report of a tractor modification for a farmer in our area, we found that it consisted of a rope with which the farmer tied himself to the seat of a garden tractor. He then performed odd jobs around his property.

Very little indeed has been done for disabled farmers. They are not a noisy group and do not demand attention. In most cases they do not even know what rehabilitation engineering could do for them.

Mr. Hofford had to wait for several years to receive his machine and his situation is not atypical. Disabled farmers are forced into idleness where, with an appropriate aid, they would be capable of significant contributions. It is especially disturbing considering the fact that farming is, in many ways, so uniquely suited for placement of disabled employees. Threat of unemployment is not as significant on a family farm as it is in a big industrial complex. A person is not displaced from his familiar environment; he works "at home," continuing to do what he liked to do before he became disabled or what his family has been doing. He enjoys the support and understanding of his closest friends and is contributing to the family effort. The hours are flexible and so is the sequence of work. Modification of the working environment is easier in the informal environment of the farm than in the more rigidly structured industrial plant. The work is more individual and the worker is not part of a strictly timed effort of a team, such as with an industrial assembly line.

Farm Application: Influence on the Project and Employment Considerations

When attempting to place a handicapped person we first try to locate a potential employer. Then comes the effort to modify the working tools and the workplace, if it is necessary.

This was our first opportunity to work with a highly motivated disabled person who already had an "employer"--his own family, parents, relatives and, as it turned out, his neighbors, near and far. What did it mean for us, who were involved in fund raising, design, construction, instruction and all other aspects of this work?

One very obvious effect was Mr. Hofford's full concentration on the project. When we started, not many people believed that we would succeed; they doubted that the machine could be modified, questioned Mr. Hofford's ability to control the machine and work with it consistently for several hours a day, as was his goal. We could not guarantee the success ourselves and were not pretending we could. At the same time everybody realized that Mr. Hofford's intensive cooperation was essential. Mr. Hofford's "employer" not only believed that the project would be successful, but committed himself fully with his representation at meetings, investment into the machine and modifications on the farm.

We had an "employer" and the "employee" attending every meeting together from the very beginning; they were present when we were preparing the outline of the project and could point out potential problems (such as, for example, turning radius of the machine in the confined space of a barn) and potential solutions (rerouting the traffic in the barn or widening certain portions of the walks).

We have benefited from this exchange of ideas. The employer, on the other hand, could see the progress of the project and knew in every stage of the work what the employee would be able to do and could plan his operation accordingly. Everything was ready on the farm when we wanted to test the machine. Mr. Hofford had systematic work prepared immediately after he finished his training period.

We recognized this combination of factors when Mr. Hofford approached us and our subsequent experience confirmed that the decision to accept the project was the right one. Mr. Hofford helped us to develop a system which will help many others; he was an inspiration to all involved, from the very start to the present, when he is using his machine on an everyday basis.

Return on the Investment

During the past ten years the workers in Rehabilitation Engineering have invested much time convincing the granting agencies, general public, including the disabled population, that it is not unreasonable to spend a few hundred dollars on an aid which would make it possible for a two-hundred-dollars-per-day patient to leave the hospital and live in his/her own house.

During those ten years the disabled population has matured from simple on/off aids to more powerful ones and, eventually, to aids which will help them work. The aids are becoming much more complicated and with it comes a requirement for more funds. The discussions now are about the wisdom of spending several thousand dollars on a project.

The first thing to realize, before considering the appropriateness of supporting the project, is that not all the aids have the same impact on the recipient and will not provide the same "return on investment." There is a basic difference between the aid which is used mainly for entertainment (remote control operation of a television set) and an aid which will reintroduce the user into the work force.

We must consider several factors before arriving at a figure which would be a monetary limit for a particular project. How much money have we already spent on education and professional training of the person? How much would we spend if during his/her projected life-span he/she remained inactive? How great a portion of the overall sum is to be spent on the purchase of equipment (in our case the loader) which would have to be purchased even for an able-bodied employee to work with? How much money is typically spent for such equipment per able-bodied employee for a comparable position? How much money would we be willing to spend for the retraining of a person whose original trade is no longer in demand--an accident of a sort in the life of that person?

I will not, intentionally, present our budget. It would only be representative of our own conditions, our own project, our abilities and limitations. I will, instead, urge anybody connected with planning a project like this to consider carefully the criteria outlined above before deciding how much money they would like to commit to the particular work and to the particular user.

Conclusion

We have developed a modification system for a disabled farmer to use with his skid loader. The system is universal in terms of disabilities of its users and the machines to be modified. It was a unique experience to work with a farmer; we feel more should be done for farmers in general.

There were some doubts about how much money is appropriate to spend for such a project. I have attempted, in this communication, to explain some aspects of our thinking about this question. It is important to realize that modifications like this make it possible for disabled people not only to move around, but to work--for their own benefit, for the benefit of their families and society as a whole. There is no specific amount of money which should not be exceeded in attempting the modification; each case should be considered separately, taking into account possible benefits and realizing that much would be done for an able-bodied person if he/she was to accept the job for which the modification is intended.

We are grateful for the opportunity to be associated with the project and would be happy to be involved in a similar way in the future.

Herbert Evert and Randy Black

The Development of a Workplace for a Visually Impaired Information Specialist: One Case

At the University of Wisconsin-Madison, the challenge of providing persons with disabilities equal access to higher education is taken most seriously. In addition to such standard accommodations as ramps, modified curbs, Braille-labeled elevators, and altered restrooms, information concerning their temporary or permanent disabilities is collected from students on their registration forms, and our McBurney Resource Center for Persons with Disabilities attempts to meet their various needs. At the McBurney Center, available services include advance *Timetable* and textbook information, registration assistance or proxies, parking and transportation arrangements, housing information and assistance, wheelchair attendants, readers, library services, modified forms of information (Braille tape, large print, etc.) use or rental of such equipment as tape recorders, auditory calculators, etc., keys to buildings and elevators, and alternative testing and evaluation arrangements. In addition, our Campus Assistance Center offers a DIAL information service which is a telephone audio tape library available 24 hours per day on subjects of interest to students including registration and records, services for disabled students. Each semester's *Timetable* makes reference to these sources of assistance for disabled students, lists the campus buildings which are not accessible to wheelchairs, and quotes the campus policy statement that "a student with a disability may request a change in classroom location if a particular course is necessary for a general and/or major requirement." And our Memorial Library has set aside rooms for the use of such specialized equipment as the *Optacon*, auditory calculators, and tape recorders.

This very commitment, however, poses an obvious problem: the more successful we are in educating persons with disabilities, the more pressure we are and will be under as a society to find them the employment for which they are prepared.

Our case study in employing the visually-impaired as Information Specialists took place in the University's Office of the Registrar which is housed in the A.W. Peterson Building located on the east end of the campus. Our efforts came about as a direct result of the presumed relationship between education and employability. It was in 1968 that a middle-aged blind man who had earned both baccalaureate and masters degrees at another institution in Wisconsin finally, out of desperation, sat in on the Governor's Capitol office doorstep until he received some assistance in finding employment. One of Madison's daily newspapers picked up the story and gave it a good deal of coverage which included criticism of state government and the universities for assisting in this man's education, but then not finding him gainful employment. As a result, this gentleman became first a Veteran's counselor and, subsequently, in 1973, was hired as an Information Specialist at the Registrar's Information Desk in the lobby of the Peterson Building.

Prior to and since 1973, workplace adjustments have been made for the sake of employees with temporary disabilities or disabling diseases, and the Registrar's Office had previously employed a person who was semi-paraplegic for whom some minor long-term adjustments were necessary. But not until 1973 did we purposefully set out to modify a position description of long standing within our office with the intention of employing a person with a specific disability.

Hired on the basis of his knowledge of the University, his phenomenal memory, and his ability to make notes for himself with a Braille typewriter or a stylus and slate, there were nevertheless many unknowns and seeming risks involved in the employment of our initial blind Information Specialist. When he died late last year, he and the Registrar's Office had undergone seven years of trial and error which resulted in a position tailor-made for a visually-impaired individual. And this is the position Randy Black assumed early in 1981:

FACULTY/ACADEMIC POSITION DESCRIPTION
TITLE: SPECIALIST - INFORMATION
STATUS: ACADEMIC STAFF

Function

The incumbent is responsible for the day-to-day management of the Registrar's Information Desk including but not limited to the supervision of the Information Desk, the maintenance of stocks, and the oversight of the release of student information according to policy.

Principal Activities

In carrying out this function, the incumbent is responsible for the following activities:

- Hire train, schedule and supervise the personnel employed in the Information Booth. (1 classified, 3-5 students).
- Maintain supplies of *Timetables,* school and college bulletins, brochures, campus maps, forms, etc., for distribution to students and the public.
- Ensure compliance with policies governing the release and/or withholding of student information.
- Serve as the locus for telephone inquiries and the proper transfer of calls to appropriate sections or offices.
- Oversee the provision of address, phone number, and next-of-kin information changes for students together with address audits of the student data base.
- Have working knowledge of Grades I and II Braille and moderate typing ability by means of which to operate Braille-output computer terminal.
- Oversee the validation of identification cards for students who register late.
- Participate in the decision making, coordination and review functions of the Assistant Registrar's staff.
- Perform such other tasks as may be assigned by the Assistant Registrar or Registrar.

[illegible] computer terminal [illegible] the Informa[illegible] specific information [illegible]

[illegible] which converts [illegible] Information Board [illegible] at that time [illegible] terminal.

[illegible] output device [illegible] These that we [illegible] interactive with a standard com[illegible] our Information Desk environ[illegible] On the other hand, [illegible] whether printed or not and [illegible] Braille.

[illegible] requirement of being inter[illegible] Stuart, Florida. Shortly after we [illegible] Model LED-30, we learned of a very similar [illegible] France and handled by Telesensory [illegible] while our experience in the University's [illegible] have worked with both machines, [illegible] of the LED-30 ordered with which [illegible] difficulties unresolved to date, an LED-15 [illegible] Meanwhile, our computer center had ordered an [illegible] students, and we have had some experience with

[illegible] terminals, asynchronous page embossers [illegible] Braille characters. They differ in speed [illegible] characters per second at a price of about [illegible] characters per second at a price of about [illegible] between the LED-15 and the LED-120 besides those of [illegible] letter by letter while the latter prints [illegible] advantage of the line embosser is that we cannot [illegible] inputting until we push the line return key. If [illegible] place while inputting a name, we have to go [illegible] With the letter-by-letter embosser, we [illegible] the name. As noted, the line embosser had the [illegible] information much more quickly than the letter [illegible] a better maintenance track record as well. Either [illegible] pound weight, but we decided to use 80 [illegible] paper so that those pages we wished to keep for [illegible] the Braille embossing.

[illegible] data processing people faced the first of [illegible] have 80-character lines; the LED-15 uses [illegible] transaction this Braille-output terminal was going [illegible] with this difference in mind. Each 80-character line [illegible] two lines on the LED-15, or the second half of the line is [illegible] terminal transactions currently in use at the [illegible] taken more time and money than we could afford at [illegible] one transaction, SINM (Student Name Lookup), [illegible] transaction for the Braille terminal called SBRA (Student information in Braille). We designed the SBRA transaction to provide only the student data information which we are allowed to give out to the public under the provisions of the 1974 Family Education Rights and Privacy Act governing access to and confidentiality of student records. Thus the SBRA transaction could serve the dual purpose of providing the public information available on students to anyone on campus who is cleared for CRT access as well as being a properly formatted primary inquiry transaction for the Braille-output terminal. We are happy to report that SBRA has found uses in both modes.

Access to SBRA is gained by either the student's name (last name, comma, plus first name) or the 10-digit student ID number. The following information is then available through SBRA: name, campus address, campus phone number, permanent home address, major, birth date, classification and year at this University, matriculation date (semester/year first registered), semester/year last registered, number of credits earned toward a degree (or degree credits), credits in progress, the last educational institution the student attended, and the last degree earned and date granted from this University. All of this information can legally be given out to anyone who requests it UNLESS the student has filed a "withhold" form with the Registrar's Office which restricts access to that student's information to University personnel only. One unusual feature of this University's implementation of the privacy legislation is that the student can pick and choose which information s/he wishes to withhold, as in the following example:

```
SMITH, JOHN
 NM  SMITH, JOHN JAY
$CA  239 N SHERMAN NO 1
     MADISON WI           #53704
$CP  #241-2759
$HA  322 S SHERMAN NO 10
     MADISON WI           #53704
 MJ  ENGLISH
 BD  #12-27-57
$CL  UNS #9
 MD  #177
 LAST REG #182
 DEG CRS #122
$CRS IN PROG #06
 LAST ED INST ATTENDED
  UNIVERSITY OF WISCONSIN-WHITEWATER
 LAST DEGREE EARNED AND DATE GRANTED
  BS-EDUCATION       #12-22-80
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In this example, the student has withheld only part of his public information, viz., his campus and home addresses, phone number, classification and year at the University, and number of credits in progress. The "$" sign before these items indicates to the operator that they have been withheld and are not to be released. The "$" sign is an arbitrarily selected visual substitution for the Braille symbol we use. Thus, by early 1981, we had the LED-15 installed and the first transaction in use.

The other transaction we use with the LED-15 is the STNM (Student Name Lookup) transaction mentioned earlier. People requesting student information often give us inaccurate spellings of names, informal first names, or nicknames. Access through STNM requires a correct spelling of the last name and the first one or two letters of the first name. If a name is unavailable through SBRA, STNM is used as a double check to be sure that the student is not on the file under a slightly different name. STNM also helps in those rare instances where two students have exactly the same first, middle, and last names. Then the only way to be certain that we are dealing with the proper individual is to have the student's ID number. STNM provides some additional but non-public information such as the ID number, sex, and marital status of students which is helpful in such cases.

While the LED-15 Braille-embossing computer terminal is certainly the single most significant and costly adaptation made to the Registrar's Information Desk as a work station for the visually-impaired, neither it nor the minor modifications mentioned at the outset were the only means we discovered for this purpose.

As for sighted employees, it is very helpful to have cabinets and file drawers labeled as to their contents. To do this, we use a BTW400 *Scotch 3M Braille Dymo Labeler*. It is available through the American Foundation for the Blind catalog and it costs about $40. While it can use 3/8-inch tape, we prefer the 1/2-inch dymo tape because we find it much easier to read. While we were at it, we also labeled the vending machines in our canteen room.

With the labeling completed, the next project was the production of reference copies of all the inter-office policy brochures. This aspect of the modification process required reading on tape various printed materials and then putting it into Braille form. The machine we purchased for this purpose is the *Perkins Braille Writer*, manufactured by the Howe Press of Watertown, Massachusetts, and costs approximately $300.

The writing of Braille is based on a six-dot cell. Depending on the dot combination used and the context of the material being read, you can write anything from A-Z, and everything in between if you know the Braille code. Braille writers are being produced today which use a typewriter keyboard set-up instead of using only the six keys of the *Perkins Braille Writer*. This could eventually end the need for those wishing to learn how to write Braille to learn a difficult Braille code. If s/he knew how to type, a person using one of the new Braille typewriters could very easily put such material into Braille form. The keyboard for our LED-15 Braille embosser utilizes just such a keyboard.

As supervisor of the Information Desk, Mr. Black is required to attend weekly staff meetings. For the purpose of taking notes, he makes use of a "slate and stylus." The slate can be either metal or plastic. We prefer the metal ones. Each slate has four lines on it and each line has a series of what are called "cells" in which, using a stylus with a plastic or wooden top and a metal spike, any of the Braille characters can be "written."

While the slate operates like the *Braille Writer*, there are two important differences. First, with the *Braille Writer*, you can push all of the dots for each letter you wish to write at once. With the slate, you punch each dot for each letter individually. This is a much slower but a much quieter process, which is why it is used for taking meeting notes. The other difference is that the dot positions on the *Braille Writer* are exactly opposite when writing on the slate. On the *Braille Writer* dots 1, 2 and 3 are on the left side and dots 4, 5 and 6 are on the right. When using the slate, those positions are reversed.

On the telephone which the blind Information Specialist most often uses, we have installed a little device called a "sound barrier." It is available from Grant Electronics in Madison, Wisconsin for $8.95. Goodrich Products makes the device. While the modified telephone bells mentioned earlier tell us which line is ringing, they do not tell us which lines are in use when we wish to make a telephone call. Pushing the barrier button to the left cuts off the telephone transmitter. If we then pick up a line that is in use, all that the parties will hear is a soft click which will not disrupt their telephone conversation. In fact most people will not even hear the click.

Another piece of equipment which we use when we need to record something off a telephone is a "telephone pick-up coil." At least two kinds of coils are available. The one most commonly seen is a suction cup device sold through Radio Shack.

for around $2.00. The second type which we prefer goes around the earpiece like a ring. Unfortunately it is much harder to get, but it is available through Grant Electronics for a cost of around $4.00. We prefer it because it provides much better sound quality when compared with the suction cup. While we do not use the pick-up coil a great deal, it has come in handy when we have needed to take a good deal of information from someone over the telephone in a short period of time.

These modifications and devices allow Mr. Black to function effectively as the supervisor of the Registrar's Information Desk. They do not, however, allow him to do the exact same job that his employees do. For example, when he receives address changes from students, he cannot yet enter them onto the data base. The transaction is not yet available for formatting reasons on the LED-15 computer terminal which he uses. Similarly, he is unable to validate student ID cards inasmuch as he cannot yet access the transaction which would tell him whether or not students' fees are paid. These are some of the modifications we foresee for the future.

From our experience, however, we have learned that adapting the workplace for persons with disabilities is not an exact science. In adapting this one position for the visually-impaired, the many decisions we have faced indicate that it might have been done in many different ways. A Braille-embossing computer terminal is at the center of our operation, for instance, but some visually-impaired persons read large print rather than Braille, or can only use an auditory-output device, because they do not read Braille.

Moreover, while there are various technological developments to meet certain needs, the delivery systems for such developments to the disabled users must be improved. It takes much too long for many such devices to be delivered and installed once they are ordered, and they are most often not ordered until there is a demonstrated need. In the meantime, both the disabled user and his/her employer are frustrated.

Finally, while we have described in some detail our use of a Braille-embossing computer terminal, we wish to point out that most of the other modifications made to the Registrar's Information Desk at the University of Wisconsin-Madison were adaptations of materials at hand or relatively inexpensive additions. All of our telephone modifications and devices, for instance, are very inexpensive; the *Braille Writer* costs less than an electric typewriter; and the tape recorder, notebooks, file folders, and much of the paper are standard office supplies. It is simply not true that modifying a work-site for a person with a disability is always expensive. It may only require some creative though and some affirmative action in the best sense of those words.

This in no way denigrates the need for, and role of, technological advances for disabled persons. Employing well-educated disabled people at the level to which they are prepared will be at least as great if not a greater challenge than that of access to the preparation in the days ahead. As access to education increases, in no small part due to technological advances, the well-educated disabled person will be equipped to handle the work-related tasks of his or her able-bodied counterparts only by means of more economically justifiable technological modifications and advances. With more educated disabled people in our society, the need for such technology can only increase.

References

Triformations Braille Terminal
Triformation Systems, Inc.
3132 S.E. Jay Street
Stuart, FL 33494
(305) 283-4817

University of Wisconsin-Madison Installation

Technical Information:

Thomas J. Scott, Technical Support Specialist
Administrative Data Processing
University of Wisconsin-Madison
3169 Computer Science and Statistics Building
1210 W. Dayton Street
Madison, WI 53706
(608) 263-1774

Users:

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Randy G. Black, Information Specialist
Office of the Registrar
University of Wisconsin-Madison
121 A.W. Peterson Building
750 University Avenue
Madison, WI 53706
(608) 262-3712

SAGEM Braille Terminal
Telesensory Systems, Inc.
3408 Hillview Avenue
Palo Alto, CA 94304
(415) 493-2626

University of Wisconsin-Madison Installation

Prof. Edouard J. Desautels, Dept. of Computer Sciences
University of Wisconsin-Madison
2207C Computer Science and Statistics Building
1210 W. Dayton Street
Madison, WI 53706
(608) 262-0620 or 262-1204

Perkins Brailler
The Howe Press
Perkins School for the Blind
Watertown, MA 021[illegible]

Scotch Model BTW400 *Braille DymoWriter*
Labeler Manufactured by 3M
Contact: American Foundation for the Blind
15 West 16th Street
New York, NY 10011
(212) 620-2000

Telephone Sound Barrier
Goodrich Products, Inc.
Contact: Grant Electronics
4606 Verona Road
Madison, WI 53711
(608) 271-0551

Jack M. East

Barrier Free Office Design

A major problem area in the business of finding employment and utilizing technology for and with disabled persons is the development and implementation of concrete action plans. Unfortunately, in private enterprise, employers often give lip service without planning specific implementation strategies. It is this author's hope that all conference participants will return to their communities with specific action plans concerning the utilization of technology and the development of jobs for the disabled.

A recently disabled person goes through stages of treatment which may be termed "steps of rehabilitation to employment." Initially, the medical condition of the person is the primary concern. Then the individual receives physical, psychological, occupational, and recreation therapy, and finally vocational training or retraining takes place. The vocational aspect of the disabled individual is the area which will now be addressed.

A tendency across the nation today is to train or retrain individuals for outdated job markets. Each year millions of dollars are spent in the area of vocational rehabilitation; unfortunately, this training does not keep pace with the changing trends of current job markets. Job development programs in every state and community should be developed to provide current information to employers and disabled individuals. An active information system has the potential to link disabled individuals with job opportunities in areas of need. The implementation of information systems throughout the nation would greatly enhance the organization and accessibility of job information, while providing a linkage from employer to employee to job.

The American Amputee Foundation is a private organization which is not dependent on state or federal funds. Since 1975 this organization has slowly but successfully established funding sources despite the fact that the competition for dollars has become increasingly tighter. The work of this foundation includes innovations in the areas of bio-medical engineering and myo-electrically controlled limbs. The foundation works with spinal cord injured, as well as in the preventive area of amputation. Additionally, this organization operates a diabetic foot-care clinic and a head and stroke clinic.

Three years ago the American Amputee Foundation sponsored a series of seminars on employment of handicapped people throughout the state of Arkansas. Geared to some seven hundred businessmen, these seminars were aimed at educating private industries about the laws governing employment of handicapped persons and the availability of job tax credits. These seminars revealed the fact that most of the businessmen in the state were not aware of laws concerning access for handicapped persons. There is a strong need for workshops of this nature to educate businessmen about existing laws which govern employment of the handicapped.

Placing a handicapped individual into private industry involves many important considerations. These include the expenditure of extra time, energy, and money. To insure successful placement, a concerted effort must be taken to follow the employee's adjustment. Sensitive intervention on the part of the job counselor is a critical factor. First, the physical space must be considered and evaluated. Some modifications which assist disabled individuals at the job site include TTYs for the hearing impaired, wheelchair ramps, accessible rest rooms and water fountains, lowered elevator buttons, and audible and visible alarm systems. But the role of the placement counselor goes far beyond physical-access issues. Even more important than the physical adjustment is the importance of building a successful relationship between the handicapped individual and his/her employer. The placement counselor has the important responsibility of helping to facilitate a good working relationship between the disabled employee and his/her employer. Successful intervention can result in positive attitude changes and can impact on the employer's future relations with other disabled employees.

Our office has successfully accommodated a disabled employee. Steve Little, a former All-American football player who is now a quadraplegic, works with us as a public relations manager. Currently, we are fundraising to sponsor a wheelchair basketball team, the Rollin' Razorbacks, which is one of 285 semi-professional ball teams in the United States. Our budget is $7,000, including transportation and housing for a 15-member team. We have set up an in-house telephone room for marketing purposes, and Steve works with us in our continuous fundraising efforts.

With appropriate work-place modifications, Steve is able to accomplish telephone sales and marketing. A speakerphone, donated by Southwestern Bell Telephone's STAT group, a community action group within the telephone company, enables Steve to place calls easily. Steve also is assisted by a handicapped assistance credit card which allows the operator to place all calls for him. A career in brokerage appears feasible for Steve.

Many modifications were made to accommodate Steve in the working environment. One fairly inexpensive modification which we accomplished was a simple working ledge which allows comfortable access for Steve's wheelchair. Additional adaptations were also completed to accommodate Steve's right hand, which is operated by an electrically-controlled splint which opens and shuts his hand. Therefore, the right portion of the working ledge is higher than the left side. A special work bench was constructed using two-by-fours, a plywood cover or ledge, and a formica covering.

Tape recording equipment and telecommunication devices can be purchased from companies that specialize in environmental control systems for the handicapped, or can be purchased inexpensively from local Radio Shack stores. For example, a gooseneck speakerphone can be purchased for about $[illegible].00. Contributions from Bell System can help to defray costs. The Southwestern Bell STAT group not only donated the speakerphone, but also contributed the installation and service charges for the unit for one year.

Our office modifications were inexpensive and easy to accomplish by an in-house maintenance group. Soundproofing was necessary due to the speakerphone. This process was accomplished very simply by using carpet remnants and plywood. When bolted to the wall, triangular framed carpet remnants do an excellent job of soundproofing. This project cost less than $30.00.

Other inexpensive modifications on the job site can substitute for more costly ones. While completing an evaluation of a building, one building manager stated that he did not have the funds to modify a water fountain. A creative and inexpensive solution was achieved by installing a cup dispenser near the existing fountain in reach of a wheelchair. The costly expense of plumbing alterations were avoided and a workable solution was reached quickly. Furthermore, the employer was readily compliant to the recommendations and later provided accessible parking and made large printed material available for a visually-impaired employee.

According to statistics we have over 35 million handicapped individuals in the United States today. Of those 35 million, 52% are still unemployed. The question is, why? We have the technology and we have specialists working in vocational rehabilitation and employment security. However, private enterprise is the critical area. Employers must realize that they can accommodate handicapped individuals and benefit from their services. Modifications can be made if the effort is taken. Employers who have successfully accommodated disabled employees must share their experiences with others. If an employer is willing to be creative and put forth effort, then successful accommodations can be achieved.

Questions and Answers

How do you raise your money? How large is your yearly budget and how do you use it?

Our telephone room is one method of fundraising. Due to the fact that Arkansas people are very strong football fans, we have begun marketing and manufacturing 20-30 items that deal with the Razorbacks and we sell these items at booths and at football games. We also run public service announcements which help our marketing efforts. This phase of our project has been very successful. We turn this money back into project expenses and have been able to purchase two accessible buses. We provide free, around-the-clock transportation to the clients of the Arkansas Rehabilitation Institute. This year one of the buses will be leased to an independent cab driver, and this will create another source of revenue.

How do you get people to buy the items to support your program?

I think you have to be from Arkansas to appreciate what football fans are really like in this state. We didn't have to dream up a real great pitch in order to sell our merchandise once it was exposed to the public. The merchandise is good quality, and I think that makes a difference.

How large is the association? Do you have a rehabilitation center of your own?

We do not operate our own center but we are affiliated with an existing rehabilitation institute. We are implementing services to orthopedically-impaired individuals through the rehabilitation institute.

Could you comment more on your budget?

We operate with two different budgets. The American Amputee Foundation has its own budget. Additionally, we augment services to the Baptist Medical, a private rehabilitation agency which, in turn, has its own operating budget and we lease space from the Arkansas Rehabilitation Institute.

How successful have your efforts been to raise money for the Rollin' Razorbacks?

This has been a very rewarding project, both financially and attitudinally. In the last three months, Steve has been able to generate almost $45,000 for their budget and the football season has just started. That will give you some idea of what is possible. By the use of telephone marketing, and with a very positive presentation, programs can survive without the government dollar.

Don R. Warren

Innovations in Adaptive Equipment and Job Site Modifications

It is good to be with you this afternoon to share some of the concepts that have been developed over the past four years in Wisconsin for the state agency of the Division of Vocational Rehabilitation.

The rehabilitation engineering component in the state agency is relatively new and came out of an innovation and expansion grant from the federal government that mandated that we start serving the more severely disabled clients by finding ways to modify the job structure so that they can adequately do the job. Not only adequately do the job, but do the job in an equivalent fashion as an able-bodied individual and in a cost-effective approach.

This has many facets to it. Obviously it's not a simple process and many times involves the work of a lot of disciplines: the medical personnel from the hospital--the occupational physical therapists; the nursing staff; and the physicians along with the rehabilitation engineers.

Rehab engineers are kind of a strange breed in and of themselves. What is a rehab engineer? Even the rehab engineers have a hard time answering that, but often it's an individual who has come through a multiple of disciplines--in my case, neurophysiology and neurosurgery--with engineering counterparts. Often we see people in rehabilitation engineering who've come through the engineering components, then come into the medical service delivery model and work through occupational therapy/physical therapy (OT/PT), nursing or one of the allied health areas.

The important point here is that the service delivery of this process--the rehabilitation engineering process--is a multidisciplinary process. It requires all these facets to provide the best solution. Often the best solution is the simplest solution, but what looks to be simple is often very complex to make. This is kind of a diabolic situation, but we find that in order to keep things simple they have to be very complex in the design aspects. The simpler the process, the better the device will work in the long run. We find that if you build a very complex system it requires more maintenance. It requires more preventive maintenance, and it requires more time to train the individual to use it. So we use the old principle that many of you may have been familiar with back during the war. "Kiss" was written across all the drafting rooms in the Navy. It means "keep it simple, stupid." So the simpler it can be, often the more effective it can be, and it enhances the whole process and keeps it less expensive.

If we can go into a job site and just look at the job site and find an environment where we can place a person with a disability, that's the best approach. If we can just train the person to operate within that environment, it doesn't cost us anything; all we have to do is train the individual to work in that environment. Often those environments are difficult to identify, expecially from an employer's standpoint.

Often we come into situations where people don't appreciate or even know what some of the disabilities are. I was recently in a paper mill up north in Wisconsin where they're grinding up logs making paper pulp. We were taken to this door and given ear plugs to wear; then they gave us glasses to protect our eyes. We went in one more door and ran into a foyer area where they gave us a headset to put on over the ear plugs. They opened the next door and we were observing the process of debarking logs and grinding them into small chips where they're subsequently dissolved and made into paper. Up on a gantry overhead there were several employees who were kind of surprised by our appearance, and started nudging each other and pointing. They thought we were the inspectors. We were just there to look at job sites for the state, basically, and all of a sudden this signage went on that we weren't familiar with.

We stood there and watched them work for a while; their main job was to orient the logs as they came out of this big washing machine that rolls the bark off and lines them up properly to hit the grinder. The noise intensity was so great in that room that one could scream and never be heard. Your body would shake and your eyes would water just from the percussion on your system. We were glad to get out of there obviously, and on the way out after we'd disarmed ourselves of the protective garments, we asked them if they'd ever thought about hiring a person with a hearing disability in that environment. And the guy sort of stopped and shook his head and said, "Well, is that a disability?"

Here they were trying to meet a quota. This was back in the days of 504 implementation and there was a certain number of equal opportunity people around monitoring government contracts, and they hadn't realized that there was a site where they could have a disabled person very easily implemented. These guys had their own sign language. There was no way you could hear yourself even think in that room, and they had developed their own signage which was not the typical sign system. So this would be an example of a very simple modification.

We got into all kinds of modifications as a result of the agencies asking us to assist them; everything from computer terminal modifications to modifying dairy barns so that the disabled quadriplegic or paraplegic could milk 95 dairy cows twice a day, or modifying tractors for quadriplegic operations, or modifying vans and automotive equipment for disabled individuals in all degrees to operate safely.

The gamut of expertise that's required of the rehabilitation engineer is quite extensive, therefore one has to have on staff people who are comfortable working with dairy cows on one hand and capacitors, resistors and transistors on the other hand. So you need a rather wide cross section of expertise to work in that field.

Often we find that the job of the rehabilitation engineer is just that of defining the need. After all of you bring your ideas in of what you want the client or patient to be able to do and it's resolved to a final check order in which we're going to try to accomplish that, someone has to undertake to be the broker for this implementation process. That broker usually ends up being a therapist or an engineer who can stand back with the required empathy to observe the process, have the input and keep it all in order. It's kind of like a general contractor to a construction project in doing this rehabilitation process.

Many times that's all that has to be done; once the definition of the concern is expressed and clarified, nature takes its course and things happen. Often it takes more prompting than that. We were recently involved in a situation where we had a lady who was an expert one-handed typist. She only had one limb on her upper extremity, and she was an expert typist, very, very accurate. She had worked her way up through the company and was keeping up with her able-bodied cohorts when they were working standard electric typewriters. But all her able-bodied cohorts were given the opportunity to have a word processor as the company evolved and technology presented itself.

Well the computer company that manufacturers this word processor wasn't attuned to modifying the keyboard for this individual. It is a simple process of modifying one of the chips in the board such that it can recognize either a one-handed keyboard or a two-handed keyboard. It simply changes the profile of the keys, a very simple software modification, not even a hardware modification. The company had already done some things in regards to the blind population in dealing with their needs of having talking typewriters. They weren't willing to make these adaptations at that point in time.

After we defined the need very clearly and offered to do it for them with an alternate piece of equipment that wasn't their brand, we found their position changed considerably. They became very cooperative and willing to implement the process, not only for the left-handed person but also for the right-handed person. It took, I must say, a considerable amount of prompting to get that to happen, almost to the point of threatening to publish the data in a national medical journal or a rehabilitation avenue that would make it a more eminent domain of information and anyone could then emulate their terminal; obviously they didn't want that to happen.

In that situation we were merely the catalyst to define the need and express it to the manufacturer of the system so that they then could respond in an appropriate way and make modifications. Another beautiful example of that is the things that you'll see later that the phone company has done in regards to adapting equipment for this population. How many years ago was it that if one was hard of hearing there was nothing for him to do to amplify the sound? Automated dialing is also a rather recent modification; if one were very spastic or couldn't hit the buttons, one button would dial the whole number. Think of the chances of making a mistake as a cerebral palsied individual tries to hit a touch-tone phone. What are the chances of a correct dialing if they only have to hit one button that dials the whole number for them as opposed to having to hit a seven-digit code?

We've seen these things evolve for able-bodied folks. These weren't designed for people with special needs. These were designed for folks like me who aren't too bright in the morning and can make those same mistakes on that keyboard in the process of interfacing this technical environment that we have about us.

We've seen companies like Sears & Roebuck and Radio Shack bring products into the marketplace that enhance the environment of able-bodied folks and inadvertantly have enhanced that of the disabled population. These devices were not designed initially for the disabled population, but rather for the able-bodied folks. You may be familiar with the little devices that plug into the wall. They're called a "home control unit" that Sears sells. These are around $14. You plug one of these into the wall, plug your lamp in and from anywhere in the house if you have the transmitter module, you can hit a button and turn on and off this lamp. It used to be that it cost a couple of thousand dollars to do this kind of a modification. Now the whole process can be implemented for less than a couple hundred dollars.

So these devices were built for those of us too lazy to go turn off and on the light, basically, rather than for the population for which they are very appropriate.

Some of the other kinds of devices that we've constructed of late have been devices that give people the ability either to go back to work or enhance their employability. One such device could be demonstrated by this dictating machine. It's a standard Lanier tape deck that has been modified to the extent of unplugging its microphone and plugging in this little black box. The function of this little black box is to provide the quadriplegic individual who couldn't work a microphone button the ability to do dictation like you or I would who can still work the microphone button. All those functions have been replaced by switches up here which are puff controlled. This is a puff technology where you merely puff in a tube and it turns on the tape deck and performs the functions. The indicators are on the top with little lights that light up and tell you what status you're in. If I wish to record I puff in this one, now we're recording, and I'm talking near the microphone, so it's picking me up as if I were talking into a hand-held mike. This is all done by merely breathing into these little holes. Now I can do this from some distance; you don't want to sneeze into it or you can cause some chaos in the process. So this gives the quadriplegic the ability to do the same kind of dictation, going in and changing words and sentences, maintaining the articulation of a hand-held microphone with a low-cost modification to an off-the-shelf product.

We try to always modify off-the-shelf technology rather than going out and reinventing a special tape recorder for this special population. One other feature that we found important was the ability to change the tape so that by adding a little guide one can flip the tape out and cause it to be changed, the idea being that this gives him a turning table on which to turn the tape and replace it. We also can add an additional tape to the top and let it slide in. This gives the individual independence in that process of doing dictation which sometimes is a very private kind of thing.

Another area where we've put together a device was a housing company up in Wausau that was building prefab houses. They had an employee who had been there for several years and who wanted to stay, but was going blind with diabetic retinopathy and could no longer read the blueprints. If he stayed, he had to find another job. Well, without vision there aren't too many jobs in the housing industry that one can do. So we went through the plant and identified a job which involved measuring the Romex wire that's used for wiring the outlets and switches in the house. If you know electricians, they're pretty fussy folks about how long those wires are. They don't mind the wires being a little too long, but they don't want them too short. The contractor, of course, doesn't want the wires too long because that copper is like gold nowadays when it comes to the price per pound and they don't want it wasted. So the concern was how could we make the blind individual able to operate a device that the able-bodied folks use by setting a dial to zero and then grinding the wire through it until they get the right footage, stopping it, cutting it off, binding it, labeling it and throwing it in a bin.

That was the task that we identified for this individual to do. So, what we did was take that device and put a shafting coder on the end of it and hooked it to another device that enables the system to speak out the footage as it winds the footage onto the system. Here again it was a case of taking an off-the-shelf speaking system out of a calculator.

This device is actually accurate to about one hundredth of a foot, far more accurate than the gauge that the able-bodied folks are using. We did have a problem with it though. After it had been in for about three days they said all of our wires were about a foot too short. We figured it had to be something that was grossly wrong, and sure enough we found the problem. The company knew that the electricians always wanted a little extra wire and thus, added an extra foot to their specifications. Knowing that the workers who crank the wires out are a little sloppy, the company specified one foot shorter so that it would come out the right length and everyone would be happy. So who's specifications do we get? We got the company's specifications that said that these things need to be a foot shorter than what was really necessary.

The communication link is very important between the company and the rehabilitation engineers because we were telling the company how long they told us to have them cut. We don't have a fudge factor. If they wanted us to build a fudge factor in it would be very easy to do.

A lot of the things that we do are very simplistic. Here's one that evolved out of a need. We had a quadriplegic individual who couldn't empty his own leg bag. The problem was when he'd bend over to try to open the leg valve to let the bag empty, he couldn't do it, couldn't get back up into the chair. We looked into the prospects of having electronic devices manufactured that would do that for him. We went out to the automobile one day and were working around the car and we discovered this little valve that sits on top of the air cleaner and opens and closes the damper to let the air in and out. We found it works great as a pinch tube, to pinch the urinary tube off that comes from the catheter. All we do is run this tube up his leg underneath the collar. He sucks on this tube, it opens the valve up, lets the urine drain and as soon as he quits sucking on it it shuts the tube off--very simplistic. It eliminates the need of having to have aides there every so many hours. It cuts that cost and gives the person independence. He can now do this wherever and whenever he wants to. In addition, that feature is a very low-cost approach to that problem.

In fact I think we have folks here today who may even admit to having these. So we found them very successful and we're finding that we can't make them fast enough now to meet the demand. Ford Motor wants to know what we're doing with all these--they think we're repairing an awful lot of cars and we don't even have a license to work on Ford cars. So sometimes we take weird solutions to things.

There was a case where we had an individual running around in an environment that was rather hazardous and needed to call for help. So we took a garage door opener and put a puff switch in it in a piggyback so that when he puffed on the tube, it would send a radio frequency transmitter signal to a receiver which would turn on an alarm and alarm the supervisor that they'd better start looking for this fellow because he was in a bind. We used the same kind of switching for lots of other things. We have vans that we've hooked up these systems, with head controls, where the halo switch is operated. Merely bumping your head on the switch does the same thing. All we're doing is using the puff bulb that your head bumps into to turn it on. It's a very compatible environment. There's no wires to break. We use silicone tubes that are not temperature sensitive, and the kinds of switching are mandated by the kind of environment that it's going to be used in.

We've got a lot of technology available to us now to meet your needs. The thing that we have to emphasize today is that the technology is here. If you want to implement the technology, it's up to you to define your needs, express those needs in a multidisciplinary approach to those of us who are responsible for delivering those services, and we will meld those concepts together and try to come up with alternatives.

What we do is create options. Now when we create options for you folks we found by history that you like to take all the options you possibly can--most people would. We'll say, "by the way, would you like to have it do this?" Oh yeah, that would be nice. "And it also can do this." By the time you get done with us engineers we'll have you doing things that you really didn't ever plan to do in the first place, and probably don't even need to do. So it's up to you to keep us in tow in dividing the "nice to have" versus the "need to have" implementation process.

Look at the process of specifying a wheelchair, a standard manual chair. I'm sure the VA buys lots of these things and by the time they go through the process of purchasing and the therapists have added their features to it, then somebody says, well, we need something that requires low effort, so that the individual can use it. What they mean is they need one that's got good tires on it and good wheels. Low effort might end up coming out with one that's got electric controls on it, and all of a sudden you've inadvertantly upped the price and now you have an electric wheelchair.

Someone else mentions the fact that this wheelchair user will be running around outside a lot. He probably needs something that's going to be able to get him up and over curbs, an all-terrain kind of thing. So he wants some wheely bars on it so it doesn't roll over. He's got some decubitus ulcer problems so he's got to have something that's going to recline for him, so you end up with another feature added to it. By the time it gets to the engineering group they've embellished it more, and they've got it up to an all-terrain vehicle.

Then somebody says, well, it's got to be heavy-duty so it will withstand all of this, and it comes out with another feature. So the engineers kind of go rampant on these things, and by the time you get done you've got something that looks like something that's supposed to climb stairs.

The VA has sponsored research in the area of curb climbing and stair climbing, and we did come up with a stair climbing wheelchair that will go upstairs with the alternate action of two arms. It's not for a quad, it's not for many paras, but it is in the research stage. So the engineering community is still working on stair climbing wheelchairs.

So given this kind of challenge the engineers will come up with a solution. You have to monitor your challenge to us. We are usually involved in the gray area, if you will, between man, the machine and the computer in trying to learn how to use this joystick. If we use the wrong tool we're going to alienate the client or patient, we're going to alienate the community, the employer and we'll probably turn a bunch of edges that we may never get a chance to restore. We've got to do it right the first time. Often we don't get a second chance. So it's very important that you give us the information that we need to do the work. If we get that information in whatever form, it helps us plot the path of what you want done.

It does take a lot of research on your part to define the problem and bring us that problem. If you can put that on a piece of paper for us, in any form of a sketch or whatever, it helps us in defining the need and often we can come up with a solution. If we can't come up with a solution, we probably can go out of state and find a solution.

Feedback is the most crucial point of this whole thing. If you can communicate with the disciplines involved, we can then give you the best solution, but not without the feedback. Otherwise we'll create an OSHA-approved horse or a cowboy with emission controls. We've seen the overkill and we want to avoid the overkill in that situation.

In one situation there was a client who needed the ability to dial out a pre-recorded number or a pre-programmed number by merely hitting one of 16 different buttons. The key pad was very awkward for him. There are rental-type devices and those for purchase; the concern you must remember in deciding which way to go is with regard to service and maintenance on the equipment. Also, if you're having the individual use this system to dial, for instance, for an aide to come get him out of bed in case of fire or something, you might want a system that has a greater reliability than one that's only used to call the neighbor down the street for an informal chat.

Another device that's not commonly known as a communication device is one that can be carried around like a pocket calculator. As you type the message on the hand set it displays it on two sets and enables you to communicate. If you wish to talk over the telephone, it is a modem that can be attached to the transmitter section of the phone and the receiver section and communicates through a link in the back. This is a portable TTY or portable teletype, and it communicates with the standard communication format that communicates with all the telephone company's equipment or any standard communication TTY.

I had a client over in Kenosha who was a DVR counselor and had to access client files. She was an individual who had polio, was paralyzed from that, then fell out of a wheelchair and was further paralyzed from a spinal cord injury as a result from the fall and had a very limited range of motion, had no ability to raise her arms, no grasp and she was performing the functions of a rehabilitation counselor.

It is a rather rigorous process to access so much when you can't get your wheelchair close enough to the file cabinets to even get the paper out. So we built her a special file cabinet that she could drive under. She could drive her wheelchair under it and then work from her lap to the table. Here again we needed the feedback. We looked at the problem that arose and asked the counselor what kinds of files she was going to file? She told us that they're letter size files, so we built this cabinet for letter size files. We installed it, got it hung on the wall, and then the real test came. They brought in this huge stack of files to shove in the file. There is a little plastic tab on the top of the regular manila letter file, which proved to be the quarter of an inch that would not let the file even go in the cabinet--lack of communication. Had we been sent a copy of it, we would have known.

So we took the system back, modified it, cut it all apart, rebuilt the cabinet and got it implemented so she could pull the files in and out.

So those little things that seem trivial can be very consequential when we're building these things that have to have tight tolerances and wherein space is of high concern.

Additionally we had to build a forms file for her. The state bureaucracy has all kinds of forms to fill out and she had to be able to get at those forms. So again we built another special file. Her desk was set up with a very minimal throw that's just about wide enough for a telephone to sit on, a lazy susan in the corner that could be rotated and all of her brochures that she frequently accesses posted on the wall so she could get at them.

Another client was an individual, blind from birth, serving as a telephone receptionist at a federal housing allowance office concerned with answering 18 incoming lines and 70 extensions, using braille for taking notes, operating a standard typewriter and trying to keep chaos from occurring in this office in which the attendees were those who were there trying to get federal assistance. She needed to know when people came to her desk; she couldn't tell when someone walked up to her desk, and without knowing that, she could be sitting there working away and someone might be standing there for a while.

We thought that was a simple problem. We'll just put a rubber mat out there and when somebody steps on the mat, that'll set a little vibrator off on her chair or desk that she will feel. Then she'll know to look up and say, may I help you, or whatever. Well, the profile of individuals in federal housing allowance offices, which we soon learned, was about 70 percent four-footers running around all over this place, constantly back and forth across this mat, and she couldn't distinguish between a child standing on the mat or an adult standing on the mat.

So, we then decided to put an ultrasonic system in that measures when someone comes in front of her desk and would send off the same signal, but it would only look at things four feet or taller in front of her desk. This little beeper was put in the ceiling and would sense anything that was within that range.

It was working fine, except that when we went back to readjust her phone system she complained of the noise that the thing was giving off. We thought that was rather unique because this is set in a frequency range where only the bats and very few animals can hear this frequency, but she could hear that frequency because upon evaluation she could tell when I was unplugging it and plugging it back in. On top of that, she had learned to recognize the waves of air going by her desk when people four feet or taller were there versus the under four foot population, which meant that we no longer needed that device.

We later discovered after finding that she heard such high frequency that we could run the frequency range of the telephone keyboard tones so high that they were out of the frequency range of the able-bodied individuals around. Now you watch her operate and it's like indications from heaven coming and telling her which button to push because the phone rings and she goes over and pushes this button and you can't even hear or find out how she knew which button to push.

She's now working the job very independently and has been on the job for about three and a half years. So it meant the difference in her being able to do the job. In addition, many of the things that we initially put on her equipment have subsequently been removed because of her ability to adjust to the job site.

We tend to overkill at the beginning, sometimes rightfully so, and often only to find that we get to bring the thing back in house and have it available for someone else to use down the road.

We were down at the General Motors plant in Janesville with a client who had a prosthetic limb and in the process of having to step sideways had difficulty moving that limb along, so we built him a little cart that he could squat on and have all his parts that he was assembling in this cart. He could keep himself in pace with the conveyor belt just by hooking a little hook on the conveyor belt and dragging his cart with it. Then he'd unhook his hook and slide himself down and start on the next one.

We went back a few weeks after and here was a whole row of carts lined up on the conveyor belt, all hooking themselves along doing the same thing. All the able-bodied folks thought that was a great idea and they tried doing the same thing. So what's good for the person with the special need turns out to be good also for other people who have similar job functions.

Another client was trying to run a book store as a cerebral palsied individual, non-vocal, with very, very gross motor function so that he could not make change from the cash register. He could push buttons if given a guarded keyboard, so we took the keyboard out of the standard cash register, which could make change for him, moved that keyboard down into another box and put a guarded keyboard over it. A guarded keyboard is nothing more than a piece of plastic with some holes in it.

What it does is allow a person with a very spastic hand to come across a keyboard and get their finger in the one they want without hitting all of them across the way. This afforded him the ability to make the change because it was positioned in a place that he could get at from his wheelchair and make his dollar bill change or hard money change with his hand. He couldn't make the silver money change but this afforded him to do that through the standard part that you're familiar with at the grocery store.

Another unique [illegible] was for a mentally retarded population. The adaptation consisted of [illegible]dial arm saw that was being used by a workshop where they had fiv[illegible] retarded people trying to cut boards off to 16 inches plus or min[illegible]-second of an inch. Their problem was that they had them standing in [illegible]inders, practically, to keep their arms out of the saw. They had be[illegible]m so they could only reach in so far. Another guy was in kind of a[illegible] reach out of this box and pull the parts off so he couldn't get into [illegible]here are people standing on mats to keep them from alarming. If they [illegible]off the mat it would alarm the system.

The other big concern [illegible]that over 40 percent of their production was reject. They weren't lining [illegible] boards up right, so with some adaptation on the saw, we put some pneumatic controls on it and a small microprocessor, and we automated the saw to where it reduced the reject rate to less than one percent, increased their speed from [illegible].7 seconds to 3.2 seconds per cycle, and we also eliminated the number of people required to operate it. We eliminated them down to one in fact, so that one person could do what all the others had to do before.

The problem was we had one guy running this whole show now and we needed to keep putting the boards in this thing. We put this little light on and every time it came on he was supposed to shove the board in. That didn't work too well because he found this made a great coat rack and he didn't have to look at the light, and it wasn't really that motivating in the first place.

In talking with his counselor we found out that there was a certain piece of music that he really enjoyed hearing, so we went up there one day with a tape deck and started playing the music to see if that would lull his thought processes and keep him feeding these parts into the machine. We also found that if we would slow the music down, he would speed up his work to compensate for the reduced record. So, what we did was to hook the tape recorder to the microprocessor. When the machine cycle was slowed down, the tape would slow down, and as he would speed up, the tape would speed up. Then he could hear his music at the pace that he wanted to hear it at and he would keep pushing the parts in just lickety split. So it was a case of finding an item which the person enjoyed listening to. When we went back later the music was playing so fast you couldn't even understand what it was.

So we ended up having to tune the whole thing way back down again, doubling his productivity by playing music for him. If he slowed down, the music would get very slow. Everybody else in the plant was very sick of hearing the music though, I must admit, so they isolated this thing into a special room.

Another individual had set off blasting caps in an oven, lost his sight and his other arm and hand. He has one fingernail that still had tactile sense in it. The other fingernail was de-enervated. It couldn't feel the sensations. So by using a braille mike--this is a micrometer that's used in the tool and die industry--we got him a job as a tool and die maker running a turret lathe and numeric-controlled machine tools in a Wisconsin factory.

Another lady couldn't squat down and file pieces in filing cabinets without falling on the floor and not being able to get up. So by taking a standard walker, putting a little seat on it that is supported by a cable and putting a pouch in the back where she could place her various files, she was able to access the lower drawer file cabinets, get herself down and up and back in. Then she could pull the little seat up and walk around with it and lower herself back down--a very simplistic kind of modification.

There was a renal patient who had very low weakness in her lower extremities. The state was about to buy her a chair lift to take her up and down the stairs with her groceries and laundry and all the things that go into the basement, but it was determined that she could make it up and down the stairs; the problem was that she couldn't carry all these things up and down the stairs.

We went to Sears, bought a garage door opener, mounted a platform on it, hooked it on the stairs, and now she's got a dumb waiter on which she hits a button and the opener carries the things upstairs. She unloads them, goes upstairs, loads it back up and sends things back downstairs. So she's able now to use a $135 garage door opener that cost about $400 by the time we got it all modified instead of a $3500 device that was going to occupy the whole stairwell and be less effective in the long run.

We also worked on a dairy farm building mobility devices. In this case it was easier to modify the environment for the cows than it was to modify the environment for the client. We put a ramp up for the cows to climb up instead of the wheelchair having to go down in a pit. By getting the client lowered and getting the cows up he was able to access the appropriate parts in an appropriate time frame to milk 95 dairy cows twice a day from a wheelchair and operate his farm independently.

We also modified tractor accessibility systems so he could get on and off his tractor, do row crop farming and operate pretty independently.

A client working in an electronics manufacturing facility had to access many various tables. It seemed to make more sense, rather than modifying a table, to modify the wheelchair so that it would go up and down; it didn't limit him to a specific site, but rather enabled him to go to a lot of different sites in the facility and work wherever the jobs were.

We modify standard wheelchairs with custom adaptations as required by various clients for whatever the specific needs of the job might be. One custom-built chair required that the client be able to see through the surface with a special lucite reflection that inhibited ultraviolet rays because of a welding environment.

Toileting is a problem with a lot of clients. We had a situation where the employer would hire the client as long as the client could toilet himself. The employer didn't mind feeding this client, who was a cerebral palsied individual, but he wasn't going to work on the other end.

So, recognizing that, we went to the data base and found a European device that's been around for years, some of you have probably seen it. You sit on it and when you're done you hit a button down on the floor and it blasts you off from the rear with cold water. Knowing the American ingenuity, we searched the data base again and found that, sure enough, there was a device on the market that squirted instead of cold water, hot water from the front and back and wasn't so obtrusive, but then additionally, if you stayed on it had a blow dryer that would blow you dry. So it would wash you with warm water front and rear and blow you dry.

What it meant was that now instead of this device being something for the aristocracy it was something that meant that a client could be employed because he now had a system of toileting himself independently, and the employer found that there were other members of the staff that enjoyed using it as well, so it turned out that a simple $300 off-the-shelf modification in an area that you would never expect to be a problem area was used to solve the problem.

What it boils down to is that the rehabilitation engineering field is a really wide open area. There's a lot of things happening in it. It's a high-technology area. It requires the input from you folks to help us know what your needs are, to prioritize your needs so that we can be successful in the development of products that will meet those needs, and we now have a chance to request those things that heretofore you may not have.

Many of you may feel like you're the only one out there doing anything. You're the only guy on the job that's doing the job. You're the only one who's getting the work done, and it's an insurmountable job to try to accomplish, and we recognize that there's a lot of tasks around that could be accomplished more easily by interdisciplinary approaches, so we do need to work together and bring together the ideas that you have with the technology that is available and come up with some solutions. None of us are getting any younger in this process, and if we can work together we can have things implemented before we ourselves may need it. As was pointed out, we may be the users of some of these technologies.

Work with us and we're sure that you will find a bright light in the process of satisfying some of these needs. It's very rewarding to work with these individuals and see them come to fruition with their jobs, and we feel that the bottom line is that ability is of little account without opportunity. We feel the opportunity is there if you merely ask for assistance and tackle some of these heretofore seemingly impossible situations.

Jack R. Clarcq

Employment for Disabled Individuals: Skills Needed to Meet The Needs of Employers

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Introduction

The focus of this paper is on the employment of disabled individuals. What skills employers look for in disabled individuals is an important dimension of the employment process. However, it is only one factor to consider for those involved in the education, training, and job-placement processes for disabled individuals. One must consider employment of disabled individuals in a broader context. This is the context of career development that includes career selection, preparing an individual for a career, entry into the world of work, and long-term career accommodation. Since we are living in a rapidly changing technological world, the role of technology in the career-development process is an additional consideration.

This paper will (1) identify the major components of a career-development process for disabled individuals, (2) describe, by example, how technology is used in the process of career development, (3) present considerations related to working with employers so as to facilitate job entry and long-term employment accommodation of disabled individuals, including identification of employment skills needed by disabled individuals, and (4) present an overview of the job-placement history of a select group of disabled individuals as an illustration of what can be done. Experiences gained at the National Technical Institute for the Deaf (NTID) at Rochester (New York) Institute of Technology (RIT), will be used to illustrate application of concepts and ideas presented in this paper.

Career Development--A Process

Career development is in reality a lifelong process. This process has as its primary objective that of preparing individuals for "earning a living" and "living a life." Individuals must have the necessary technical, personal, social, and civic involvement. Success in meeting the latter needs to be measured in part in terms of the degree to which disabled individuals secure employment commensurate with their training and abilities and the degree to which they are able to move upward and laterally within their chosen career area (Clarcq and Bishop, 1975).

The process of career development includes preparing individuals for employment in a complex and rapidly-changing technological world. It also includes entry into a chosen career and long-term career accommodation.

Preparation of a disabled individual for a career should be initiated early in a person's life. This involves the concept of career awareness. Experiences should be provided in the early years that relate educational experience to the world of work. Career preparation also involves providing opportunities for individuals to assess their own values and interests relative to career options and then select an option that is consistent with their values, interests, motivations, achievements, and aptitude. Finally, career preparation involves providing individuals with the education and training that will give them the skills necessary to enter a career. The career selection, or job-entry process, involves selectively matching an individual to a job. For disabled individuals, this translates into a comprehensive placement program that develops career opportunities for disabled people. Career development, however, does not end at the point of job entry. Disabled individuals must develop skills that will enable them to respond in a positive fashion to change--on and off the job. This relates directly to long-term accommodation to the work place and the larger society in which disabled people must function.

Application of Technology

There can be no mistake--we are living in an era of ever-advancing technology that is creating a hurricane of change in all human institutions. Consider changes over time in genetic mixing and control, energy conversion, methods of travel, tools and weapons, mechanisms of change and problem solving and storage. When we think of technology, we generally think of machinery. However, technology "...in a broader sense includes all practical knowledge, including information about which plants are good to eat, the words and grammatical structures with which we communicate, and the social arrangements we have found effective. At its most general, technology might be defined as the ability to do things." (Cornish, 1979).

We will now turn to the role that technology can play in preparing disabled individuals to select a career and develop skills necessary to enter a career. Of significance is the fact that technology, in its broadest sense, is a primary tool to be used in preparing disabled individuals for living in a technological world. The examples that follow will describe how technology is used at NTID to assist hearing-impaired individuals to (1) develop career decision-making skills, (2) assess expressive and receptive communication skills, thus enabling professionals to design and develop individualized programs of communication skill development, and (3) develop technical and related skills necessary to function independently in the world of work and society.

Career Decision Making

Technology can be used as a tool to assist disabled individuals in developing career decision-making skills. At NTID, a program developed by Educational Testing Service, called *System of Interactive Guidance and Information (SIGI)*, is being tested as a base to teach hearing-impaired students how to make rational, well-informed career decisions. *SIGI*, a microcomputer system, assists in blending a person's values with career information. The system (1) assists students in clarifying and determining the relative importance of their work values, (2) matches values to various career options, (3) provides comparative information related to the advantages and disadvantages of occupations, (4) provides information about education and special skills required for an occupation, and (5) assists students in deciding the personal desirability of selected occupations. As a student progresses through *SIGI*, he or she must continually set priorities and make decisions. It should be pointed out that *SIGI* is not meant to stand alone. Rather, it is a tool for use by both hearing-impaired students and career counselors.

Evaluation of *SIGI* indicates that hearing-impaired students enjoy working with the system. Students have indicated that the program provides them with useful career information, demonstrates how human values enter into the career decision-making process, and assists them in deciding on occupations which may interest them. Evidence to date suggests that *SIGI* has not been totally effective in providing hearing and hearing-impaired students with an understanding of decision making as a process. It would appear that application of a decision-making process needs to be reinforced in a variety of situations.

Communication Assessment

The *Master Hearing Aid (MHA)*, a major research and demonstration effort being conducted by NTID and the Massachusetts Institute of Technology, provides an example of how technology can be used in the communications-assessment process. The *MHA* simulates characteristics of particular hearing aids as they relate to an individual's residual hearing. This process provides an audiologist with information that can be used to select an appropriate hearing aid that will maximize the use of residual hearing. It is a future expectation that a simulated signal chip from the *MHA* will be able to be implanted into the individual's hearing aid. The cost of the new aids is expected to be lower than current hearing aids.

A second application of technology related to assessment and instruction is illustrated by NTID's communication skills data bank. This data bank stores information on a student's demographic characteristics, communication skills, and communication courses taken at NTID. Communication skills relate to English, manual language, speech reception and speech production and are profiled for each student. Demographic characteristics include home town, educational background and previous communication functioning, e.g., ASL, oral, etc. Courses taken refers to the student's history in communication skill development at NTID. Information on students is available via computer terminal and hard copy. These data provide communication counselors with an understanding of the individual's level of functioning, background, and previous communication training. This data-based management system allows for scheduling of instruction according to an individual's communication needs. Without a data-based management system, it would not be feasible to select courses to meet the individual communication needs of a heterogeneous group of hearing-impaired students.

Skill Development

Technology is used in a variety of ways at NTID in the process of assisting hearing-impaired students in the development of communication and technical competencies. It is also used to develop instructional materials for use in the teaching and learning process.

At NTID, a classroom has been specially designed where hearing-impaired students learn how to use telecommunication devices. Experiences in telephone communications and use of telecommunication aids are available to students. Of significance is the fact that multiple training options are available to the individual student, depending on the person's communication skills. Individuals are counseled into either the telephone or telecommunication course depending on their expressive and receptive communication skills. In the telephone communication course, students learn how to improve their ability to use their hearing aids with the phone, to use the telephone more effectively with strangers, to make long distance calls and appointments, and learn special strategies to improve their talking and listening on business and pay phones. In the telecommunication aids course, emphasis is placed on using telecommunication equipment while gaining experience in using the phone. Students are made aware of various telecommunication devices and learn how to use special codes for telephone calls to family and friends, emergency calls, appointments, and how to deal with bad connections. Follow-up with students indicates that they are using the telephone or telecommunication devices for personal use.

A speech spectrograph device is used to assist in improving pronunciation by providing the hearing-impaired student with drill and practice. The spectrograph displays speech visually and matches the produced with desired speech. It is an effective and efficient technique for providing drill and practice and frees the professional to work with students in other ways.

A research and development project, *Dynamic Audio Video Interactive Device (DAVID)*, provides hearing-impaired students with drill and practice in speechreading. This interactive system is a unique marriage of television and computer-assisted instruction (CAI). *DAVID* combines the CAI capability of providing drill-and-practice skills requiring constant repetition with instructional television's capabilities of offering stimuli material in color, motion, and sound. *DAVID* allows hearing-impaired students to work in private and not be threatened by making mistakes. This translates into a reduction of student frustration. Material used is taken from technical areas, thus reinforcing vocabulary used in technical classrooms and providing reality to the experience. It appears that any instructional situation that would benefit by student interaction with visual, motion, and color stimuli would be a candidate for *DAVID* instruction.

A self-instructional learning laboratory is available to hearing-impaired learners. Combining a variety of technologies, this learning laboratory provides self-instruction in sign language, speechreading, and writing. This allows students to work at their own pace and reinforces concepts generated in the classroom.

Technology, in the form of microcomputers, is also used to develop technical competencies necessary for job entry and mobility. The Apple computer is utilized at NTID to provide instruction in engineering design, accounting, word processing, computer programming, and medical records. Microcomputers provide students with opportunities to learn basic technical principles and operations related to their major, using technology that they will find on the job. In addition, microcomputers provide students with an opportunity to become acquainted with the use of technology in a non-threatening manner. Additional educational advantages relate to the relatively low costs for microcomputer hardware and software (e.g., Apple hardware sells for approximately $6,000, and software programs are in the $150 to $800 range).

Advanced technology is also used at NTID in learning laboratories to develop technical skills necessary for job entry and mobility. This technology allows hearing-impaired students opportunities to become acquainted with the technology that they will find in the world of work. Examples include technologies used in manufacturing processes, medical science, graphic arts, and photography and business.

As a final illustration, technology can be used to create instructional materials for use by hearing-impaired learners. Television is a major source of information and entertainment to the hearing impaired. However, because the audio portion is generally inaccessible to the hearing-impaired person, only a portion of the message is received. Adapting television programs through the captioning process provides the hearing-impaired individual with a significant portion of the message that is conveyed. Research, conducted in the United States, has demonstrated that, in an educational setting, adding captions to a video presentation facilitates the transmission of cognitive information and knowledge acquisition for the hearing-impaired learner (Braverman, 1979). At NTID, captioned instructional television programs are designed by instructional teams and used to present information to hearing-impaired learners.

An analysis of the above suggests that technology is a powerful tool to be used in the education and training of disabled persons. Creative application of technology can assist in preparing disabled individuals for successful job entry and mobility.

Working with Employers--A Selective Placement

The primary mission of all involved in developing programs to meet the needs of the disabled is to reverse their employment history. This can be accomplished by ensuring that each person is prepared for job entry and mobility through appropriate education and training. Simultaneously, program planners must maintain a comprehensive job-placement program, which provides disabled people with every possible assistance in finding suitable employment by maintaining liaison with business and industry, employment agencies, organized labor, private or voluntary agencies and other sources of employment. The job-placement program must actively and aggressively promote the development of opportunities for disabled people. To accomplish this basic mission requires development of an innovative process--one that will not leave employment of disabled people to chance (Clarcq, 1973).

One key to successful placement is to ensure that disabled individuals have the competencies or skills that are needed by employers. As has been previously illustrated, technology is a powerful tool to use in the development of such skills. Program planners must ensure that education and training programs designed for disabled individuals are marketable. To accomplish this all-important element requires that the programs which are developed meet both the needs of disabled people and the requirements of employers. It is fully expected that both will change, and therefore the program must also change to keep pace.

There are a variety of techniques that can be used to ensure that the curricula developed are marketable. Constant contact with employers is an important dimension in designing education and training programs. Employers can participate on advisory committees that have as their primary role defining employment trends generally and more specifically the nature of the competencies required for successful job entry and mobility. Feedback from employers and graduates regarding the accommodation of program graduates to the work environment is another dimension of keeping current. What happens to program graduates is a critical feedback element.

At NTID, a "Graduate Feedback and Evaluation Program" is in place. This program has two primary objectives:

- To measure the degree to which the Institute is meeting its primary goal of preparing graduates for successful employment.
- To provide feedback to program planners regarding the accommodation of the Institute's graduates, which is vital to ensure that programs of study are kept in harmony with the needs of students and employers.

This evaluation program will collect data from graduates and employers at varying time intervals to determine how graduates are accommodating to the work world, technically, personally, socially, and from a communication perspective. Information collected will relate to variables such as entry-level salary and job functions, salary history, upward-mobility patterns, general performance on the job, etc. This information will be compared with similar accommodation of nondisabled people in order to determine if the history of unemployment, underemployment and lack of job satisfaction is being reversed. This will be the acid test of program effectiveness. Finally, faculty and staff must stay up-to-date with the latest advances in their fields in order to reflect these in the educational environment.

Actively promoting the development of employment opportunities for disabled people is a critical component of the job-placement process. Such a program must keep prospective employers informed about the general types of positions for which disabled people are qualified. Such an approach must also be aggressive. It is incumbent upon program planners to develop fresh, innovative and creative marketing strategies related to placement (Clarcq, 1973).

Employment of disabled individuals will not happen by chance. Aggressive and creative marketing strategies must be used to open up the doors of employment to disabled people. The National Center on Employment of the Deaf (NCED) at NTID illustrates such a creative approach. The NCED provides consultation, training, employee selection and information services to employers. Consultation is provided regarding how to employ qualified deaf people successfully. This consultation includes advice on how to help deaf workers grow on the job, assists employers in becoming more aware of deafness and employment-related issues and provides an environmental or job analysis to help assure on-the-job success. Training of employers is also important. In-depth training workshops on deafness and its implications for employment are available to employers. Employers are provided with a thorough understanding of deafness as an impairment, and they are able to learn first-hand about the experiences of the deaf employee. This information in turn will help the employers to organize their staff and work environment to assure the deaf employee's success. A computer-based Career Matching System is available to employers. This information-processing system assists employers in selecting qualified deaf applicants based upon the employer's criteria. Finally, the NCED provides a clearinghouse of information on the employment of deaf persons. Employers and others can obtain answers to questions on safety, communication, insurance rates, tax benefits on employing deaf persons, and many other important issues. The NCED also benefits deaf people and professionals serving deaf people by providing a variety of services to them, including career matching, training, and access to employment information. It should be pointed out that extensive use of print and non-print media is used to support NTID's employment marketing program.

Another important feature of a job-placement program is selectivity in marketing. Generally, employers are not aware of what skills disabled people possess. They need to be educated to the fact that disabled people have assets and skills in terms of productivity, stability, reliability, and responsibility. Often, with simple modifications in the work environment, skilled disabled workers can be successfully accommodated. At NTID, skill profiles, describing the individual's technical and communication competencies, are used to facilitate an appropriate match between the person and the job. The profiles provide the employer with information not typically available about job applicants. Skill profiles stress the person's strong points, allow for selective job placement, and let the employer know what to expect. An additional and important component of a job-placement program relates to continuing support to the employers. It is necessary to ensure availability in working with employers, to answer questions and provide support as necessary.

A job-placement program must provide support to the disabled person in terms of preparing the individual for the job search. Programs available to the hearing impaired at NTID illustrate this concept. As an example, NTID graduates are provided training in resume writing and interviewing. Captioned interviewing tapes are used by hearing-impaired students, as is a job-search handbook.

Creative marketing and selective placement of disabled individuals is necessary if history is to be reversed. The benefits of such an approach are significant to both the employer and the disabled individual.

Reverse History

The NTID experience has demonstrated that the history of the hearing-impaired person in the world of work can be reversed. As of 1980, approximately 96% of NTID graduates who have successfully completed their training program and who have chosen to enter the labor market, have found jobs. Approximately 94% have found jobs commensurate with their level of training. NTID graduates have found jobs across the United States and abroad, and are employed in business, industry, education, and government. The graduates are working in a variety of positions formerly not available to the deaf. Deaf people now are successfully functioning alongside their hearing peers as engineers, lawyers, medical technicians, photographic technicians, accountants, artists, and many other highly-technical jobs. The course of history can and is being reversed.

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James R. Carlisle and Raymond Fulford

Use of the Computer as a Multi-Task Tool by a Vocally Impaired Accountant

We debated what the format of this presentation should be as Jim has done most of the work and I am simply along for the ride. As a result, I am going to give a brief introduction explaining the program we offer at Courage Center which assists people with disabilities as they strive to utilize technology to its fullest advantage. Jim was one of the people who used these programs to substantially improve his own position.

Courage Center, located in Golden Valley, is a comprehensive rehabilitation facility offering over seventy programs to the disabled. Two of these are Rehabilitation Engineering services and the Technological Work Evaluation (TWE) program. For this presentation the TWE is the one on which we will focus. Rehabilitation Engineering plays a major role in the TWE by providing technical support where special arrangements or adaptations are required to optimally or functionally allow an individual to interact with a computer terminal.

The TWE is an evaluation program which explores an individual's potential to enter computer programming training or to pursue employment in the computer field. The basic philosophy behind the program is that with the proper preparation and support, a person should be able to pursue training in available, regular programs. In the Minneapolis-St. Paul area, the county vo-tech schools and institutes such as Brown Institute and Control Data Institute are a few.

Jim participated in the TWE primarily to address the technical adaptations which would facilitate his using a terminal. A few of the technical details are a keyboard mask and switches located at the front of the terminal. These switches are power switches, but Jim explains them further in his portion of the presentation. With that, why don't we switch gears now as Jim talks about his use of his Apple II computer.

Some say the computer age is a challenge, but my employment situation as an accountant was much more challenging before the use of a computer system in my office. Being unable to write, I used two IBM Correcting Selectric typewriters, a Texas Instruments calculator, and an old National adding machine. With this equipment, it was very cumbersome for me with my limited speed to have to insert volumes of pages into the typewriters. Although the two machines did cut down on the paper shuffling somewhat, it was very time-consuming to type figures on the records, to total these amounts by keying them into an adding machine, and then to transfer the sums back to the typewritten sheets again.

As my accounting practice grew with clients from throughout the Twin Cities area and from out-state regions such as Rochester, Minnesota, I looked into using time-sharing computer services which I found too costly because of my slow way of working. Thus, I started to use mail-in computer processing, but the preparation of the input data forms for the processor took almost the same amount of time as it did to do the work myself. The advantage of sending the bookkeeping material out for processing was that much of the work could be done by clerical help. This left me more time to solve the accounting problems and review the printouts which were made easier by the computer accuracy. The main drawbacks were the costs of the office staff and computer processing service.

To minimize my costs and the difficulty of paging through thick record books, of manually maintaining accounts, and of typing reports, I decided an in-office computer was a necessity. As I began exploring the computer world I saw how such an office system would increase my productivity and efficiency--to help solve the problems which impeded the growth and profitability of my accounting office. I was impressed with the way the multi-key functions I often used could be performed by pushing just one command key and how bookkeeping figures need only be keyed in once for double-entry journalization and automatic posting to the ledger accounts. Also, with this single input operation, all information could be totaled, balanced, and stored, ready to be recalled at a press of a key for monitor display reviewing, record up-dating, or report reproduction on a printer. This one-time data entry, which would save many hours of work, could be done on a standard typewriter keyboard like the one I was accustomed to using. Therefore, it would not be necessary to adapt my cerebral palsy ways to a new work situation.

My individual, one-finger typing skills and working abilities being what they are, some adaptations did have to be made to the Apple computer which finally arrived at my office in mid-December, 1980. One of the modifications was the construction of the keyboard guard with three built-in shiftlocks since I can use only one finger, and three keys on the Apple need to be held down at times while pressing other keys. The aluminum finger-hold plate prevents me from hitting more than one key at a time. But we have not quite solved the technology of how to keep my hand from becoming aluminum coated. Also, all peripheral off/on controls had to be mounted "up-front" using regular electrical wall switches since most computer devices are turned off in hard-to-reach places to prevent accidental shut-downs which cause memory loss. The whole system configuration is arranged on a specially designed table incorporating steps and shelves so that the equipment is within easy reach, placed at the most functional level for me to operate. For instance, there is a shelf in front of the disk drives in line with the disk slots which enables me to slide the diskettes in and out with no problem. These alterations were made at Courage Center, 3915 Golden Valley Road, Golden Valley, MN 55422, under the supervision of the Technological Work Evaluation Department.

I was recommended for the Technological Work Evaluation program by the Minnesota Division of Vocational Rehabilitation (DVR) when I applied to them for computer funding. Since neither my rehab counselor nor I knew much about computers, my two-week intensive screening at Courage Center proved to be invaluable. They analyzed my ability to operate a computer, my needs for adapted engineering and computer hardware. DVR took the Technological Work Evaluation staff's findings and approved my proposed computer package--the first such project ever O.K.'d by DVR.

Although my Apple II Plus computer is quite inexpensive by itself, $1,400.00, the peripheral equipment and software programs which I need for my accounting work ran the total cost of my system up to nearly $7,500.00. To complement the 48K memory computer with ROM Applesoft, it is interfaced with two disk drives using five-inch diskettes, a Panasonic color 13-inch monitor, and a Texas Instruments matrix printer. Since the printer has to be fast to handle the volume of work, I chose a 150-character-per-second, bidirectional model costing $2,000.00, which is the highest priced single component in my system.

Figures 1 and 2. Jim Carlisle uses his computer as a multi-task tool.

Computer hardware is usable only when programmed to function. The software package which I employ for my regular accounting work is *The Controller General Business System* copyrighted in 1979/1980 by Apple Computer, Inc. and Dakin5 Corporation. It is a large program stored on ten disks--I can do Accounts Receivable, Accounts Payable, and General Ledger bookkeeping with this system. Since I have previously mentioned the advantages of computerized accounting for me, I will not comment further on the details.

Everyone is more interested in Payroll, so here are a few words on the subjust. By just entering the employee numbers and hours worked into a program from Business and Professional Management Systems, Inc. copyrighted in 1980, my computer figures gross wages, subtracts the correct withholding taxes, and prints the net payroll checks. Of course, employee names and other information must be preprogrammed on a data storage disk which takes some time for me, but after that is done, there is no trouble meeting payday deadlines. This makes it possible for me to run much larger payrolls than I could ever think of doing by hand. Earning summaries and tax reports can be generated by activating the printer.

I also have designed my own wage and tax summary sheet which, one workmen's compensation auditor said, was the best that he had seen. This was done with the help of *Visicalc*, one of the most important new software products in recent years. Originally written and copyrighted in 1979 by Don Brinklin and Bob Frankston, and now marketed by Personal Software, Inc., this program was reviewed in the August, 1980, issue of *Creative Computing* magazine. *Visicalc* simulates a vast dynamic worksheet for financial planning. It essentially creates an enormous array of columns and terms, with fairly complex relations among them, all instantly updated every time one figure is changed. Most accountants spend a great deal of their time reworking dollar amounts on many-columned working papers deciding which numbers belong where. These recalculations were very difficult for me as I cannot use a pencil and eraser, but now that I use *Visicalc*, the electronic worksheet, my ability to "juggle" figures has increased considerably. Besides the many individual problem-solving uses and the Payroll Summary, I have created an Itemized Deductions Form and a Depreciation Schedule which are very helpful for income tax preparation.

You should hear about the software I am using now which I used to prepare these words. It is called *The Executive Secretary Word Processing System* copyrighted in 1981 by Personal Business Systems, Inc. This product was designed by John Riskin, the legally blind owner of the distributing company. Since my whole system was purchased from John's store at 4306 Upton Avenue South, Minneapolis, MN 55410, he installed the necessary Dan Paymar lower case adapter in my Apple unit. This jumper wire, along with his program, converted my computer into an electronic "super" typewriter that allowed me to type these paragraphs only once and then to edit them by correcting spelling, adding words, inserting text, moving sentences, and deleting thoughts. I can now write technical research papers by gathering the information in the program's electronic card catalog which can be recalled from storage and expanded into full form. This saves me the effort of carefully composing my ideas in my mind before typing them and of slowly retyping the final copy without mistakes. Letter-writing is made easier with the help of the preprogrammed mailing list that addresses and personalizes form letters such as my last year's Christmas greeting. If I wish to send almost the same data to different people, I type one letter and amend it for each person. Additional editing features let me create and retrieve blocks of standard text from a memory storage library, do document searches for key words, and generate rough draft printouts. There is complete control over the final printing format if the many options can be remembered, but once they are selected, they can be stored and recalled for future use. A 76-page manual describes all these editing commands, most being activated by three keystrokes and some of which I will demonstrate now. "*The Executive Secretary* is reasonably simple. Considering the options it has, it's amazingly simple." These are the words of professional writer, Dale Archibald, who, after trying the program, reviewed it in *Creative Computing* magazine for July, 198[illegible].

One does not often find products, such as those I have described, which, although created for the able-bodied public, are even more suited for use by the disabled population. Other software programs turn my Apple computer into a challenging chess or backgammon opponent when I can't find a human one by using a modem dialing device that converts computerized digital signals into electrical frequencies so they can be transmitted over telephone wires. These phone dialing and coupling capacities can bring the outside world into my office. For a service fee, data from libraries, newspapers (including the *Minneapolis Star* and *Tribune*), and the stock exchanges can be called up on the monitor screen. Free advice can be received from other computer owners by communicating through their modem systems. To speed my word input for such contacts, a friend and I are collaborating on writing a "Shorttype" program that will allow me to type most common words with just three keystrokes. The version I use presently has a very limited vocabulary, but we plan to expand it to 900 words and phrases. Words not available on the listings are typed in as usual. More of this special kind of programming is needed for disabled people so that they can take full advantage of the potential of computers.

With declining computer prices, greater availability of systems in schools and homes, plus increasing employment opportunities in the industry, I feel many more severely disabled people will be able to use this powerful tool to increase their productivity and improve their way of life. Fast advancing technology is bringing to the handicapped population an unbelievable future for using computers. Control Data Corporation in Minneapolis, Minnesota, and a California-based corporation, Interstate Electronics, are developing ways of giving computers oral commands. Such a device, called the *Vet-2,* which is compatible with the Apple II, is already being manufactured by Scott Instruments in Texas. Voice recognition will make it feasible for a computer to take my distorted speech and interpret it into understandable language. Rancho Los Amigos Hospital in Downey, California, is doing research on electrode implants that will transfer impulses from the human brain to control artificial limbs (Boston Arm variations). If prostheses can be regulated by mentally generated electrical currents, it is more than likely that this same technique could be used to directly interface mind to computer. The elimination of keyboard input by either vocal or mental communication with electronic brains could revolutionize the world of the disabled as well as the world at large.

Raymond Lifchez

Access to the Total Work Environment

In contemporary American culture, earning is the primary activity associated with work. To earn, however, one must have a skill, profession, or talent that is marketable. Many social activities center about exercising this skill or profession; many pleasures are financially possible only because one works. The sense of personal achievement and view of one's own social status are also strongly related to work. Contentment in work is likewise necessary for a sense of individual well-being.[1]

My interest is in how people with physical disabilities make use of the everyday environment. Science and technology may assist disabled individuals to achieve personal goals, but still the act of doing so occurs in some *place*: at home, on the job, in the classroom, along the street, at the bus stop. It is the architect to whom everyone looks for leadership in bringing into being good places and who potentially has the most influence in getting the whole society to attend to this issue--and we would agree that access must be everyone's concern.

Architects have been reluctant to accept leadership in this matter and have been even somewhat resistant to the task when it presents itself in their own work. Curiously, the challenge has not been unduly technological; it is not like getting a grasp on solar design. It is, in fact, much more difficult than that, because it demands that one reconsider how one sees the world and oneself in it; that one accept disability as a part of everyone's lives and then, as an architect, take responsibility for this acceptance when designing buildings.[2]

Today I will present a project completed in 1979, and now "tested" in use by several thousand people. It is a guidebook called *Getting There: A Guide to Accessibility for Your Facility*, which we wrote for the Department of Vocational Rehabilitation in California.[3] I know many of you have seen it, even used it, but what you don't know, and what is interesting, is how we went about deciding what should be done and how we obtained the material used. First, however, I want to say something about the concerns that lay behind the idea of it.

As an architect and teacher, I see the task of creating accessible workplaces from several different points of view: that of the architect, who wants to make a beautiful design; of the employer-client, who wants to maximize every resource; of the employee, who has a profound need to be treated first as a human being and secondly as an employee; and of my student, the young adult with a disability, who has every intention of making it as an architect and is frankly nervous about his or her ability to compete physically in the marketplace. As I was once told:

> Sometimes, there is a real conflict, especially in growing up, between adjusting to being a crip and adjusting to the greater world. One example is the choice between trying to learn lip-reading so you can communicate with the hearing or learning sign so you can communicate with the deaf. The same problem arises in trying to choose between making it in the larger society, [having a] conventional job and friends, versus having crip friends and role models and making it in the crip world.[4]

When required, to encourage these others, I point out a few facts about how physically disabled people have traditionally been treated, and how radically different the situation is in America today. I tell them that the original American colonies adopted all the European attitudes that categorized people with physical disabilities as pariahs, comprehended only in the contexts of religious beliefs and superstition and dealt with through purges, charms, and prayers, or, when all else failed, ostracized or set apart in some manner; the institutional solution--nursing homes, mental hospitals, segregated communities--is a direct reflection of these historic and unenlightened attitudes, but one that has at last seen its better days.

I point out that as late as the early twentieth century, the progress that had been made toward humanizing the lives of disabled people was far overshadowed by improvements in institutional confinement:

> [T]he building of new institutions improved the lot of confined persons [but], what had originated as a progressive ideal became rigid and anachronistic with the passing of time. The custodial concept . . . became dominant . . . The institution began to be conceived of as an end in itself, a universal solution to the problem of dealing with mentally and physically handicapped persons.[5]

I then go on to remind them that the old workhouse and modern-day sheltered workshop, devised to give disabled people employment, were but refinements of the concept of custodial care. The person was given work, but bore the institutional stigma as well.

Socially and politically, it has been virtually impossible until very recently for the disabled person to live in the mainstream. And the most difficult task in the mainstream today is still to succeed economically--though here, too, the chances of survival are so much better as to bear no comparison with the past.

I find it useful to point out that the motivation behind the nation's first vocational rehabilitation program (conceived only in 1918), was to assist disabled people in finding employment: it was strictly a question of economics, and in no way a recognition of deprivations and injustices unaddressed. The Social Security Act of 1935 offered among its programs aid to disabled youths and adults. Some say this was a significant change in thinking, for it "represented the recognition that assistance to disabled individuals was as much a matter of social justice as of charity."[6] But, in spite of pious declarations, no legislation at that time, or programs derived from it made any change in the real conditions of those it sought to benefit. Their economic and social status was eloquently pronounced by Jacobus tenBroek, distinguished California professor of law, and a blind man, who in 1966 wrote:

> Throughout history the physically handicapped have been regarded as incompetent to aid themselves and therefore permanently dependent upon the charity of others--in short, as indigent beggars. In medieval and early modern times they were in fact the only "legitimate"

beggars and were granted a special legal status as such. This assumption of permanent helplessness persists today in the common consignment of the physically disabled to the category of "unemployables." Whatever may be the justice or injustice of this assumption, it remains a fact that only a very small fraction--perhaps five or six percent at most--of those with serious physical handicaps are gainfully employed in ordinary open occupations. . . . [I]n the comment of the Federal Bureau of Family Services, following a nationwide survey of recipients of Aid to the Permanently and Totally Disabled . . . . "[Disabled] recipients tend to follow the usual pattern of poverty. While their disabilities make them dependent upon public assistance for their livelihoods, lack of education and low job skills play a large part in preventing their rehabilitation to self support." In sum, the seriously disabled person in our society is characteristically unemployed, underprivileged, unaccepted, and impoverished. In a word, he is poor.[7]

It was not until the 1970s, when the cause of disabled people was firmly adopted by the Civil Rights movement, that the critical issues of nondiscrimination and equal protection guarantees were finally addressed. These were the missing pieces in all previous legislation, without which no disabled individual could challenge the status quo in the courts. The rest is such recent history that many of you here have firsthand experience of landmark cases by which the "right" of the disabled "to live in the world"[8] was finally established.

As we know, it was the Vocational Rehabilitation Act of 1973 and its amendments (especially Section 504, passed into law in 1977) that paved the way for what was to follow. The act had such a powerfully positive impact on the lives of disabled people that it is commonly referred to as their "Bill of Rights."

Yes, at present, there is in Washington no consideration of what all this has meant to the nation, but even the backlash we now experience can never demean what has been achieved.

Architects and others engaged in building should know this history, but virtually none do--even though everyone's practice has been affected by it. Their self-imposed ignorance blurs the important human context in which barrier-free design is situated and robs them of the satisfaction of the social and political significance of their acts.

My work is largely derived from the impact of this legislation on my community--my town and the university campus where I teach. For a short while, my services were much in demand to make physical surveys to determine the new accessibility requirements for education and employment in federally and state funded environments. It was a very intense time; in my memory an era! In doing this work, I realized that ten years of straight architectural practice had not adequately prepared me to understand the physical world as those with disabilities understand it, and I turned to those who could assist me. From the outset, my colleagues and I insisted that all the surveys had to be carried out with the help of disabled people. We also used the best access manuals then available, but quickly realized their shortcomings as mere lists of items and dimensions, made valuable only when examined in light of observed performance and commentary by our consultants on location. We, the architects, came to know what our consultants, without any architectural training whatsoever, had known all along:

- The dangers of assuming single-purpose solutions (entrance ramps, for example) predicated on disability stereotypes.

- The fallacy of functional solutions that do not acknowledge human feelings (the back door is not the same as the front door).

- That two people with the same disability and logistical problems will not necessarily function in the same way.

- That most well-designed barrier-free solutions are better solutions for the able-bodied as well.

- That the quality of social relationships in a place greatly influences how people feel about the place, whether or not they perceive it as functioning well for them, and so on.

What made our consultants especially aware in the tasks we handed them was the commitment they had made to themselves to live in the mainstream, for this sharpened their perceptions of what is and what ought to be.

Watching our consultants at work gave us the idea for the guide. *Getting There: A Guide to Accessibility for Your Facility* was written to be used by those who make physical improvements to California state facilities, or who have contracts with the state, but actually anyone can use it, and apparently many elsewhere have. It differs from other technical literature on barrier-free design in that it determines what "accessibility" should mean in a given place by getting advice from disabled people. It is based on the idea that accessibility is both a physical and a social issue, and that these aspects are intertwined. It urges understanding of the social implications of identifying and solving the problem, which may or may not be a physical problem after all! It strongly recommends that it be used in conjunction with existing mechanical guides and guides to special problems. Our guide lays out a procedure for looking at a facility to itemize what has to be done to achieve better accessibility.

The purpose of the guide is to make one more sensitive to how an existing facility is inaccessible, and by thus itemizing what has to be done, to establish priorities among the desired changes. A sub rosa agenda exists as well: to make sure that those with physical disabilities are put into a position of giving management and their architects good advice, which disabled individuals so abundantly possess.

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Participation of disabled individuals was central to the design of all the workshops. The following list contains the names and addresses of all people participating in the three 1981 workshops. Asterisks indicate persons who are themselves disabled.

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