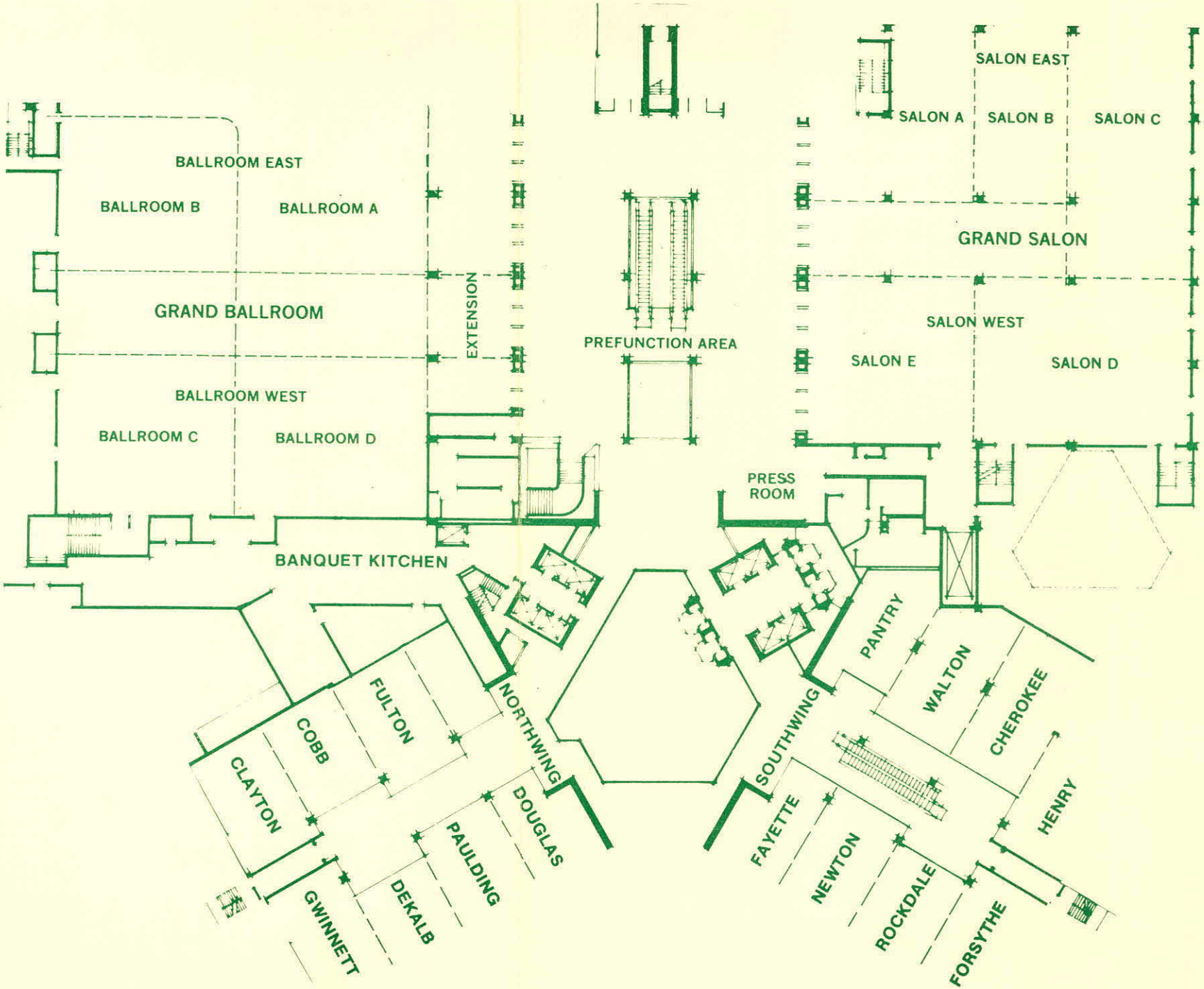
David P Kelso

Interagency Conference on Rehabilitation Engineering

ATLANTA HILTON
ATLANTA, GEORGIA

August 26-31, 1979

ATLANTA ● HILTON



PROGRAM AT A GLANCE

1979 INTERAGENCY CONFERENCE ON REHABILITATION ENGINEERING

Visit the Exhibits

SUNDAY AUGUST 26	MONDAY AUGUST 27	TUESDAY AUGUST 28	WEDNESDAY AUGUST 29	THURSDAY AUGUST 30	FRIDAY AUGUST 31
	8 a.m.-6 p.m. Registration	8 a.m.-6 p.m. Registration	8 a.m.-6 p.m. Registration	8 a.m.-6 p.m. Registration	8 a.m.-12 noon Registration
	MORNING SESSIONS				
		8 a.m.-12 noon Technical Workshops	8 a.m.-12 noon Technical Workshops	8 a.m.-12 noon Technical Workshops	8 a.m.-12 noon Technical Workshops
	9:30 a.m.-12 noon Exhibits Officially Open	9 a.m.-12 noon Instructional Courses	9 a.m.-12 noon Instructional Courses	9 a.m.-12 noon Instructional Courses	9 a.m.-12 noon Instructional Courses
	AFTERNOON SESSIONS				
	1:30 p.m.-2 p.m. Opening Keynote Address 2 p.m.-3 p.m. Plenary Session	1:30 p.m.-2:30 p.m. Plenary Session	1:30 p.m.-2:30 p.m. Plenary Session	1:30 p.m.-2:30 p.m. Plenary Session	
3 p.m.-6 p.m. Registration	3 p.m.-6 p.m. Exhibits Open	2:30 p.m.-6 p.m. Exhibits Open	2:30 p.m.-6 p.m. Exhibits Open	2:30 p.m.-6 p.m. Exhibits Open	
	3 p.m.-6 p.m. Scientific Papers	3 p.m.-6 p.m. Scientific Papers	3 p.m.-6 p.m. Scientific Papers	3 p.m.-6 p.m. Scientific Papers	
	SOCIAL FUNCTIONS				
6:30 p.m.-8 p.m. Welcoming Reception	7 p.m.-8:30 p.m. ICRE Reception			7:30 p.m.-11 p.m. Awards Banquet	

WELCOME

As program chairman it is my pleasure to welcome you to the 2nd Annual Interagency Conference on Rehabilitation Engineering. The purpose of the conference is to provide a forum for the interchange of information for those working in the field and to provide a mechanism by which the results of this work may be presented to consumers and to allied professionals. The conference plan has four major components: **exhibits** where industrial products and research activities are displayed, **instructional courses** where the latest methods and techniques may be learned, **scientific sessions** for the reporting of research and development, and **technical workshops** to develop recommendations for future work. In addition there are daily plenary sessions discussing one of the major topics of independent living. In each of these sessions a representative from the government will present the national program and a consumer will present the needs of the disabled.

Although the conference is primarily technical in focus, the underlying theme is cooperation among consumers so that real needs can be known, among the technical people in sharing information and among the many agencies that sponsor and support this work. It is expected that many of the past year's activities and accomplishments in rehabilitation engineering will be part of this annual conference which can in one forum and in one setting substitute for a number of other smaller conferences and workshops. This can reduce the amount of travel people need to perform yet permit that broad opportunity for all concerned to interact.

Rehabilitation Engineering is now coming of age. Our great wealth of technical knowledge and ability may at last yield solutions for that section of our population who can most benefit from it — those with physical limitations. Even a brief tour of the exhibits is sufficient to illustrate the sophistication of some of the aids to daily living. Equally important are the simple devices, which although unspectacular are essential to achieve a full and effective life-style. All of these aids stem from directing technology with a specific purpose — to help the physically disabled. This specific technology also helps the population at large. Environmental controls for example, developed first for the handicapped are now used by the general public. Curb cuts are a boon to shopping carts and baby carriages. Easy access buses will be an aid to us all. Thus it is hoped that when attending this conference and participating in the various events, the prime concern will be technology for mankind so that all of us no matter what our disabilities can share equally in the future.

As always a major part of any conference is the opportunity to meet informally those many friends and colleagues who enrich our lives. There should be time in the busy schedule of ICRE 1979 to allow this important activity. We hope the conference meets your goals and that you help in planning the next by a candid response to the critique shown on page 78 of this program. Next year we are going international, meeting in Toronto June 15-20, 1980 in conjunction with the 14th Congress of Rehabilitation International. We hope to see you all there.

Welcome to ICRE 1979. Bon Conference!

Colin A. McLaurin
Program Chairman

CONFERENCE SPONSORSHIP:

National Institute of Handicapped Research (NIHR) of the Department of Health, Education and Welfare

Veterans Administration

CONFERENCE COORDINATORS:

Joseph E. Traub, National Institute of Handicapped Research (NIHR)

Anthony Staros, Veterans Administration
National Rehabilitation Engineering Center (VANREC)

PROGRAM COMMITTEE:

Colin A. McLaurin, **Chairman**

Raymond Cheever
James Cockrell
Douglas Hobson
Deborah Kaplan
Richard E. King
Ira Laster, Jr.
John A. Leslie, Jr.
J. Raymond Pearson
Margaret Pfrommer
C. Gerald Warren
A. Bennett Wilson, Jr.

CONFERENCE MANAGEMENT

Convention Management Consultants
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CONTENTS

GENERAL INFORMATION

REGISTRATION — Prefunction Lobby, Second Floor

Sunday, August 26	3:00 p.m.- 6:00 p.m.
Monday, August 27	8:00 a.m.- 6:00 p.m.
Tuesday, August 28	8:00 a.m.- 6:00 p.m.
Wednesday, August 29	8:00 a.m.- 6:00 p.m.
Thursday, August 30	8:00 a.m.- 6:00 p.m.
Friday, August 31	8:00 a.m.-12:00 noon

MESSAGE CENTER — Prefunction Lobby, Second Floor

A Message Board will be located in the Registration area for those persons who wish to leave messages. There will also be a locator file at the registration desk indicating each participant's hotel and room number.

EXHIBITS — Exhibit Hall, Lower Level

The exhibits will be open from 9:30 a.m.-12:00 noon and from 3:00 p.m.-6:00 p.m. on Monday, August 27. Tuesday, August 28,through Thursday, August 30, the exhibit hours will be 2:30 p.m. to 6:00 p.m.

PRESS ROOM — Paulding Suite, Second Floor

Members of the working press will have the Paulding Suite, Second Floor available for their use. Mr. David Knoller will be available to answer any inquiries.

FACULTY — AUDIO VISUAL — Douglas Suite, Second Floor

The Douglas Suite, located on the Second Floor, will be available for Faculty and Speakers from 9:00 a.m. to 5:00 p.m. every Conference Day. Faculty and Speakers should report directly to the Douglas Suite upon their arrival. Mr. William Romahn will be available to assist.

ANCILLARY MEETINGS

The Rehabilitation Engineering Society of North America (RESNA) will meet in the Henry Room on Wednesday Evening at 7:00 p.m.

The Program Committee for the **1980 International Conference on Rehabilitation Engineering** will meet in the Henry Room on Friday evening at 7:00 p.m.

The **American Paraplegia Society's SCI** post graduate course for VA physicians will be held August 28, 29, and 30 in the Gwinnett Room.

SOCIAL EVENTS

Welcoming Reception — Prefunction Lobby, Second Floor

Conference registrants are invited to the Welcoming Reception on Sunday Evening from 6:30 to 8:00 p.m. Cash bar will be available.

ICRE Reception — Ballroom East

Tickets for the ICRE Reception are available at the registration desk for $5.00 per person. Hot and Cold Hors D'oeuvre Buffet is provided and a cash bar will be available.

Awards Banquet — Ballroom West

Registered participants with tickets are cordially invited to attend the Awards Banquet on Thursday Evening from 7:30 to 11:00 p.m. Tickets may be purchased at the Registration Desk, Prefunction Lobby on the Second Floor. The Banquet will honor winners of the Student Design Competition.

CONFERENCE COMMITTEE

Inquiries regarding the Conference may be directed to those persons wearing a GREEN Committee Ribbon. The Conference Committee welcomes your suggestions and comments. Your cooperation in completing the evaluation form provided on page 78 of this program will be appreciated.

TECHNICAL WORKSHOPS

The Technical Workshops have been structured to supplement the main theme topics of the Conference and address a number of key current issues in the field of rehabilitation engineering. The purpose is to create a forum in which researchers, clinicians, consumers, third party payors, administrators and other health care providers can conduct **indepth** discussions and make recommendations to serve as guidelines for continuing progress. The workshop participants are expected to contribute information and experiences in small group sessions and therefore the sessions are organized on a "by invitation only" basis. As may be seen in the daily program schedule, the seven workshops will run concurrently throughout the morning and groups are strongly encouraged to remain together throughout the week. If you have not received a letter of invitation and feel you can make a contribution to one of the workshops, please check with ICRE registration personnel in the Prefunction Lobby, second floor. Shown below are the seven workshop topics and their session leaders.

SESSION I
HOME & PUBLIC BUILDINGS
Leader: John Jonas

SESSION II
EDUCATIONAL & VOCATIONAL DEVICES AND SYSTEMS
Leader: Richard Foulds

SESSION III
WHEELED MOBILITY
Leader: Thomas Krouskop

SESSION IV
PUBLIC TRANSPORTATION
Leader: Michael Boblitz

SESSION V
DELIVERY OF REHABILITATION ENGINEERING SERVICES
Leader: Gordon Moskowitz

SESSION VI
INFORMATION RETRIEVAL & DISSEMINATION
Leader: James Reswick

SESSION VII
ROLE OF INDUSTRY IN REHABILITATION ENGINEERING
Leader: Morris Milner

STUDENT DESIGN COMPETITION

Continuing in the tradition of the Conference on Systems and Devices (CSDD), a student design competition will take place as a component of the **2nd Annual Interagency Conference on Rehabilitation Engineering.** Students will be competing in two categories. Pre-Conference judging has selected three finalists in Class A — "Papers Presentation", and six finalists in Class B — "Prototype Model Exhibit Presentations." Class A finalists will present their papers in the Sessions Reporting on Research and Development. Class B finalists have been provided exhibit space in the exhibit hall.

Conference participants are invited to view the students exhibits and talk directly with the students during the exhibition. Final judging of both categories will take place during the Conference and the winners will be awarded prizes during the Awards Banquet on Thursday Evening. Support for student participation has been derived largely from durable medical equipment firms. A listing of those firms that have contributed in excess of $200.00 may be reviewed in the registration area and the student design exhibit area.

PROGRAM SCHEDULE

SUNDAY, AUGUST 26

3:00 p.m.-6:00 p.m. — **REGISTRATION.** Prefunction Lobby, Second Floor.

6:30 p.m.-8:00 p.m. — **WELCOMING RECEPTION.** Prefunction Lobby, Second Floor.

Registered participants are cordially invited to attend the Welcoming Reception. Several cash bars will be available. Your cooperation in wearing your Official Conference Badge to the reception will be appreciated.

MONDAY, AUGUST 27

8:00 a.m.-6:00 p.m. — **REGISTRATION.** Prefunction Lobby, Second Floor.

9:30 a.m.-10:00 a.m. — **OPENING CEREMONY IN EXHIBIT HALL**

Max Cleland, Administrator of Veterans Affairs
Robert Humphreys, Commissioner, Rehabilitation Services Administration
William Spencer, Director, Texas Institute for Rehabilitation and Research
Acting Director, National Institute for Handicapped Research (NIHR)

10:00 a.m.-12:00 noon — **EXHIBIT PRESENTATIONS & DEMONSTRATIONS**

1:30 p.m.-2:00 p.m. — **OPENING KEYNOTE ADDRESS.** Ballroom East.

Max Cleland
Robert Humphreys
William Spencer
and
Deborah Kaplan, Public Interest Law Center of Philadelphia and American Coalition of Citizens with Disabilities (ACCD)

2:00 p.m.-3:00 p.m. — **PLENARY SESSION.** Ballroom East.

HOME & PUBLIC BUILDINGS
David Williamson, Office of Independent Living for the Disabled, Berkeley, California.
Vivienne Thomson, Handicapped Services Specialist, Boston Housing Authority

3:00 p.m.-6:00 p.m. — **EXHIBITS OPEN**

3:00 p.m.-6:00 p.m. — **SESSION REPORTING ON RESEARCH & DEVELOPMENT**

SESSION A — HOME AND PUBLIC BUILDINGS
MODERATOR: Margaret L. Young — Ballroom A

A PLAY ENVIRONMENT PROJECT FOR CHILDREN WITH DISABILITIES — R. Levy
EVALUATION OF KITCHEN DESIGN FOR HANDICAP-ACCESSIBLE APARTMENTS — Patricia Falta

MOBILE HOMES: ALTERNATIVE HOUSING FOR PERSONS WITH HANDICAPS — Rodger W. Decker

PROTOTYPES OF AN ELEVATOR VOICE MODULE — Paul A. Obester

AN OPERATIONAL TRIAL OF THE ELECTRONIC INFORMATION EXCHANGE SYSTEM FOR THE REHABILITATION ENGINEERING COMMUNITY — Jane H. McCarroll

COMMUNICATION UNIT FOR INDIVIDUAL HOUSING OF THE SEVERELY DISABLED — Elmer A. Hoyer

SESSION B — COMMUNICATION DEVICES FOR NON-VOCAL PERSONS

MODERATOR: Robert N. Scott — Ballroom B

HANDIVOICE: AN ELECTRONIC COMMUNICATION SYSTEM FOR NON-VOCAL PERSONS — Carol G. Cohen

THE AUTOCOM: AN ELECTRONIC COMMUNICATION SYSTEM FOR PERSONS WHO ARE SEVERELY IMPAIRED VOCALLY — Bruce J. Boehm

UTILIZATION OF NON-ORAL COMMUNICATION DEVICES FOR CHILDREN WHO ARE SEVERELY HANDICAPPED PHYSICALLY — Judy Montgomery

DEVELOPMENT AND EVALUATION OF A MODULAR CLASSROOM COMMUNICATION SYSTEM FOR CHILDREN WHO ARE VERBALLY IMPAIRED AND PHYSICALLY HANDICAPPED — P.J. Nelson; O.Z. Roy; G. Park; J.R. Charbonneau; S. McNaughton

INVESTIGATION INTO DIRECT LINE OF SIGHT AS A MEANS OF NON-VOCAL COMMUNICATION — Richard A. Foulds; Randall W. Fincke

ELECTROMAGNETIC HEAD TRACKING, A NEW COMMUNICATION DEVICE FOR PERSONS WHO ARE SEVERELY HANDICAPPED — James C. Krieg

EVALUATION OF SOME ELECTRONIC GAMES FOR CHILDREN AND ADULTS WITH PHYSICAL HANDICAPS — J.W. Arenson; O.Z. Roy; Peter J. Nelson; C. Cote-Baldwin

7:00 p.m.-8:30 p.m. — **ICRE RECEPTION.** Ballroom East.

TUESDAY, AUGUST 28

8:00 a.m.-6:00 p.m. — **REGISTRATION.** Prefunction Lobby, Second Floor

8:00 a.m.-12:00 noon — **TECHNICAL WORKSHOPS.** Grand Salon East
BY INVITATION ONLY.

9:00 a.m.-12:00 noon — **INSTRUCTIONAL COURSE T-1.** Walton.

AIDS TO INDEPENDENT LIVING
Chair: Marian Hall
Instructors: Diane Atkins, Barry Romich, Kristjan Rangarsson.

Technical aids, available commercially, will be presented primarily within the following selected categories: Lifts and Transfer aids; Bathroom aids; Reaching, Carrying and Holding aids; Page turners; Mobility aids; and Environmental Controls and other electronic aids. Features of equipment within each category will be compared. Emphasis will be placed on relating the features of the various equipment to disability problems.

9:00 a.m.-12:00 noon — **INSTRUCTIONAL COURSE T-2.** Rockdale.

MANAGEMENT OF THE MORE SEVERELY DISABLED UPPER-LIMB AMPUTEE
Chair: Dudley Childress
Instructors: John Billock, Marcus Phelps, T. Walley Williams, III, Richard Lehneis

The application of both body-powered and externally-powered prostheses for the more severely involved upper-limb amputees will be covered. The various types of control systems available will be described, and examples of combining parts of different systems to provide maximum function on an individual basis will be presented.

9:00 a.m.-12:00 noon — **INSTRUCTIONAL COURSE T-3.** Fayette.

READING SYSTEMS FOR THE BLIND
Chair: Howard Freiberger
Instructors: Lawrence A. Scadden, Harvey L. Lauer, James C. Bliss, Raymond C. Kurzweil, Oleg Tretiakoff.

Systems enabling people who have no useful vision to read ordinary print without help will be reviewed. Recently developed reading devices using braille and audio recording will also be explained.

1:30 p.m.-2:30 p.m. — **PLENARY SESSION.** Ballroom East.

EDUCATIONAL AND VOCATIONAL SYSTEMS
Herbert Taylor, Datapoint Corporation
John Leslie, Cerebral Palsy Research Foundation of Kansas, Inc., Rehabilitation Engineering Center at Wichita State University.

2:30 p.m.-6:00 p.m. — **EXHIBITS OPEN**

3:00 p.m.-6:00 p.m. — **SESSION REPORTING ON RESEARCH & DEVELOPMENT**

SESSION A — VOCATIONAL SYSTEMS
MODERATOR: Judy Montgomery — Ballroom A

VOCATIONAL REHABILITATION VIA RESEARCH UTILIZATION — Carol Whitcraft; Charles J. Laenger, Sr.

A CONSOLIDATED WORKSTATION FOR MOUTHSTICK USERS — Raymond E. Fulford

DEVELOPMENT OF A COMPUTERIZED WORKSTATION — M.J. Hodgetts

TYPEWRITER MODIFICATIONS FOR PERSONS WHO ARE HIGH-LEVEL QUADRIPLEGICS — J.R. O'Reagan; S. Reger; C. Cummings

COMPUTER PROGRAMMER AID FOR PERSONS WHO ARE QUADRIPLEGIC: A MICROPROCESSOR-BASED PAPER HANDLER — J.H. Aylor; R.L. Ramey; D.A. Bandjunis; W.W. Kirkman

STUDENT DESIGN PAPERS

A WARNING DEVICE FOR THE HEARING IMPAIRED — Dexter Williams; Victor Pang; Kitty Gostlen (Memphis, Tennessee)

A STUDY OF THE FEASIBILITY OF DEVELOPING VOLITIONAL KNEE CONTROL FOR ABOVE-KNEE PROSTHESES — Donald Myers (Philadelphia, Pennsylvania)

CAN OPENER FOR THE DISABLED — Daniel Riverst; Jacques Pellerin (Montreal, Canada)

SESSION B — READING SYSTEMS FOR THE BLIND
MODERATOR: James O'Leary — Ballroom B

VERSABRAILLE™ SYSTEM AND EXPANDED APPLICATIONS — Vito A. Proscia

EMPLOYMENT APPLICATIONS OF COMPUTER RELATED SENSORY AIDS FOR PERSONS WHO ARE BLIND AND PARTIALLY SIGHTED — Susan H. Phillips; Yvonne S. Russell

SPEECH OUTPUT READING MACHINES FOR BLIND USERS IN VOCATIONAL AND EDUCATIONAL SETTINGS — Gabriel R. Groner; Rob Savoie

A TALKING TYPEWRITER FOR PERSONS WHO ARE BLIND — Samuel C. Lee; Ted W. Wright; Chu-Ching Nei

WEDNESDAY, AUGUST 29

8:00 a.m.-6:00 p.m. — **REGISTRATION.** Prefunction Lobby, Second Floor

8:00 a.m.-12 Noon — **TECHNICAL WORKSHOPS** — BY INVITATION ONLY

9:00 a.m.-12:00 noon — **INSTRUCTIONAL COURSE W-4.** Walton.

COMMUNICATION SYSTEMS FOR NON-WRITING AND NON-SPEAKING PERSONS
Chair: Maurice LeBlanc
Instructors: Gregg Vanderheiden, Richard Foulds, Elain Trefler, John Eulenberg

For people who cannot talk with their voices or hands, some means of communication is crucial to satisfy basic physical needs and any intellectual/educational endeavors. National need and current status of communication systems for such people will be explored and a description of research activities and methods to make these new developments commercially available will be presented. Discussion about the future of this new and growing area of work will conclude the seminar.

9:00 a.m.-12:00 noon — **INSTRUCTIONAL COURSE W-5.** Rockdale.

GAIT ANALYSIS TECHNIQUES AND THEIR CLINICAL APPLICATION
Chair: Sheldon Simon
Instructors: Jacquelin Perry, Thomas Cook, Thomas Andriaechi, David Sutherland

Advances in technology have facilitated gait analyses, particularly the contributions these make toward patient care. Techniques to be discussed are motion analysis, measurement of cane forces, correlation of motion and vector data, footswitch definition of stride characteristics, and dynamic electromyography. Clinical problems to be covered include cerebral palsy, amputations, Parkinsonism, muscular dystrophy, arthritis, and amyolateral sclerosis.

9:00 a.m.-12:00 noon — **INSTRUCTIONAL COURSE W-6.** Fayette.

WHEELCHAIR PRESCRIPTION AND MAINTENANCE — I
Chair: C. Gerald Warren
Instructors: Darlene Hertling, William Bryant.

This course will present the rationale, the procedures, the options, and the expectations for prescription and use of manual wheelchairs. It will present a comprehensive overview, including the fundamentals of wheelchair use, the "state of the art in available equipment", and new concepts for the functional use of wheelchairs by disabled individuals.

1:30 p.m.-2:30 p.m. — **PLENARY SESSION.** Ballroom East.

MOBILITY NEEDS OF THE DISABLED
Jeananne Whitmer, Center for Independent Living; Berkeley California

MOBILITY RESEARCH, DESIGN & DEVELOPMENT
J. Raymond Pearson, University of Michigan, Rehabilitation Engineering Center
Panel: Ronald I. Lipskin; Charles M. Scott; Gerald R. Thorley; H. Gerald Bouman.

2:30 p.m.-6:00 p.m. — **EXHIBITS OPEN**

3:00 p.m.-6:00 p.m. — **SESSION REPORTING ON RESEARCH & DEVELOPMENT**

SESSION A — WHEELCHAIR PRESCRIPTION AND MAINTENANCE
MODERATOR: Cliff Brubaker — Ballroom A

THE ASSESSMENT CHAIR: A TOOL FOR THE SELECTION OF POWERED WHEELCHAIR CONTROL INTERFACES — Damian Wiechula

A MECHANISM TO REDUCE BODY DISPLACEMENT IN POWERED RECLINING WHEELCHAIRS — C. Gerald Warren; Michael Ko; Edward Delahanty

MYOELECTRIC WHEELCHAIR CONTROL SYSTEM — George Crawford; Alain B. Rossier; Mehdi Sarkarati

AZIMUTHAL CONTROL FOR A POWERED WHEELCHAIR — Robert A. Weber; Craig W. Heckathorne; Gregory Rombola; Dudley S. Childress

EVALUATION OF STAND-UP WHEELCHAIRS — Joseph W. Darlington; Saleem J. Sheredos; Madison Lyles

A MANUALLY OPERATED STAIR-CLIMBING WHEELCHAIR — Norman Van Dine

SESSION B — ENVIRONMENTAL CONTROLS
MODERATOR: David Bayer — Ballroom B

EXPERIENCE WITH THE UNICOM BY A PERSON WHO IS QUADRIPLEGIC: FROM THE ACUTE CARE SETTING THROUGH REHABILITATION TO COLLEGE George F. Dalrymple; Philip A. Drinker; Cynthia Folsom; Ellen L. Lee; Derek Rowell

IMPROVEMENTS IN MYOELECTRIC CONTROLLERS FOR ASSISTIVE DEVICES — Neville Hogan

A DAMPED JOYSTICK: ADAPTIVE CONTROL FOR THE TREMOR-DISABLED — Michael J. Rosen; Mark H. Sloan

NEW DIRECT ACCESS CONTROL INTERFACE — M.J. Hodgetts

A ROBOTIC AID FOR PERSONS WHO ARE SEVERELY DISABLED, THE HUMAN INTERFACE — Larry Leifer; James Sachs; Rickson Sun

A VIBRATING PLATFORM FOR PERSONS WHO ARE SEVERELY AND PROFOUNLY RETARDED — Kurt M. Marshek; Joseph R. Gartner; Robert H. Lytle

CONCEALABLE HELMET FOR SEIZURE-PRONE INDIVIDUALS — James L. Mueller;Kalisankar Mallik

THURSDAY, AUGUST 30

8:00 a.m.-6:00 p.m. — **REGISTRATION.** Prefunction Lobby, Second Floor

8:00 a.m.-12 Noon — **TECHNICAL WORKSHOPS** — BY INVITATION ONLY

9:00 a.m.-12:00 Noon — **INSTRUCTIONAL COURSE TH-7.** Walton.

WHEELCHAIR PRESCRIPTION AND MAINTENANCE — II
Chair: C. Gerald Warren
Instructors: Margaret Pfrommer, Saleem Sheredos, Dudley Childress, David Bayer, Robert Graebe, Elaine Trefler.

This course will present the rationale, the procedures, the options, and the expectations for prescription and use of externally powered wheelchairs. It will present a comprehensive overview, including the fundamentals of wheelchair use, the "state of the art in available equipment" and new concepts for the functional use of wheelchairs by disabled individuals.

9:00 a.m.-12:00 Noon — **INSTRUCTIONAL COURSE TH-8.** Rockdale

MOBILITY SYSTEMS FOR THE BLIND
Chair: Lawrence Scadden
Instructors: Deborah Gilden, Leicester Farmer, John Brabyn, Gary Kelly, William Gerrey.

This seminar will address the application of technology to the travel needs of totally blind individuals. The long-cane, the most widely used and accepted travel aid for blind people, has received extensive scientific investigation. The results of these studies will be discussed along with a review of attempts to engineer improved models. Electronic travel aids, currently in existence, will be demonstrated, and expectations for future systems will be described.

The environmental orientation problem presented by the need to locate a particular place within a specific geographical area will be examined, and two research programs which are attempting to alleviate this problem through the design and distribution of electronic environmental marking systems will be described.

9:00 a.m.-12:00 Noon — **INSTRUCTIONAL COURSE TH-9.** Fayette.

FUNCTIONAL AND THERAPEUTIC ELECTRICAL STIMULATION
Chair: Donald McNeal
Instructors: Jens Axelgaard, Bruce Bowman, Robert Waters.

Cyclical transcutaneous motor stimulation is used effectively in rehabilitation to increase or maintain muscle strength and prevent or correct deformities. Areas of application include rehabilitation of hemiplegic patients, correction of scoliosis, and exercising post surgical joint repairs or replacements. Electrical stimulation, in combination with biofeedback, is being used to re-educate and exercise poorly controlled muscles in hemiplegic patients and to increase range of motion of joints of the upper extremity. Electrical stimulation also offers an alternative to bracing in the treatment of scoliosis. Cyclical stimulation of the muscles on the convex side of the curve during the hours of sleep applies corrective forces to the spine halting further progression. Both of these applications will be discussed in detail in this course.

General principles of cyclical transcutaneous motor stimulation will also be covered. Topics to be discussed will include a review of available electrodes and the pros and cons of each, appropriate waveforms to minimize sensation, placement of electrodes, effect of polarity and a general review of the principles of electrical stimulation.

1:30 p.m.-2:30 p.m. — **PLENARY SESSION.** Ballroom East.

PUBLIC TRANSPORTATION
Ira Laster, Office of Environment and Safety — U.S. Department of Transportation.
Sigi Shapero, TRANSBUS, Pennsylvania Alliance of Physically Handicapped.

2:30 p.m.-6:00 p.m. — **EXHIBITS OPEN**

3:00 p.m.-6:00 p.m. — **SESSIONS REPORTING ON RESEARCH & DEVELOPMENT**

SESSION A — MOBILITY AIDS
MODERATOR: Michael Rosen — Ballroom A

A TRAINING PROGRAM IN THE UTILIZATION OF LIFT-EQUIPPED AND KNEELING BUSES IN THE WASHINGTON METROPOLITAN AREA — Donald W. Dew

HANDICAPPED DRIVER PERFORMANCE — Steven I. Reger; Cynthia Claus; James O'Reagan; Barbara Brown

DIGITAL SIMULATION TECHNIQUES FOR DRIVER TRAINING AND SKILL EVALUATION — Louis E. Boydstun; Davis Kessel; Gary D. Langolf; James M. Miller

AN ENGINE-GENERATOR POWER SOURCE FOR ELECTRIC WHEELCHAIRS James R. O'Reagan; James J. Kauzlarich

THE PIVOT AMBULATING CRUTCHLESS ORTHOSIS (PACO): A MOBILITY CONCEPT FOR PERSONS WHO ARE PARAPLEGIC — Lawrence E. Carlson; Martin T. Prast

GAIT ANALYSIS AND THE CARS-UBC ELECTROGONIOMETER — R. Hannah; S.J. Cousins; J. Foort

SESSION B — SEATING AND PRESSURE CONTROL AND REHABILITATION ENGINEERING PHILOSOPHY
MODERATOR: Robert H. Graebe — Ballroom B

A SHAPEABLE MATRIX FOR SEATING CHILDREN WITH DISABILITIES — S.J. Cousins; S.J. Tredwell; R. Hannah; J. Foort

AN ACTIVE SEATING SYSTEM FOR THE PREVENTION OF PRESSURE SORES — William E. Drew

A NEW BED AND MATTRESS SYSTEM TO PREVENT BEDREST COMPLICATIONS AND INCREASE MOBILITY — J.B. Redford

TECHNOLOGY FOR HANDICAPPED CHILDREN — ROLES OF THE PROFESSIONALS — Elaine Trefler; Jeryl Mitchell

DEVELOPMENT OF A USER-VALIDATED REHABILITATION DEVICES PERSCRIPTION METHOD — Charles J. Laenger, Sr.; Samuel R. McFarland

A COMPARATIVE LOOK AT THE FUNDING AND PHILOSOPHY OF A REHABILITATION ENGINEERING CENTER — Jonathan C. Bretz; Debra A. Hulseberg

USE OF SEMI-CUSTOM TECHNOLOGY FOR REDUCING COSTS AND INCREASING APPLICABILITY OF REHABILITATION ENGINEERING — Gregg C. Vanderheiden; David P. Kelso

7:30 p.m.-11:00 p.m. — **AWARDS BANQUET.** Ballroom West.

FRIDAY, AUGUST 31

8:00 a.m.-12:00 Noon — **REGISTRATION.** Prefunction Lobby, Second Floor.

8:00 a.m.-12:00 — **TECHNICAL WORKSHOPS** — Grand Salon East

9:00 a.m.-12:00 Noon — **INSTRUCTIONAL COURSE F-10.** Walton.

RECREATION AIDS FOR AMPUTEES
Chair: Ernest Burgess
Instructor: Doris Miller

Problems encountered by amputees in resuming former and new recreational pursuits will be discussed and solutions to many of these problems will be presented.

9:00 a.m.-12:00 Noon — **INSTRUCTIONAL COURSE F-12.** Rockdale.

ASSISTIVE DRIVING AIDS FOR THE DISABLED
Chair: David H. Harden
Instructors: Ted Cole, Thomas Armstrong, Paul Olson, Robert Juvinall, Make McDermott, Louis Boydston, Lawrence W. Schneider, David J. Semlow.

This course will give a description of some of the latest practices and innovations for evaluation and training of severely handicapped drivers. Leaders in this field will be explaining their programs for development and/or assessment of methodologies and equipment, both for evaluation/training and vehicle driving by the impaired driver.

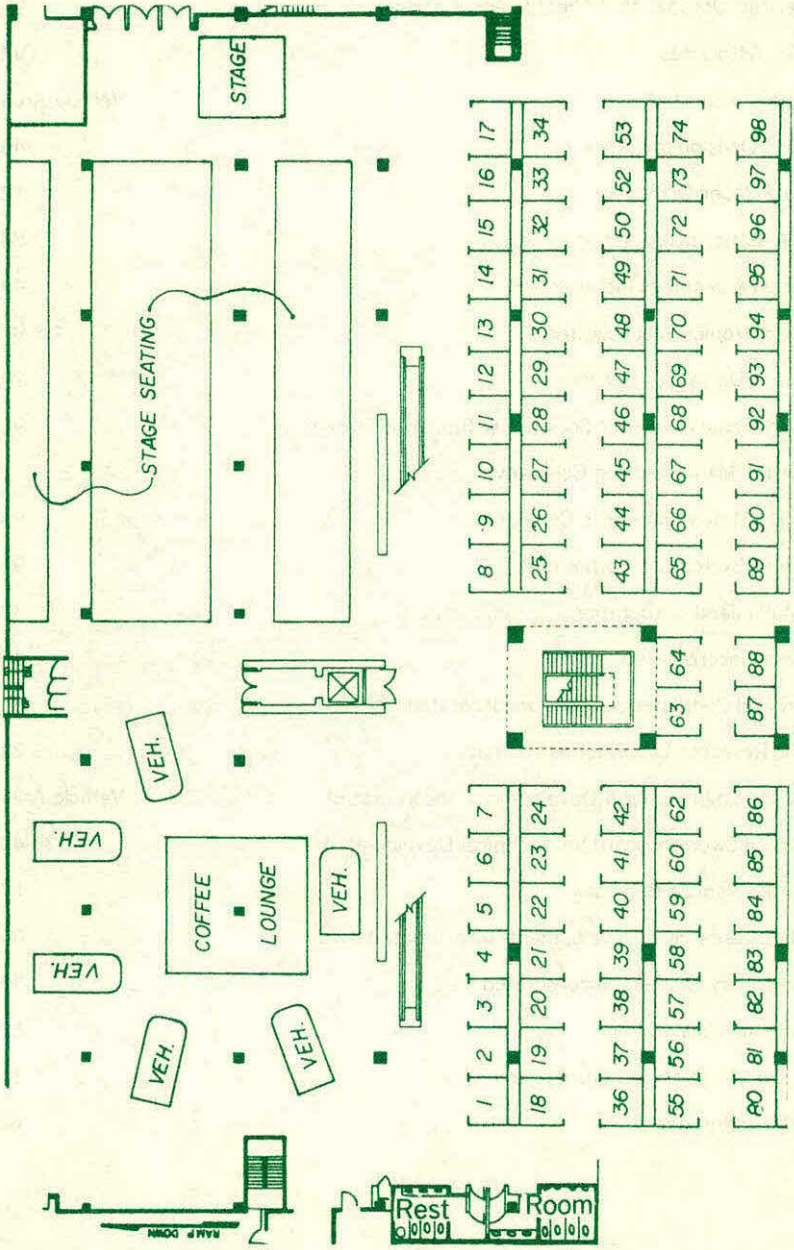
TECHNICAL EXHIBITS

EXHIBITOR	BOOTH NOS.
Baylor College of Medicine Rehabilitation Engineering Center	42
California, University of Biomechanics Laboratory (Mobility Aids Project)	80
Case Western Reserve University Cleveland Veterans Administration Medical Center	56-57
Cerebral Palsy Research Foundation of Kansas Rehabilitation Engineering Center	8-9
George Washington University Job Development Laboratory	43
Harvard-Massachusetts Institute of Technology Rehabilitation Engineering Center	23-24
Helen Hayes Hospital	53 & 91
Iowa, University of Rehabilitation Engineering Center	96
John Hopkins University Applied Physics Laboratory	85-86
Michigan, University of Rehabilitation Engineering Center	31-32 Vehicle Area
Moss Rehabilitation Hospital Rehabilitation Engineering Center	48
National Institute for Handicapped Research	81-82
Northwestern University Rehabilitation Engineering Center	65-66
New York State Education Department Office of Vocational Rehabilitation	3
New York University Medical Center Rehabilitation Engineering Center	89
Ontario Crippled Children's Centre	44
Ranchos Los Amigos Hospital Rehabilitation Engineering Center	90
Smith-Kettlewell Institute of Visual Sciences Rehabilitation Engineering Center	41
Southwest Research Institute	58

COMMERCIAL EXHIBITS

EXHIBITOR	BOOTH NOS.
American Occupational Therapy Association	91
ARTS Associates	93
Braun Corporation	Vehicle Area
Cybex, Division of Lumex	46
Durr-Fillauer Orthopedic	12
Die-A-Matic, Incorporated	87-88
Everest & Jennings Incorporated	49
HC Electronics, Incorporated	2 & 91
Hosmer-Dorrance Corporation	20
International Council of Societies of Industrial Design	91
Kingsley Manufacturing Company	1
Liberty Mutual Insurance Company	98
Lifeline Systems, Incorporated	91
L. Mulholland Corporation	33
Lumex, Incorporated	47
Maryland Computer Services, Incorporated	83
Mono Research Laboratories Limited	28
Mobility Engineering & Development, Incorporated	Vehicle Area
National Swedish Board for Technical Development	36-40
Prentke Romich Company	17
ROHO Research & Development, Incorporated	60
Telesensory Systems, Incorporated	30
Trans-Aid Corporation	52
United States Manufacturing Company	14
ZYGO Industries	62

INTERAGENCY CONFERENCE ON REHABILITATION ENGINEERING



EXHIBITS

Kingsley Manufacturing Company **Booth 1**
Costa Mesa, California
This manufacturer will show hand-painted cosmetic gloves for prosthetic hands and prosthetic feet molded of medathane to include sculptured toes for ladies high-heel and disco shoes, ladies sandals, and juvenile shoes. Also displayed are the Mortensen hydraulic prosthetic knee controls and weight-actuated friction knees.

HC Electronics, Inc. **Booth 2**
Mill Valley, California
This manufacturer will use an 8 mm film to show the PHONIC MIRROR HandiVoice, a speech output device for non-speech persons, as well as other speech and hearing instruments.

New York State Office of Vocational Rehabilitation **Booth 3**
New York, New York
This exhibit demonstrates worksite and vehicle modifications for severely disabled OVR clients. A variety of work settings will be photographically portrayed with clients' case histories available to delegates.

VA Prosthetics Center **Booths 4, 5, 6, 7**
New York, New York
Two video players and a collection of tapes will show this Center's programs in rehabilitation engineering including orthotics, prosthetics, and allied fields. Also shown are the Center's recent developments and its ongoing projects including work on a variety of devices such as wheelchairs, environmental control systems, automotive adaptive equipment, and communication aids. VAPC's clinical activities in orthotics, prosthetics, and orthopedic shoes will also be depicted.

Cerebral Palsy Research Foundation of Kansas **Booths 8, 9**
Rehabilitation Engineering Center
Wichita, Kansas
This exhibit will present a Vocational Rehabilitation theme based on taking a non-productive individual and making him productive by use of the Available Motion Inventory, Evaluation Research and Training, and Engineering Design and Application. A three dimensional lay-out of the Timbers Project will be featured.

VA Office of Technology Transfer **Booth 10**
New York, New York
This VA Office publishes, semi-annually, the Bulletin of Prosthetics Research. The Bulletin is the only publication which prints scientific material reflecting ongoing, nationwide research and development in the broad field of rehabilitative engineering. The exhibit features enlargements of illustrations, tables of contents, and other interesting data from recent issues of the Bulletin. This display is mounted behind a table which will contain handouts of useful reference material and literature in the field of rehabilitative engineering.

U.S. Architectural & Transportation Barriers Compliance Board **Booth 11**
Washington, D.C.
This Board enforces the Architectural Barriers Act of 1968. Under the Act, all facilities designed, altered, constructed or leased with Federal funds after August 12, 1968, must be accessible to and usable by handicapped persons. This "Access America" exhibit includes publications on how to file a complaint with the Board and

on barrier-free design. General information about the Board and its function and a resource and publications list will also be available.

Durr-Fillauer Orthopedic **Booth 12**
Chattanooga, Tennessee
This manufacturer and distributor of prefabricated prosthetic and orthotic components and supplies to the orthopedic field throughout the world will exhibit some of the latest developments in prosthetics and orthotics.

Texas A&M University **Booth 13**
College Station, Texas
Exhibited are automotive adaptive equipment for independent mobility. Devices shown and audio/visual displays will cover wheelchair lifts for vans, restraints for wheelchairs and occupants, and vehicle primary (steering, accelerator, and brake) and secondary controls.

United States Manufacturing Company **Booth 14**
Pasadena, California
Displayed will be commercially available prosthetic and orthotic components especially some new designs. Included are several lower limb orthotic systems, a plastic joint, hydraulic and mechanical prosthetic knees, and several lower-limb prosthetic alignment tools and limb structures.

Trace R&D Center, University of Wisconsin **Booths 15, 16**
Madison, Wisconsin
This exhibit will have three parts: (1) A display of communication and control aids developed by the Trace Center as well as aids from other parts of the world; (2) A resource exhibit giving summary information on research efforts around the world in the area of communication rehabilitation engineering; and (3) A presentation of a proposed system for standard interconnections for communication and control aids: this display will represent the preliminary efforts of an international group of researchers and manufacturers to achieve standards for interchangeability.

Prentke Romich Company **Booth 17**
Shreve, Ohio
This developer and manufacturer of electronic aids for severely handicapped persons will show areas of activity which include communication aids for the non-verbal physically handicapped, and environmental control systems for high level spinal cord injured quadriplegics. Recent developments include a programmable microprocessor-based communication aid and an improved selection of environmental control devices. The other portion of the display (Romich, Beery & Bayer, Inc.) shows powered wheelchair control systems for use by spinal cord injured quadriplegics and severely cerebral-palsied individuals. Devices include specialized controllers: joystick, chin controller and head rest controller. Other parts of the display include wheelchair control packages suited to various needs and such auxiliary functions as emergency signals, monitoring features, lights, tape recorders, power recline, and remote control of fixed location environmental control devices.

Virginia Polytechnic Institute & State University **Booths 18, 19**
College of Architecture & Urban Studies
Blacksburg, Virginia
This exhibit shows the research and development to date on the design of bathroom fixtures for the disabled. Included are three prototype shower fixtures and a slide and video tape presentation on the testing of the prototypes.

Hosmer-Dorrance Corporation **Booth 20**
Campbell, California
Exhibited are the latest concepts in prosthetics and orthotics including above-elbow and shoulder-disarticulation prostheses with the functional prosthetic hand and hook, a knee-ankle-foot orthosis and the femoral fracture brace.

VA Maxillofacial Prosthetic Center **Booth 21**
Wilmington, Delaware
A new form of silicone prosthesis material, generically defined as polydimethysiloxane (PDM Siloxane for short), has been developed for maxillofacial and orofacial reconstructions. Offered are safe and effective prostheses with exceptional chemical resistance and skin-like flexibility, without being injurious to internal human tissues. The exhibit consists of three parts: (1) The depiction of the basic chemical, molecular architecture developed for tear resistance and elasticity like that of human tissue along with internal pigmentation to match that of human skin; (2) The various prosthetic devices made using simple dental stone molding techniques; and (3) A unique, highly relevant toxicity testing system using actual human excised donor (HED) tissues to demonstrate safety to human tissues in persons of all ages, races, states of cancer, and imposed radiation. PDM Siloxane in standard internally pigmented shades is now available throughout the Veterans Administration and numerous affiliated maxillofacial clinics.

VA Medical Center **Booth 22**
Castle Point, New York
This Center's exhibit focuses on leg ischemia secondary to athero-sclerotic occlusive disease, its increasing prevalence in today's aging population and the frequently resulting amputation. Shown are objective, noninvasive methods to assess wound healing potentials, to eliminate long waiting periods necessary for visual evidence of healing or non-healing to occur, and to aid clinical judgment in accurately determining the lowest level of amputation possible consistent with wound healing.

Harvard-MIT **Booths 23, 24**
Cambridge, Massachusetts
In this display there will be video tape and devices showing this Center's present work in gait analysis, spasticity measurement, orthotics, scoliosis correction, nonvocal communication, tremor suppression, Braille display, EMG biofeedback, computer interactive knee prosthetics and myoelectric signal processing.

University of Tennessee, Rehabilitation Engineering Center **Booths 25, 26**
Memphis, Tennessee
This Center's exhibit will feature technical aids developed for children and young adults. Specialized seating devices, advanced wheelchair control system hardware, and electronic workstation control will be displayed. A backdrop of enlarged posters will illustrate other developments of the Center. Handout materials will be available for those wanting more specific information on developments exhibited and on other activities of the Center.

Center for Biomedical Design, University of Utah **Booth 27**
Salt Lake City, Utah
The exhibit will include a presentation of this Center's research on the "Utah Artificial Arm", and other rehabilitation engineering projects. A video tape will be used for the display. The prototype of the arm prosthesis will be demonstrated by an amputee.

Mono Research Laboratories Ltd. **Booth 28**
Shelbourne, Ontario, Canada
This exhibit will be demonstrating an automated feeder for use by persons with limited or no use of their arms. A number of methods employed in using the automated feeder will be shown.

VA Medical Center **Booth 29**
Gainesville, Florida
This exhibit illustrates the development and present status of a new artificial larynx for use, primarily by laryngectomees. The purpose of this project is to develop a device that could be used by the largest number of laryngectomees regardless of the particular surgical procedure used yet: (1) freeing the hand from holding the device; (2) providing a mounting of the device to the surface of the neck; and (3) having to be cosmetically and acoustically pleasing. Pictures, descriptions and models of existing artificial larynx devices and the new model will be displayed. Attention will be given to developmental engineering concerning the device itself and the neck mounting. Acoustic analyses of the device's output including when coupled to the neck through the vocal tract will be provided.

Telesensory Systems, Inc. **Booth 30**
Palo Alto, California
This exhibit will present three new systems developed by this company. Monday and Tuesday a special demonstration of the Voice Output reading system for blind people will be offered. This system converts print, handscanned by a miniature camera, to high quality synthetic speech. Throughout the week, the VersaBraille system, an electronic cassette braille information processing reading and writing device, will be demonstrated. The VersaBraille system is a most advanced cassette braille system, revolutionizing the braille medium. The Autocom (AUTOmonitoring COMmunication board) will also be demonstrated all week. The Autocom is an advanced portable electronic communications system for individuals who are both motor and speech impaired. The system is a highly flexible communications device accommodating numerous input/output modes. Also featured will be other TSI products such as the Optacon reading machine, the Speech plus talking Calculator, and various electronic travel aids for blind people.

University of Michigan, Rehabilitation Engineering Center **Booths 31, 32**
Ann Arbor, Michigan Vehicle Area
This exhibit will include a statement of the objectives of the research program of this Center. A prototype of a servomechanism control system to facilitate operation of the accelerator and the brake by paraplegic drivers with minimal upper extremity strength capacity will be displayed. This unit will permit operation from a wheelchair. Included also will be a special tie-down system for safe installation of wheelchairs in vans or buses. In addition, this exhibit offers (in the vehicle area) in a modified Dodge Omni equipped with a compatible wheelchair, an access-egress system, a Creative Controls, Inc. brake and accelerator servomechanism, a cruise speed control and other assistive devices.

L. Mulholland Corporation **Booth 33**
Saticoy, California
This exhibit will show innovative equipment to fill critical needs especially precise postural control systems, both for standing and seating for the client with Cerebral Palsy, post-trauma brain lesions, degenerative muscle diseases, high spinal cord lesions, and hydrocephalus. Also displayed are communication and environmental control systems, tailored to the complex and highly individual needs of the multiple handicapped or severely involved individual.

VA Medical Center **Booth 34**
Augusta, Georgia
This Center has fitted 500 rheumatoid patients having painful forefeet with plastizote modifications of three types: (1) A plastizote sandal for first aid; (2) A plastizote shoe for severe deformity; and (3) An extra depth shoe with plastizote insole for the usual permanent footwear prescription. This is offered as a frequent and valid alternative to operative treatment of the rheumatoid arthritic foot. A 3 minute film is shown to illustrate the improved gait of the patient wearing his footwear and plastizote insoles. The exhibit shows these types of footwear and how these are fitted to the arthritic foot. A pressure mat displays the redistribution of weight bearing to nonpainful areas.

Styrelsen for Teknisk Utveckling (STU) **Booths 36, 37, 38, 39, 40**
(National Swedish Board for Technical Development)
Stockholm, Sweden
STU sponsors research and development for individual persons or organizations in six major areas; this exhibit will cover "Social and Community Technology" from which the following aids for handicapped people are shown: (1) A child's artificial limb which works on direct brain-commands through skin contacts; (2) A one-time use insulin syringe which reduces infection risks; (3) An adjustable and collapsible wheelchair; (4) An electric stimulator for people suffering from incontinence; (5) A special bag for children having undergone colostomy operations; (6) A combined wheel- and bathchair; (7) The Sentifone tactile communication aid for deaf people, and finally (8) A speech amplifier for people with impaired voice resources.

Smith-Kettlewell Institute of Visual Sciences **Booth 41**
Rehabilitation Engineering Center
San Francisco, California
This Center applies modern sensory technology to the development and evaluation of assistive devices for blind persons. Included in this exhibit are assorted measuring instruments, audible indicators, and adaptations of devices commonly used by sighted individuals in a wide variety of vocational settings. In addition, a prototype of the "talking lights" (an audible sign using infrared transmission) designed to label locations, public transportation vehicles, etc., will be demonstrated.

Texas Institute for Rehabilitation and Research **Booth 42**
Baylor College of Medicine
Rehabilitation Engineering Center
Houston, Texas
This exhibit presents devices in two areas of rehabilitation engineering: (1) Tissue pressure management; the pressure evaluation pad, reminder of excessive pressure and site time monitor are highlighted; and (2) Consumer identified needs; a lapboard respirator, medicine security box and a carbon implant material are displayed.

George Washington University **Booth 43**
Washington, D.C.
Independence in life activities, especially employment, will be presented in this display by means of photographs and descriptions of simple aids and environmental adaptations.

Ontario Crippled Children's Centre **Booth 44**
Toronto, Ontario, Canada
This Centre will display various devices including mobility aids, biofeedback devices, seating systems, powered upper-extremity prostheses, orthotic devices and urinary devices. Poster displays will depict research activities including gait studies, electrostimulation of muscle, thermography in tissue trauma and assessment of upper extremity function.

VA Medical Center — Brentwood **Booth 45**
Los Angeles, California
This exhibit, sponsored by the Veterans Administration Rehabilitative Engineering Research and Development Service and the Brentwood VA Medical Center of Los Angeles, California and showing the FIELD CONTROL ELECTRODE (FCE) uses a slide-tape presentation, models, and photo displays to explain the FCE concept and to suggest potential clinical applications. The FCE concept incorporates electric field control elements placed between a circumferential electrode-pair for stimulation to alter the spatial ion density transiently within a nerve trunk. Simultaneous application of stimulus and field control potentials is believed to excite selectively a small subset of nerve fibers within the nerve trunk. Clinical application of the FCE and an associated microprocessor controller should permit selective, patterned activation of discrete muscle groups. User commands to the master controller unit would produce desired movement of paralyzed limbs or functional control of body organs.

CYBEX, Division of Lumex **Booth 46**
Bay Shore, New York
This exhibit will present the Cybex II Isokinetic Instrumentation System. This dynamometer accurately measures, displays, and stores on strip chart recorders, data on musculoskeletal strength, power and endurance. Under precise control of the Cybex II Speed Selector, the dynamometer provides safe, perfectly-variable (accommodating) resistance in both directions of movement at limb velocities from zero to 300 degrees per second. Any applied force is instantaneously matched and measured whether a prescribed sub-maximal effort or an absolute-maximum power contraction. Cybex offers two strip-chart recorder models. The Cybex II Dual-Channel Recorder simultaneously prints out both torque (foot pounds) and range of motion (position angle in degrees) on two parallel grids. Variations in torque specific to points in the range (such as caused by pain, weakness or instability) are easily located for analysis. Range of motion completeness or deficiencies can be quickly observed and quantified. The single-joint-angle microswitch marker is provided, but more complete range of motion information must be calculated when needed. A research bibliography will also be available in the booth.

Lumex, Incorporated **Booth 47**
Bay Shore, New York
Exhibited is this company's line of aids to daily living especially four new products: (1) The "Park Bench" Transfer Tub Seat. This is the first padded transfer tub seat allowing the patient to close the shower curtain completely and ending messy water drippage; (2) The "Park Bench" Adjustable Bath Seat. The adjustment of this seat is designed to meet the patient's individual seating requirements; (3) The Drop Arm Commode. This unit, which provides easy lateral transfer, comes in two models: Model #6437, with soft seat, is ideal for paraplegics and quadriplegics. Both arms drop independently by "quad release" which requires no finger dexterity or strength to operate. And Model #6435 which has a solid plastic seat and lid. Its arms are released by pull buttons; and (4) The Drop Arm Shower and Commode Chair with a unique four-way adjustable seat. Booklets about patient aids and the care of patients in the home will be available in this booth.

Moss Rehabilitation Hospital **Booth 48**
Rehabilitation Engineering Center
Philadelphia, Pennsylvania
The central theme of this Center's exhibit will be the equipment designed for clinical use to show the vector representing the force between the ground and any object touching the surface, either statically or dynamically. Clearly visible, the vector may be recorded on film, (still or motion), or video tape, for instant replay. The vector display system may easily be added to existing force plates.

Everest & Jennings, Incorporated **Booth 49**
Los Angeles, California
This wheelchair manufacturer will display several new items for both manual and power-drive wheelchair users.

VA Rehabilitative Engineering Research & Development Center **Booth 50**
Hines, Illinois
The exhibit focuses on two areas in which this Center has concentrated its efforts to improve the diagnosis and surgical management of disorders of the spine. The exhibit illustrates the clinical and experimental possibilities of studying the neural mechanisms underlying the somato-sensory evoked potential as an aid to diagnosis with data both from a group of normal subjects and from patients with lumbo-sacral radiculopathy. Surgical management of spinal disorders could be improved through greater understanding of the forces involved in operative manipulations. The exhibit also presents newly developed instrumentation to monitor these forces and a device for studying the biomechanics of spinal segments following fusion.

Trans-Aid Corporation **Booth 52**
Carson, California
This company shows its patient handling systems including the Lift Aid portable lifter, the Trans-Aid institutional lifter and the Medi-Chair combination wheelchair stretcher and lounge chair.

Helen Hayes Hospital **Booth 53**
Center for Biomedical Engineering
Rensselaer Polytechnic Institute
West Haverstraw, New York
Biomechanical factors in decubitus ulcer formation are being investigated by the Soft Tissue Mechanics Research Group at Helen Hayes Hospital and Rensselaer Polytechnic Institute in cooperation with the VA Medical Center at Castle Point, N.Y. Under RSA support, the objective is to develop fail-safe clinical systems to warn of incipient tissue damage. As shown in the exhibit, the approach involves computer modeling of tissue properties as well as interface pressure and shear. Animal studies are providing essential baseline data on stress-time relationships for tissue viability. Under VA Prosthetics Center support, a comprehensive testing program on wheelchair cushions has been developed and will be shown; new information on how to obtain and interpret clinical measurements of pressures between buttock and cushion will also be provided.

Children's Hospital at Stanford, Rehabilitation Engineering Center **Booth 55**
Palo Alto, California
This display will demonstrate special controls and interfaces developed at this Center and elsewhere. Exhibited also are various communication aids developed at this Center and in other rehabilitation engineering facilities, including a versatile portable speech prosthesis.

Case Western Reserve University **Booths 56-57**
Rehabilitation Engineering Center
Cleveland, Ohio
Recent advances made by this Center are exhibited. Included are systems which employ functional electrical stimulation to provide controlled upper-extremity function in quadriplegic patients and for gait modification in cerebral palsy children. Techniques and results for intraoperative measurement of muscle function during tendon transfer are presented. Methods which have been developed to enable the severely disabled to control external aids are also shown, and a powered wheelchair

controlled by shoulder movement is demonstrated. Research results from the VA Motion Study Laboratory are displayed. Some samples of clinical gait analysis are demonstrated.

Southwest Research Institute
Rehabilitation Engineering Center **Booth 58**
San Antonio, Texas

This Center has been conducting rehabilitation engineering research and service delivery for eight years. The Institute staff, cooperating counselors, and clients will be on hand to discuss past and current programs. The focus of the center is direct delivery of technical support to government and private industry to enable the competitive employment of severely disabled persons. The display includes photographs, audio-visual presentations, and devices.

Texas Rehabilitative Commission — Project IMPART **Booth 59**
Austin, Texas

This exhibit will show a rehabilitation engineering information service. Slides and brochures will display how the project is organized to solve problems of handicapped patients through technology transfer.

ROHO Research & Development, Inc. **Booth 60**
East St. Louis, Illinois

This exhibit will show the ROHO DRY FLOATATION SYSTEM, a pneumatically-operated cushion which uses the floatation properties inherent to fluids. As a result a high percentage of the suspension forces are hydrostatic. Therefore, most users can experience continuous sitting or lying on the ROHO DRY FLOATATION SYSTEM without producing pressure sores.

Zygo Industries, Inc. **Booth 62**
Portland, Oregon

This exhibit will display communication systems for the multiple handicapped including visual communication systems, operating controls, message displays, mounting fixtures, and mobility systems and published educational programs. Also shown will be a display printer, adapted wheelchair trays, and operating switch mounting fixtures.

University of Virginia, School of Medicine **Booths 63, 64**
Rehabilitation Engineering Center
Charlottesville, Virginia

This Center's exhibit will feature a wheelchair testing procedure which displays the instantaneous torque generated at the hand rim. Visitors will be able to transfer to the test wheelchair to record their performance. Also on display will be other projects such as the new motor wheel, a manipulator, a new wheelchair design, and some concepts in spinal engineering.

Northwestern University, Rehabilitation Engineering Center **Booths 65, 66**
Chicago, Illinois

This exhibit shows the efforts of this Center to refine internal joint replacement through investigations of biomechanics and biomaterials. Also shown, with the aid of a sound-slide presentation are technical aids being used by disabled people. Highlighted are a powered wheelchair, an environmental control system, a microcomputer system, an upper-limb powered prosthesis, and an upper-limb powered orthosis.

Student Design Exhibition Finalists

Arroya Sled For Paraplegics — **Booth 67**
Peter Axelson, Stanford, California

Curb Climbing Wheelchair — **Booth 68**
Roger N. White, Ruston, Louisiana

Play Scape: An Aid To Mainstreaming — **Booth 69**
Bruce Lund, Herb Velefque, Tim Wiener, Chicago, Illinois

The Door Opener — **Booth 70**
A. Lee Winick, Palo Alto, California

Two Channel Electrical Stimulator Providing Standing Of Paraplegic Patients — **Booth 71**
Sega Janez, Ljubljana, Yugoslavia

Eyemovement Communication And Control — **Booth 72**
Ira Michael Leafsky, Philadelphia, Pennsylvania

VA Rehabilitative Engineering Research and Development Center — **Booths 73-74**
Stanford University and VA Medical Center
Palo Alto, California
This Center's exhibit presents (1) Advanced technology and basic research projects such as the development of Robotic aids, microcomputer systems for the blind, and new instrumentation for nerve function diagnosis; (2) Intermediate design and development projects based on engineering graduate student participation such as the body barograph; and (3) Immediate technology design studies based on engineering undergraduate student participation such as the quadriplegic reacher.

University of California — **Booth 80**
Biomechanics Laboratory (Mobility Aids Project)
Berkeley, California
Two wheelchairs are displayed in this exhibit: (1) The PC2 wheelchair with (a) a seat height adjustable from 6" below to 6" above normal seat height, (b) fully reclining backrest, (c) an 8" curb climbing capacity, (d) an independent four-wheel spring suspension, and (e) a high-performance drive package; and (2) The spring suspension wheelchair with independent four-wheel spring suspension and a high performance drive package on a simple frame to which different seat and footrest combinations can be attached.

National Institute for Handicapped Research (NIHR) — **Booths 81-82**
Department of Health, Education and Welfare
Washington, D.C.
This exhibit will demonstrate the process employed in research, development, evaluation, and service delivery to apply technology in providing solutions of the problems in rehabilitation of the disabled.

Maryland Computer Services, Inc. — **Booth 83**
Bel Air, Maryland
This company will display its line of employment aids and the braille translation system based on a lightweight microcomputer equipped with synthesized voice output. Products will include the talking information management system, the automatic

form writer, the talking word processor, the talking computer terminal, and the braille translator.

John Hopkins University Applied Physics Laboratory **Booths 85, 86**
Laurel, Maryland
A new chin-operated wheelchair control for the high spinal cord injured person is described in this exhibit. This device is small and compatible with the use of a mouthstick. Possible vocational worktable layouts and components are shown in one-half of the exhibit. The other portion of the exhibit describes the powered robotic arm/worktable system for the high spinal cord injured person. This device provides manipulation capability, is microcomputer controlled, and may be operated without attendant assistance for interfacing.

Die-A-Matic, Incorporated **Booths 87-88**
York, Pennsylvania
This exhibit shows an innovative system providing foot-control for armless drivers. This device is especially designed for use in compact cars. Also shown are a cable brake control, driver education classroom equipment, and other kinds of controls for the physically disabled.

New York University Medical Center **Booth 89**
Rehabilitation Engineering Center
New York, New York
This exhibit presents the progress of this Center's clinical and engineering evaluation of control techniques including pneumatic, speech recognition (voice) and wireless systems. Displayed are excerpts of functional and engineering specifications which have been developed for such devices. New ideas will be presented for use of environmental controls with emphasis on safety, expanded utility and methods of installation in the residence and office of the disabled consumer. Preliminary results of a retrospective study showing the impact that electronic assistive devices have on the quality of life of high level spinal cord injured will also be presented.

Rancho Los Amigos Hospital **Booth 90**
Rehabilitation Engineering Center
Downey, California
Three areas of major activity are shown by this Center: (1) Functional Electrical Stimulation for Treatment of Idiopathic Scoliosis. Application of cyclic electrical stimulation by means of surface electrodes applied to the side of the chest of scoliosis patients at night has demonstrated effective management of their scoliosis; (2) Spinal Cord Monitoring. Spinal evoked potentials in response to peripheral nerve surgery, thereby providing contact information concerning the function of the spinal cord. Such information promises to increase the safety of spine surgery where the spinal cord may possibly be threatened; and (3) Project Threshold. A new Rehabilitation Engineering delivery service is now applying technology to persons with disabilities who are clients of the California State Department of Rehabilitation. The process of the client-team interaction will be shown as well as certain of the technical innovations.

FREE-TAKE-ONE **Booth 91**
Pamphlets, brochures, cards, leaflets, etc. are prominently displayed and available at this exhibit booth for Conference attendees.

ARTS Associates, Incorporated **Booth 93**
Boston, Massachusetts
This exhibit presents (1) The LPVT (Large Print Video Terminal) for use by both the visually impaired and those with normal sight. Three keyboard-selectable character

sizes up to 1½ inches high and eight interchangeable foreground and background colors allow each user to select the options most suited to his or her own vision and (2) The ORATOR, a stand-alone talking terminal (to be released in September 1979). Full word pronunciation and spelled speech are available. Users have a 98.7% comprehension level on first hearing.

VA Medical Center **Booth 94**
Tuscon, Arizona
This Center's exhibit will present the Zoroc Intermediate Prosthesis. The Zoroc appliances consist of knee-disarticulation, below-knee, and above-elbow prostheses. Demonstrated are the utilization of immediate postoperative prosthetic techniques and their association with rapid postamputation rehabilitation. The introduction of the Zoroc resin-coated plaster complements the Immediate Postoperative Program, allowing the patient to be measured for a plastic temporary prosthesis with continued ambulation during its fabrication. This procedure also allows evaluation of the clinically marginal ambulatory patient without large prosthetic costs saving rehabilitation time and resulting in shorter hospitalization and decreased medical costs.

Tufts New England Medical Center **Booth 95**
Rehabilitation Engineering Center
Boston, Massachusetts
This exhibit presents the RSA-funded research in the core area of non-vocal communication and related topics. In addition, information is provided on this Center's direct client services within medical, vocational, and educational settings in New England.

University of Iowa **Booth 96**
Rehabilitation Engineering Center
Iowa City, Iowa
This Center was established in October, 1977 to develop and utilize various engineering technologies to improve the identification, evaluation, and rehabilitation of chronic low back pain. The initial emphasis is on certain common types of "mechanical" low back pain. Outlined in the exhibit are the many projects being carried out to meet these goals and some of the methods to be used in the investigations such as bracing, biofeedback, transcutaneous nerve stimulation, Moire topography, etc.

Liberty Mutual Insurance Company **Booth 98**
Hopkinton, Massachusetts
This is a display of an operating Boston Elbow. This prosthesis is currently in use on forty above-elbow and shoulder-disarticulation patients. It is powered by nickle-cadmium batteries which can be recharged by a High Speed Battery Charger which will also be shown. The elbow is controlled by sensitive electrodes placed over the biceps and triceps muscles or some other antagonist pair in the case of a high level amputee. A short film will be available describing the Company's research on the acquisition of control information from severed nerves. Information will also be available on how prosthetists can receive training on fitting the Boston Elbow system. Several centers are now doing fittings and more will be added soon.

Braun Corporation **Vehicle Area**
Winamac, Indiana
This company shows its complete wheelchair/van conversions in this exhibit. The Tri-Wheeler electric wheelchair will also be on display.

Mobility Engineering & Development, Inc. **Vehicle Area**
Van Nuys, California

The Mobility Engineering and Development, Inc. wheelchairs which can accommodate the special needs for van use are high performance devices combining several features previously unavailable in a single product: (1) Powered height adjustment, (2) Variable wheelbase, (3) Secure hold-down structure for use in vehicles, (4) Independent four-wheel torsion spring antisway suspension, (5) Full power recline of seat back. Two models will be exhibited: one with positive power steering and the other with the traditional differential steering (casters for front wheels). A van modified so as to be driven by severely handicapped persons will also be exhibited. This vehicle has a combined single lever control system. All electrical controls are brought to a single panel. Back up systems are provided for all primary control systems.

ABSTRACTS OF SUBMITTED PAPERS

HOME AND PUBLIC BUILDINGS

A PLAY ENVIRONMENT PROJECT FOR CHILDREN WITH DISABILITIES — Levy, R.

A project to study play environments and equipment for children with disabilities has recently been initiated to effect a comprehensive understanding of the requirements of children with disabilities and the relation of their developmental process to play. At the same time at the Mackay Center a play environment is being designed for the special requirements of persons with multiple disabilities.

Some basic aspects of this project include (1) the development of a theoretical base about the relationships among play, therapy, education, and environment; (2) the estimate that the physical environment plays a significant role in the development of a child and that there is a distinct relationship between social involvement and personality development; (3) the hypothesis that the physical environment and active manipulation of it help to improve interaction among children with disabilities (and the personnel of the institution); and (4) the observation that children with disabilities are generally overprotected by well intentioned adults and that this restricts the child from living or experiencing an environment.

It is important that the child be able to explore the environment without submitting to a structured program. In this way, the complexity of the problem of the child at play will be realized and some new concepts which relate to "creativity" and "adventure" playgrounds will be developed.

A play environment project now being developed in Montreal is described. Planned is a play environment for 250 children with disabilities within a school or rehabilitation setting. The environment and the kinds of play equipment to be constructed at the Mackay Center are presented. Design processes used and the various constraints which have been identified are discussed. Some of these constraints are the long, severe winters in Canada, the existing structures within which the play environment must be sited, and the wide variety of needs in a population containing children variously disabled and with variable ages from 4 to 18 years.

EVALUATION OF KITCHEN DESIGN FOR HANDICAP-ACCESSIBLE APARTMENTS — Falta, Patricia

Accessible housing and integrated support services for severely (physically) disabled persons based on the Swedish FOKUS designs for "integrated living" have been introduced in Montreal to determine their feasibility and desirability for introduction throughout Canada.

One of the key elements of FOKUS apartments is a special kitchen. A prototype of this kitchen was imported into Canada for use by persons with disabilities who live in the "integrated" apartment units. Evaluation involved assessing meal preparation by persons with severe disabilities. Energy and time conservation, safety and ease of use, accessibility to equipment and storage, validity of height and mobility features are some criteria. Parts difficult or hazardous to use were identified.

The FOKUS kitchen, based on human-factors, did not meet the varied needs presented by our population. The socioecomics aspects of this kitchen also failed to meet Canadian norms.

We decided to use standard kitchen cabinets and equipment in the "integrated" apartments concentrating on simple design modifications to accommodate persons with handicaps. Barrier elimination, deliberate layout and selection of equipment to achieve accessibility, some added equipment, relocation of switches and outlets, and custom alterations as needed were employed.

Kitchens so modified are adequate for persons with physical disabilities, including quadriplegics, the target group of the demonstration project. Minimal architectural or manufacturing changes are involved at low cost. Special design knowledge is not mandatory. The kitchens also represent prevailing designs and are useful not only for the debilitated elderly but the population at large.

The project has shown that the disabled can adapt to and are often best accommodated by standard living environments if these are accessible in physical, psychological, social and economic terms. It is often possible, and in many situations, preferable to rely on simple modifications and adaptation to existing equipment than to invent special gadgets.

MOBILE HOMES: ALTERNATIVE HOUSING FOR PERSONS WITH HANDICAPS — Decker, Rodger

Mobile homes can be adapted to serve the physically handicapped and/or elderly safely and economically without inconveniencing able-bodied persons who in fact find the adaptations to be an advantage enhancing the independence of all and generally improving their psychological state.

It is estimated that in the United States as many as 15 million persons have handicaps which require special housing considerations. Lack of such housing has caused many of the disabled and/or elderly to compromise their futures and restrict their vocational choices. In many instances, an institutional residence has been elected prematurely. The adapted mobile home is an economical alternative.

PROTOTYPES OF AN ELEVATOR VOICE MODULE — Obester, Paul A.

Elimination of architectural barriers to the disabled includes making public buildings accessible to persons who are visually impaired. Independent operation of elevators needs to be considered. Elevators equipped with Braille and raised numeral controls are now being used but accessibility is not complete since feedback on floor position and car directory is not available to the passenger who cannot see.

RSA recognized this problem when it offered the concept of audible announcements of car position (floor number) and direction (up or down) within the elevator. This would not only benefit the visually impaired but wheelchair occupants who often are not able to turn around to see position indicators.

In early 1978 the Rehabilitation Engineering Center at the Smith-Kettlewell Institute for Visual Sciences contracted with Telesensory Systems, Inc. to develop a speech-output announcement system for elevators. In September 1978 the world's first all solid-state computer speech synthesizer was installed in one elevator of the Hubert H. Humphrey Building of the Department of Health, Education, and Welfare in Washington, D.C.

Earlier verbal elevator announcements utilized magnetic tape cassettes or cartridges. The TSI unit (called an Elevator Voice Module, or EVM) however has no moving parts and requires no maintenance. It uses a microprocessor running a computer program analyzing the input signals from the elevator control to determine the timing and content of messages. The same microprocessor then retrieves digital data from words stored in read-only memory, converts the information to analog form, and outputs the speech to a speaker mounted in the roof of the elevator car.

In May 1979 four additional EVM units were installed in the Hubert H. Humphrey building. Additional evaluation including trials of different vocabulary and voice combinations are planned.

AN OPERATIONAL TRIAL OF THE ELECTRONIC INFORMATION EXCHANGE SYSTEM FOR THE REHABILITATION ENGINEERING COMMUNITY — McCarroll, Jane H.

Needed among individuals and organizations involved in the application of technology for persons who are disabled are better accessibility to information and more efficient means of communication. To develop a system to meet these needs Innovative Systems Research, Inc. (ISR) received a grant from the National Science Foundation in the fall of 1977 to assess an Electronic Information Exchange System (EIES) with the assistance of a multidisciplinary community involved in research and development (R&D) of devices for the disabled. A trial network was established in January 1978 to expose members of this community to EIES while exploring its usefulness. The network included fifty organizations and individuals representing a spectrum of interests from basic and applied R&D to marketing, production, distribution and utilization.

The initial information exchange activities were of four types: (1) a community newsletter; (2) a community notebook for dissemination of general information; (3) community conferences; and (4) projects of special interest. Nevertheless, individual members initiated other kinds of activities.

The study showed that participants have a pressing need for better access to scientific and technical information. ISR now plans to obtain permission from network members to collect and analyze messages. Plans for the future include the selection of a dedicated user community, linkage to data base resources, and the provision of on-line librarian-type services to facilitate comprehensive system use. Greater participation by persons with handicaps will also be encouraged.

COMMUNICATION UNIT FOR INDIVIDUAL HOUSING OF THE SEVERELY DISABLED — Hoyer, Elmer A.

Housing for the severely disabled should provide normal degrees of privacy, but special problems arise in the communications associated with the basic needs of these people who have some aspects of daily life in which they must rely on aid from attendants, people external to the house.

A unit providing communications on basic living needs is described. It is composed of two parts: the living unit transmitter/receiver and the attendant message-center receiver/recorder.

The living unit transmitter/receiver allows the housing occupant to start a numeric scanner, stop the scanner on a desired number and then transmit this selected number, along with the unit number of the device, to the message center. The living unit receiver continuously monitors the data line. Whenever the message on the data line is from its own transmitter, the number transmitted is displayed for sender verification.

The message center receiver/recorder receives messages from any of 32 transmission units and records the unit number sending the message, the time when the message was sent, and the number sent, translated into the corresponding message. The message center has the messages stored to be called out by the numbers 0 to 7 sent by the transmitter unit. All messages are printed on a modified DATEL 40-character printer for permanent record. As many as 64 messages can be received while waiting for a message to be printed.

This system will identify messages to which no response has been made. For example, one of the eight messages is "Attendant Response". When the attendant responds to this request, he or she is required to send this message from the requesting unit in order to clear the original request.

The system will be operational in the "Timbers" housing program in Wichita, Kansas in the Spring of 1979. Costs will then be known and can be reported.

COMMUNICATION DEVICES FOR NON-VOCAL PERSONS

HANDIVOICE: AN ELECTRONIC COMMUNICATION SYSTEM FOR NON-VOCAL PERSONS — Cohen, Carol G.

The Handivoice HC 120 is designed for people who are non-vocal. It contains a precision electronic speech synthesizer which simulates the human voice. It speaks, saves, recalls and repeats any message created from the 991 words, sounds and phrases in its memory. The Handivoice HC 110, which is used mainly with children, is similar to the Handivoice HC 120 except that its stored vocabulary contains 472 words.

Three non-oral adults were involved in an evaluation to measure their potential in use of the Handivoice HC 120. All three of the adults demonstrated enough enthusiasm to learn the codes, functions, and options. The Handivoice HC 120 was selected as their communications aid. These adults as a group presented a spectrum of communications skills and varied profiles of physical characteristics and accessing styles.

Presented also is the case of a woman whose primary diagnosis was athetoid cerebral palsy. She uses the three-digit code for each vocabulary item with the assistance of a specially constructed keyboard guard.

A man who is a severely spastic quadriplegic uses a mouthstick to activate the Handivoice HC 120. About half of his vocal offerings are intelligible to others; his Handivoice HC 120 functions as a supplementary system.

Another man accesses the instrument through the "scrolling" interface. Due to severe spastic movements and impaired control of the upper extremities, he activates the equipment by scanning the digits 0 through 9 and using one gross fist movement on the touch-sensitive pad to enter each numeral mode and option.

Two boys with cerebral palsy were successfully employing Blissymbol boards; however, it was believed that both of these first-grade youngsters were capable of developing an increased competence and proficiency with more sophisticated equipment. They were assessed and the Handivoice HC 110 system was recommended for trial. With it, they learned the four-level vocabulary selections, modes, and options without difficulty. Units were obtained for each and school personnel were made aware of the device's technology, functions, and potential; regular onsite visits continued for advanced training and followup. After 12-months, due to their effectiveness with the Handivoice HC 110 both boys were mainstreamed into the regular classroom.

THE AUTOCOM: AN ELECTRONIC COMMUNICATION SYSTEM FOR PERSONS WHO ARE SEVERELY IMPAIRED VOCALLY — Boehm, Bruce J.

The Autocom provides a capability which for a reasonable investment can mainstream the non-vocal population. It is a portable, rugged, flexible communication device fitting the environment and lifestyle of the user. The Autocom input can be customized to the user and its output made as universal as possible. Responsibility for communication is that of the user, not others, for the user can readily respond to questions, write letters, or control his wheelchair, as examples. The Autocom placed on the wheelchair is always available for practice.

The system described is basically that designed by the Trace Center at the University of Wisconsin but incorporates a 28-column Blissymbol thermal printer, a conversation message viewer, two independent programmable serial I/O lines, and significant uncommitted room for additional Printed Circuit Boards (PCB's). It can be programmed for direct selection, scanning, or encoding inputs. Perhaps the most important change from the original is the vocabulary, now user programmable (up to about 4000 words), reprogrammable at any time, and memory is nonvolatile. Devices can be quickly and securely mounted and dismounted.

Input to the aid can be either through a 128 on-board reed switch matrix or by an off-board device providing serial or parallel data streams. Information is easily edited on the 32-character alphanumeric display and either stored within the aid, printed out, or sent again on the serial or parallel lines. User programmable dwell time for switch activation is provided.

The basic element of the aid is the 1802CMOS 8-bit processor. Memory is organized as factory installable 2K or 4K bytes of nonvolatile **R**andom **A**ccess **M**emory (RAM), 4K bytes of program memory, and up to 24K bytes of **E**rasable **P**rogrammable **R**ead **O**nly **M**emory (EPROM), installable by a nontechnical person in 4K byte chunks. Thus, the aid has the ability to program **P**rogrammable **R**ead **O**nly **M**emory (PROM). NiCad batteries within the aid provide power for a minimum of 8 hours before recharging is necessary to accommodate school or employment situations. There are several levels of power-down to reduce power consumption when the aid is either being used intermittently or not at all. Finally, the aid has been designed to be a commercially viable product and as such, incorporates the latest concepts of trouble-shooting, modularity and self-diagnostics, and it is easily manufactured.

UTILIZATION OF NON-ORAL COMMUNICATION DEVICES FOR CHILDREN WHO ARE SEVERELY HANDICAPPED PHYSICALLY — Montgomery, Judy

This unique (federally-funded) project was organized to provide physically handicapped, non-speaking children with communication devices. The Non-Oral Communication Center has five staff members with various education and therapy backgrounds to provide services for these children. Included are a speech/language pathologist, occupational therapist, rehabilitation engineer and instructional aide.

The program combines assessment and training in the use of mechanical, electronic and computerized communication systems. Children aged 5 through 15 years are encouraged to accomplish their academic work, social interaction and daily communications by use of the latest or modified equipment.

Current emphasis in the program is on developing games and similar entertainment as well as in psychological and perceptual testing. The objectives, progress and general form of the project are discussed.

DEVELOPMENT AND EVALUATION OF A MODULAR CLASSROOM COMMUNICATION SYSTEM FOR CHILDREN WHO ARE VERBALLY IMPAIRED AND PHYSICALLY HANDICAPPED- Nelson, P.J.; Roy, O.Z.; Charbonneau, J.R.; McNaughton, S.; Park,G.

A classroom communication system is being developed to accept a variety of inputs and offer a number of different outputs. Alternative "displays" include matrix boards, synthetic speech, TV Blissymbols, and typewritten alphanumerics. The modular approach permits customizing to different handicaps while recognizing cost restraints.

The newest module in this system is a microprocessor graphics generator which displays Blissymbols on a conventional television set (under development by Norpak Ltd., Pakenham, Ontario). A person who is handicapped can make selections from "pages" of Blissymbols shown on one part of the screen. With the modular approach, the TV display can be used as a completely self-contained communication aid or as a "blackboard" for Blissymbol messages developed from other modules in the system. A second module is a matrix board, also using a microprocessor to be used by itself or to be interconnected with other boards in a classroom situation. Transmission of messages between matrix boards is possible. With the boards connected to a microcomputer, synthetic speech can be provided to reinforce each selection or the whole message. Changing an overlay sheet on the matrix board calls out a second program from the microcomputer permitting selection of phonetic sounds, the alphabet, and numbers and mathematics symbols. This kind of program is intended for school work, whereas the Blissymbol program is used for general communication.

Putting together phonetic sounds helps non-verbal children learn to read. Answers

to assignments can be written out by means of a teletypewriter and the alphabet on the matrix.

Plans are now underway to build three or four of these Classroom Communication Systems for loan to selected rehabilitation centers or schools for an extended clinical evaluation. The evaluation will seek the relative cost-effectiveness of Blissymbol graphics and synthetic speech for communication and education, the functional benefits of various modules used alone or in combination with others, and the appropriateness of the Blissymbol vocabulary used. Because of the high cost of commercial speech synthesizers (with reasonable voice quality), alternative techniques for generating speech are still being sought, especially for a French language system. One alternative, digitized speech, will be incorporated into some of the classroom systems for comparison with a commercial speech synthesizer presently being used.

INVESTIGATIONS INTO DIRECT LINE OF SIGHT AS A MEANS OF NON-VOCAL COMMUNICATION — Foulds, Richard A.; Fincke, Randall W.

Communication using recently developed non-vocal communication aids cannot produce the rate enjoyed by most speaking individuals. As a result, the individual who is non-vocal remains limited in his ability to compete for conversation time or to produce sufficient output to be vocationally viable. Work is being done at Tufts-New England Medical Center and other institutions in the use of eye gaze as a means of control. Movement recording techniques are introduced and compared for practical value. The potential application of eye movement in both encoded and direct selection techniques are discussed. The hardware being developed at Tufts-New England Medical Center uses corneal reflection to monitor head position and orientation. The software needed to process this information into line of sight is discussed. The directions in which the research will proceed in phonemic and syllabic language and the studies of rate of output are presented.

ELECTROMAGNETIC HEAD TRACKING, A NEW COMMUNICATION DEVICE FOR PERSONS WHO ARE SEVERELY HANDICAPPED — Krieg, James C.

Current direct selection communication techniques for the person who is non-vocal and physically handicapped (NVPH) with controllable head mobility have complicated, bulky, and difficult user/device interfaces such as mouthsticks, head sticks, and large recessed keyboards. SPASYN "SPAce SYNchro" is an electromagnetic system that accurately and quickly measures head position and orientation. A person who is NVPH can assemble words, sentences, and functions by pointing his or her head at the desired symbol drawn on a target board similar to a picture of a typewriter keyboard. Resulting data can be displayed, printed, and/or interfaced with other electrical communication devices.

SPASYN technology uses low frequency quasistatic magnetic fields to measure position and orientation of one object in relation to another. The electromagnetic head tracking technology was developed for the U.S. Air Force Polhemus Navigation Sciences, Inc., to provide a Helmet Mounted Sight to measure a pilot's line-of-sight. The system achieves repeatable accuracies of $\pm\frac{1}{2}°$, with about 60 measurements per second possible. The pilot has unrestricted head motion within 10 cubic feet and the weight of the sensor mounted on his helmet is about 15 grams (0.6 oz.).

SPA-SYN-COM (SPAce SYNchro COMmunication) is a simplified, easy-to-use version of the military SPASYN system. A person (child or adult) who is NVPH merely looks at a desired alphanumeric character or symbol on a chart or target board to select it. Rapid and flexible communication depending on the user's capability may be achieved with minimum input.

To use a SPA-SYN-COM, the person wears a two-strap, soft elastic (band type) head harness attached to a pair of eyeglasses. A 15-gram sensor is attached to the top strap of the harness and a passive, film sighting device is placed on one lens of the

glasses. Additional hardware includes a microprocessor, a controlled magnetic dipole source, a target board patterned after a typewriter keyboard, an LED alphanumeric display, and a low cost printer. Once activated by a switch selected for the user, the system is calibrated quickly by sighting five calibration points on the target board. The user can then begin assembling messages by looking through his/her sighting device at the desired symbol he wishes to see on the display and/or printer. For adequate use the person should have controllable head motion over a range of about ±30° in azimuth and elevation, and he should be able to point his head to any 5° segment in this field to dwell there for a preset and selectable time (1 to 5 seconds nominal).

Because of its versatility and ease of operation for both the person who is NVPH and those who care for him, SPA-SYN-COM has the potential to meet a wide range of individual needs and offers an integrated solution to one of the basic problems of a large number of individuals with disabilities. The thrust of the present design program is aimed at building a simple, low cost system to be interfaced with any number of peripheral communication devices.

EVALUATION OF SOME ELECTRONIC GAMES FOR CHILDREN AND ADULTS WITH PHYSICAL HANDICAPS - Arenson, J.W.; Roy, O.Z.; Nelson, Peter J.; Cote-Baldwin.C.

The recreational needs of persons with severe handicaps have often been overlooked; with this in mind the Medical Engineering Section of the National Research Council of Canada has built two prototype electronic games, "Checktronics" and "Steeplechase." Board games such as these were selected since they emphasize intellectual activity and require a minimum of physical skill. It was hoped that the games would provide opportunities for social interaction that were often lacking.

The design philosophy followed uses a single switch closure for each player permitting a wide range of interfaces to be used, but primarily the same interface the individual employs to operate his or her communication aid, environmental controller, or powered wheelchair. Both prototype games were battery-powered and made portable. The Checktronics is small enough to be used on a wheelchair tray. The Steeplechase, being cognitively simpler, is more suitable for young children. Hence, it was evaluated in several centers for children with handicaps. As an incidental benefit of playing the game, the children learned counting concepts.

Checktronics was evaluated in two residential institutions for young adults with handicaps. The most frequent criticism of both prototypes was that the LED's used on the display boards were not bright enough; this problem will be overcome in newer designs.

In general, the evaluation demonstrated the importance of recreational aids for persons who are handicapped, mainly as a means of providing opportunities for social interaction and improving self-esteem through the accomplishment of independent activities.

VOCATIONAL SYSTEMS

VOCATIONAL REHABILITATION VIA RESEARCH UTILIZATION — Whitcraft, Carol; Laenger, Sr., Charles J.

Federal agencies clearly recognize the need for research utilization or technology transfer and the Rehabilitation Services Administration has funded a dynamic program for delivering — and teaching counselors and consumers how to acquire — knowledge of new devices, systems, and methods. R.S.A. provides the funding for this program while other federal agencies, particularly the Veterans Administration, readily provide information, consultation, and certain equipment for demonstration purposes.

The title of the program is "Rehabilitation Engineering Support for Technology Assessment and Transfer to the Rehabilitation Community," but the acronym IMPART which means "Innovative Matching of Problems to Available Rehabilitation Technology" is used. The IMPART program is a regional research utilization or technology transfer program. The Texas Rehabilitation Commission is the grantee and Southwest Research Institute is subcontractor.

Vocational rehabilitation engineering is provided by (1) clearly defining the problem in engineering language (This inherently involves rehabilitation engineering consultation); (2) searching for solutions with existing methods and devices; and (3) delivery of information which suggests solutions and ways to acquire or implement these solutions. Success of this program is based heavily on close working relationships between rehabilitation engineers and counselors. Such relationships not only make the IMPART program function effectively but teach field personnel how to access and utilize technology for themselves. They also learn to make judgments about the need for professional rehabilitation engineering services. A Texas Rehabilitation Commission vocational rehabilitation counselor will provide some viewpoints on IMPART problems.

A CONSOLIDATED WORKSTATION FOR MOUTHSTICK USERS — Fulford, Raymond

Individuals who function with a mouthstick are essentially restricted to manipulating materials in one plane with perhaps limited ability to use ramps or slides for higher or lower surfaces. Considering this restriction, increased (accessible) surface area may be achieved by providing unlimited tabletop storage space to be used after wheelchair movement to that location. Or the user may be positioned in one spot and the surfaces from which material is to be retrieved can be brought to his mouthstick-accessible space.

A workstation for mouthstick users has been developed, primarily as a result of two considerations: **(1)** unlimited office space in which to assemble a large tabletop space is usually not available; **(2)** a precise repositioning of a wheelchair by a mouthstick user is often a time-consuming task.

Two special workstations (desks) are now being evaluated by individuals with high level spinal-cord injuries. The desk design uses a manually operated central turntable with an electrically powered file system of letter-size file trays presenting a total of fourteen trays for material storage. Each file system resembles a large wheel and rotation in either direction is possible by depressing a contact switch. The tray in the uppermost position just clears the desk surface for either material retrieval or storage. The desk is similar in size to a large commercial office desk; the height can be adjusted by using supporting legs of suitable lengths.

Currently, four additional desks are being completed at the Woodrow Wilson Rehabilitation Center. Information is offered about the most frequent activities with these desks and the functional requirements of users to maximize use of storage capacities.

DEVELOPMENT OF A COMPUTERIZED WORKSTATION — Hodgetts, M.J.

A new direct access workstation using a microcomputer permits a severely disabled person to operate a computer accounting system. The first attempt, involving speech recognition by the computer, proved to be too slow and unreliable for those with speech impairment. In the current approach, which is faster and more accurate, a television monitor is used as a "keyboard" for lighting a spot on the screen that is viewed by a sensor mounted on a pair of eyeglasses. Keeping the head immobile for a preselected time period stops the spot on the desired key, this has the same effect as pressing a key on a conventional keyboard. In this way, the user has complete access to a computer system at a speed significantly faster than current scanning techniques.

TYPEWRITER MODIFICATIONS FOR PERSONS WHO ARE HIGH-LEVEL QUADRIPLEGICS — O'Reagan, J.R.; Reger, S.; Cummings, C.

Quadriplegics often use a mouthstick to actuate the keys of an electric typewriter for printed communication, but the common electric typewriter is not completely suited to their needs and modifications are required for complete control.

Experiences at Woodrow Wilson Rehabilitation Center have shown that when the typist succeeds in loading paper into the typewriter, he encounters problems with correcting mistakes and for review of typed copy. For complete control, a mouthstick user needs one-button correction, electric forward and reverse indexing, and easy character viewing.

A simple, inexpensive adaptation to provide reversing for an electric typewriter was designed and fabricated. The prototype used a solenoid connected to the platen and controlled by an electric switch mounted on the typewriter face. A revised model uses a gear motor connected to an IBM self-correcting, Selectric typewriter. It is operated by two contact switches mounted on the cover of the typewriter. The motor is modified to allow the shaft to rotate freely when the motor is not energized. This permitted forward indexing by either the electric indexing button or by the manual indexing knob on the opposite end of the platen.

Only a few other minor modifications were needed for electric forward and reverse indexing. The redesign did not interfere with any of the existing functions of the typewriter and proved effective and inexpensive. The cost of materials was approximately $80, and construction required minimum fabricating ability.

After the mouthstick user had access to forward and reverse movement of the platen and had correcting ability, he noted difficulty in seeing the characters being typed. A person who is a high-level quadriplegic does not have the upper trunk stability and is therefore unable to lean forward to observe the characters. A simple remedy was to elevate the back of the typewriter, angling the front of it toward the viewer in the wheelchair.

Design limitations of existing typewriters suggested that the modifications may be least extensive when applied to the Royal 5000C, self-correcting electric typewriter. The Rehabilitation Engineering Department at Woodrow Wilson Rehabilitation Center worked with a local distributor to produce a design incorporating these features. As a result, a typewriter that gives full access to an individual who types with a mouthstick is now available. The final product is a compact, functional, and aesthetically pleasing unit. The only visible modification is the forward and reverse indexing button.

The benefits of this typewriter are many for those who must type with a mouthstick. There are a few elaborate and expensive typewriting systems providing these features, but the typewriter with the modifications described is available for less than $750, a much lower cost.

COMPUTER PROGRAMMER AID FOR PERSONS WHO ARE QUADRIPLEGIC: A MICROPROCESSOR-BASED PAPER HANDLER — Aylor, J.H.; Ramey, R.L.; Bandjunis, D.A.; Kirkman, W.W.

Business computer programming is one of the professions taught to quadriplegics at the Woodrow Wilson Rehabilitation Center, Fishersville, Virginia. One of the more difficult problems in this type of training is the handling of the many pages of computer output which the trainee must read and debug. In the past, the only way these persons could accomplish this task was to have someone either turn the pages for them or post the pages around the room so that they could be read.

A device was constructed based on the transport head of a standard lineprinter which could feed the paper in either a forward or a reverse direction when the operator depressed the appropriate switch with his mouthstick. The system has proved quite popular. Several additional features were requested which are best im-

plemented by the inclusion of a microcomputer. These features are:

1. Access to user selected pages. When debugging a program, there are usually certain critical sections which must be consulted on numerous occasions. By storing these page locations the first time they are encountered, the user may request the computer, by means of a simple keyboard, to return to the desired page.
2. Rapid travel from the present location to the desired page. Travel between locations is under computer control permitting very short transport time.
3. Page-by-page advance or manual operation. Information is entered into the microcomputer by means of a simple keyboard using either one or at most, two key strokes. The paper position is detected by means of an optical sensor using the sprocket holes in the computer paper. The drive motor is under computer control to provide programmed acceleration, deceleration and variable speed operation. A two-digit readout displays the current page number. By use of the microprocessor the man-machine interface can be tailored to the particular user.

READING SYSTEMS FOR THE BLIND

VERSABRAILLE™ SYSTEM AND EXPANDED APPLICATIONS — Proscia, Vito A.

Telesensory Systems, Inc. has pursued the application of efficient, silent, electronic braille displays which can be integrated into various systems using keyboards, tape cassettes, solid-state memories and microcomputers. With this concept in mind, the present day VersaBraille system has been developed.

The operation of this device is analogous to using a standard braille book. For example, information is prepared and retrieved by chapter, page, paragraph or word. A table of contents is stored in memory so that the user can review or refer to data files which are of interest to him. In addition, when the VersaBraille system is used as a writing device, the user has full control over editing, i.e., inserting, replacing, correcting and deleting. All of these operations are performed by a single stroke of a few keys.

The entire VersaBraille system is controlled by a microcomputer through keyboard commands by the user. Data can be displayed rapidly, efficiently and accurately on a 20-character braille display.

In addition to using braille for reading and writing purposes, the system can record standard audio information or indexed audio information. Thus it provides the user with multifunctional capability in storing and retrieving data.

Other advantages of the VersaBraille system include (1) portable/battery operation, (2) less bulk than braille, (3) adaptability to any standard Phillips cassette tape for audio playback and record, (4) rapid access and search of materials, (5) quiet operation, (6) more compactness for storage, (7) less expensive than producing braille on paper or mailing braille, and (8) the availability of a greater variety of braille materials.

Another important feature of the VersaBraille system is the added flexibility provided by the Input/Output (I/O) connector. The I/O connector can be used to attach the VersaBraille system to a family of accessories including typewriters, computers, braille embossers, visual displays and data copy management systems (e.g., tape duplicators, floppy disk systems). This accessory-capability will provide the user with the options previously unattainable and thus the tools to allow persons who are blind to become more productive.

To encourage wide acceptance of paperless braille principles, TSI established that VersaBraille cassette tapes be duplicable on commercially available equipment. This would ensure a large variety and broad dissemination of braille reading materials and would engage the interests of braille publishing houses and the Library of Congress. However, of equal importance and a real need of students, teachers, agencies,

transcribers, employers and other special interest groups is the development of a tape duplication device for single and limited copies.

EMPLOYMENT APPLICATIONS OF COMPUTER RELATED SENSORY AIDS FOR PERSONS WHO ARE BLIND AND PARTIALLY SIGHTED — Phillips, Susan H.; Russell, Yvonne S.

Sensory aids and adaptive devices are now being used by persons in the telecommunications field who are blind and partially sighted. Sensory Aids Foundation provides the visually impaired population of California an opportunity to combine employment skills with the latest technology to obtain jobs formerly closed to them. Over 110 people who have been placed by Sensory Aids Foundation in such positions since September 1975 continue to work competitively. These placements represent many employment situations in professional; technical; service; and clerical categories, including switchboard and telephone operations; a police dispatcher; an airline reservationist; and an information specialist. Computers will become increasingly evident in job sites, and persons who are blind now have the ability to perform these jobs competitively through the use of sensory aids such as the Optacon, closed circuit television, braille terminals, paperless braille systems, and microprocessor-based information systems such as TIM-II.

SPEECH OUTPUT READING MACHINES FOR BLIND USERS IN VOCATIONAL AND EDUCATIONAL SETTINGS — Groner, Gabriel R.; Savoie, Rob

A major vocational and educational limitation of blindness is the lack of access to printed information. Direct-translation reading aids help to alleviate this problem by providing flexible, independent access to printed matter. Despite the usefulness of these devices, reading rates are too slow for many important applications because the blind user must perceive and interpret a complex, dynamic code presented tactually or audibly. Significantly higher reading rates, easier learning, and a larger potential user population would result if the reading machine could re-code the information into a form more easily understood.

An ideal reading machine would read aloud to the user with full word spoken speech. Spoken word output offers significant performance advantages in a reading machine for the blind. It can be understood at output rates exceeding 200 words a minute, and it can be understood by almost everyone. These advantages would not only significantly enhance the capabilities of present users of reading machines but would also expand the number of people potentially helped.

The specific requirements for a reading machine depend on how and where it is to be used. Low cost, portability and minimal training are desirable. However, cost is more critical in a vocational setting where an individual requires his own device than in an educational setting where a machine is shared by many students. Portability is less of a concern when a machine is normally based in one location than when it must be used in several. Training must be quick and easy in settings such as libraries where a reading machine is casually used by a large number of people, but it can be more extensive if a person uses the machine regularly.

The requirement for flexibility also depends on the application. A machine used for reading text books and novels can be designed to read page after page from top to bottom. However, a machine for vocational and research applications or for reading magazines and irregular forms should allow browsing, moving from place to place on a page, and skipping from one page to another.

A family of microcomputer-based, speech-output reading machines for vocational and educational applications are being developed. Microcomputers accept optical images from an electronic camera and convert these images to character streams representing letters of recognized words. Other microcomputers convert the letter strings to spoken words. The reading machines are designed to operate in real time at

reading rates over 150 words per minute with the camera moved either manually or automatically. Engineering problems include requirements analysis, optical character recognition, speech synthesis, and automatic scanning machines.

A TALKING TYPEWRITER FOR PERSONS WHO ARE BLIND — Lee, Samuel C.; Wright, Ted W.; Nei, Chu-Ching

The talking typewriter will help students who are visually impaired improve their skills in learning to communicate. The talking typewriter is a microcomputer controlled keyboard/printer with a voice synthesizer. It uses a dictionary of digitally stored sounds for the most commonly used English words. As letters are typed on the keyboard to form words, the microcomputer will search the dictionary for these words. When a word is found it will be voiced through the voice synthesizer. Words not known to the talking typewriter will be spelled.

The talking typewriter is designed to allow a user to type in text without needing to see what has been typed previously. Functional keys provide the user with the ability to hear his position in the text. For example, the last word entered can be re-voiced or deleted. If the user wishes, the sound representing each key pressed can even be heard.

The software automatically controls the margins and spacing for text entered. The user can specify a large variety of line widths, margins, and line spacings.

The use of the talking typewriter is not limited to classes such as spelling, composition and typing; it may also be used by students who are visually impaired as a learning aid in mathematics, as a computer terminal in training for computer programming, and as a foreign-language typewriter. Although the Talking Typewriter is designed for users who are visually impaired, it may also be used by sighted individuals. Therefore the addition of sound to the normal typewriter capabilities can allow typing by persons who are visually impaired, and educational lessons for those who cannot read; it can also serve as a tool to enhance the educational process for sighted users.

WHEELCHAIR PRESCRIPTION & MAINTENANCE

THE ASSESSMENT CHAIR: A TOOL FOR THE SELECTION OF POWERED WHEELCHAIR CONTROL INTERFACES — Wiechula, Damian

Many children are either unable to drive a conventional joy-stick controlled wheelchair or have difficulty, easily fatiguing doing so. To offer these patients independent mobility, a powered wheelchair modification program has been established at the Ontario Crippled Children's Centre. The program has been in operation for eighteen months and has served about one hundred children, primarily those with cerebral palsy but including those with muscular dystrophy, degenerative nervous disorders, arthrogryposis, traumatic quadriplegia and multiple sclerosis. Driving control problems encountered include limited range of motion, limited strength, limited endurance, uncontrolled movements, lack of graded movement and complete hand dysfunction.

To aid in the selection of a suitable control for each patient, a "universal" drivable electric wheelchair was developed as an assessment tool for the engineer, the therapist and the patient. The chair has over 100 combinations of switch boxes, control sticks and gated switch-selection patterns that can be located virtually anywhere on the chair. In addition, it offers head position control, large target switch control and a gentle start "electronic ramp."

The use of this chair has greatly facilitated the selection of a chair control by eliminating the expense and delay of a conventional trial and error modification tactic usually employed on a patient's own chair. The chair's modular electrical configuration allows the fitting of unusual, personalized, experimental controls, with an absolute minimum expenditure of cost and time. Different approaches to control can be

readily tried and accepted or discarded in favor of immediately available alternatives.

With the chair's adaptability the control method can be "fine tuned" to a patient through a process of many small incremental changes. When a suitable control is found, careful measurements are made and the particular control is duplicated on the patient's own chair. The capabilities of the assessment chair are continuously being expanded to encompass the needs of patients with more diverse driving control problems.

In addition to saving time, expense and the patient's own chair from the scars resulting from repeated modification, the assessment chair offers the patient a quick path to success, sparing them the frustrations and sometimes the despair of many failures.

A MECHANISM TO REDUCE BODY DISPLACEMENT IN POWERED RECLINING WHEELCHAIRS — Warren, C. Gerald; Ko, Michael; Delahanty, Edward

Cycling of the powered recliner in wheelchairs often results in shear forces on and displacement of the quadriplegic user. A powered reclining wheelchair was modified to incorporate a low-friction sliding back mechanism and was instrumented to measure the angle and position of the sliding back. This allowed determination of the arc described by the torso during recline.

Fourteen able-bodied persons who served as controls and six persons who were quadriplegic were evaluated in the chair to determine the arcs described during recline. A digital computer was used for data collection and processing. A correlation was sought between the subject's morphology and the arc described during recline; however, no such correlation was found. The arc described related more directly to seating position than to morphology, and since seating position is highly variable and dictated largely by user comfort, it was not considered to be easily controlled. It was also found that users who were quadriplegic experienced less displacement in the chair than did the able-bodied subjects. An average arc described by the torso during recline was determined, and a four-bar linkage was designed which would reproduce this arc on the chair back. A model was constructed to demonstrate that such a linkage is feasible. The linkage has been designed not to interfere with regular functions of the chair.

Research now continues to determine if a single linkage design may be adequate for a population that is quadriplegic, or if an adjustable linkage must be used to allow the chair to be adapted to the individual user. A chair will be constructed using an adjustable linkage design based on the average and standard deviation of the recline arc of a larger sample of persons who are quadriplegic. This prototype chair will be used to evaluate the effectiveness of the design.

MYOELECTRIC WHEELCHAIR CONTROL SYSTEM — Crawford, George; Rossier, Alain B.; Sarkarati, Mehdi

A system has been developed which will allow persons who are quadriplegic to operate wheelchairs without the motion required by chin-operated joy sticks or by the use of puff-and-sip systems. Myoelectric activity from still functional muscle sites (such as the upper portions of the trapezius muscles in C4 and C5 quadriplegia) is monitored to provide the control function. Coded myoelectric signals are processed to provide the control information typically derived from a joy stick. Electrical stimulation is provided to assist the operator in the timing aspects of code generation.

The decoded wheelchair commands are presented on a display board with lamps representing forward, right, left, reverse, and stop. Two channels are used for detecting coded myoelectric commands. The command code has been configured for ease in learning and safety of operation. The efferent processors convert the outputs of the isolated preamplification modules to digital format and generate 27 MHz energy to power these modules. A microcomputer is used to convert the coded patterns of pro-

cessed myoelectric activity into control signals for the wheelchair drive motors. The micro-computer also controls electrical stimulation that is used to assist the operator in timing the coded patterns of myoelectric bursts. A temporary hard-wired decoder is used to convert the motor control signals into display board commands (forward, right, left, reverse, and stop). One modular unit contains the microcomputer and control unit. Another modular unit contains the display board decoder and two timers. One timer determines the command code generation rate. The other timer determines the maximum allowable myoelectric burst duration. These timers can be conveniently adjusted to accommodate an increase in proficiency by the operator. The third modular unit (an afferent processor) drives an isolated afferent module with 27 MHz pulses. These radio-frequency pulses are rectified in the afferent module to provide electrical stimulation. The two modular plug-in units (efferent processors) include provisions for adjusting the detection threshold, monitoring the myoelectric activity of the patient, and manually simulating myoelectric activity for system demonstration when familiarizing a patient with its operation. An efferent module and an afferent module rest on top of the main frame assembly.

The system has been tested with four patients. In each case, the patient learned to operate the system after a few minutes of instruction. All have shown significant improvement in proficiency (as indicated by speed of operation and error rate) after several hours of practice. Because of the positive results obtained with the simulated system, plans have been made to construct a mobile unit for actual wheelchair control.

AZIMUTHAL CONTROL FOR A POWERED WHEELCHAIR — Weber, Robert A.; Heckathorne, Craig W.; Rombola, Gregory; Childress, Dudley S.

Differences between the torques generated by the electromechanical devices at the rear wheels of a powered wheelchair and variations in the terrain over which the chair is driven, particularly slopes which divert the front caster wheels, combine to alter a chair from an intended path. To maintain a desired azimuth, the operator must periodically reorient the chair. The constant vigilance and effort required of the operator under such conditions may prove tiring or annoying and restrict the operator's effectiveness. This problem is particularly acute for individuals with very limited control capabilities. As a means of providing automatic azimuth control, the hypothesis was posed that if the two drive wheels were forced to travel equal distances, the chair would maintain a straight path.

A commercially available powered wheelchair was used to test the azimuthal control hypothesis. The chair's electronic drive provides pulses to each motor at a rate of 400 HZ with the duty cycle determining the chair's velocity. The circumferential displacement of each drive wheel was monitored by a modified, friction-mounted bicycle generator. The armature and stator of each generator was removed and replaced by a rotating perforated disc and an optical sensor. As a drive wheel rotated, the sensor produced a train of pulses at a frequency proportional to the product of the wheel's radius and its angular velocity. The sensor pulse train from one wheel incremented an "up/down" counter as the pulse train from the other wheel decremented it. Only if the rates of the two pulse trains were different, i.e., one wheel rotated faster or slower than the other, would the counter register a nonzero value. A microprocessor would periodically monitor the counter's value and adjust the pulse width of the drive of one of the motors to return the value of the counter to zero and consequently realign the chair to the intended direction. The control implementation was adequate to correct for steady-state imbalances in the drives of the two wheels and for surface variations of floors and sidewalks.

In the case of uneven surfaces, a correction was applied to the drive whenever a wheel's velocity changed in response to a surface variation; the correction was removed as soon as the azimuth was corrected. The system was also able to counter the diverting effect of a moderately sloped running surface.

Six trials each were run in a laboratory corridor with the azimuthal control disabled and enabled. With the control disabled, the chair would deviate an average of 6.3 degrees from the straight path. But with the azimuthal control enabled, the chair deviated an average of 0.1 degrees. Over a distance of 100 feet, these deviations would convert to final displacements of 11.0 and 0.2 feet respectively from the intended end position. This demonstrates system efficacy, but under conditions where it has small benefit for the operator. The real value is noted when traveling along a sloped sidewalk.

EVALUATION OF STAND-UP WHEELCHAIRS — Sheredos, Saleem J.; Darlington, Joseph W.; Lyles, Madison

Stand-up wheelchairs provide the patient's existing skeletal structure with appropriate bracing for the erect position. In general, this is accomplished by constructing the standing frame with these features: (1) footrests constructed to prevent the feet from sliding forward or backward and to bear the user's full weight; (2) a knee restraint placed just below the kneecap to prevent the knees from buckling; (3) the seat designed to pivot at the front edge and to swing up and forward by some powered or crank mechanism; (4) the chair back and arms (with a shoulder or chest strap) connected by a parallelogram linkage to keep them oriented vertically as the seat is raised.

Six stand-up wheelchair designs have been evaluated by the VA Prosthetics Center during the last 10 years: the Humanics Rehab Chair, the Overly-Bressler Stand-Up Wheelchair, the Stand-Sit-Squat Parapodium with transporter, the LEVO, the Mobilpodium Mark III, and the Naval Oceans Systems Center (NOSC) Stand-Aid. Only the LEVO, the Mark III, and the NOSC are currently being developed and produced.

The trials noted areas in which improvements are needed in each of the designs. A new design is now under development by NOSC for the VA Prosthetics Center. This mobile-powered standing frame can dock with a high performance powered wheelchair. The prototype standing frame has been built but the wheelchair unit is still in the design stage. The VA Prosthetics Center will continue to evaluate other stand-up wheelchairs as they are developed.

A MANUALLY OPERATED STAIR-CLIMBING WHEELCHAIR — Van Dine, Norman

The need exists for a practical stair-climbing wheelchair for use by persons in wheelchairs who have the capability and desire to travel. Four different design stages funded by the Veterans Administration and RSA have led to the Mark IV StairCat wheelchair. The required wheelchair must be like a standard wheelchair, weigh about 50 pounds, be manually operated by the occupant, fold for ease in traveling, and be able to ascend and descend stairs of 36° declivity. The present model weighs 70 pounds, complete with footrests and armrests, and folds for storage in an automobile.

An alternative design provides that an attendant/companion operate the StairCat wheelchair for a person who is quadriplegic. The need for this type of device is greater than that for the manually operated system designed for those persons who are paraplegic.

A standard, foldable wheelchair frame design has been modified, accommodating special hardware to provide for climbing up or down stairs. The operator must have arm strength for a push of about 25 pounds, although as little as 10 pounds can be accommodated. An occupant reclines the wheelchair by operating the climbing mode switch and thence, by means of force arms, lowers his chair onto caterpillar-like tracks while at the same time raising the main wheels off the floor. Ascending of stairs is such that the operator goes up backward while looking away from the steps. A person's center of gravity is held low to the stairs, thus giving a feeling of well being. Climbing is accomplished by a push on the force arm levers of up to 25 pounds, depending on the weight of the operator; this is repeated until the top of the stairs

has been reached. At the top landing, the reverse sequence then takes place: the operator selects the re-erect mode and raises the caterpillar tracks under the chair seat while lowering the main wheels to the normal level for ordinary travel. It takes two minutes to traverse three steps and approximately six or seven minutes for a flight of stairs.

The design of the Mark IV StairCat wheelchair has been completed. Two units are being assembled, one for the Veterans Administration Medical Center, Spinal Cord Injury Unit, West Roxbury, Massachusetts where it will be evaluated in that clinic. The second unit will undergo mechanical evaluation at the University of Virginia Rehabilitation Engineering Center. Actual production is scheduled for the summer of 1979.

ENVIRONMENTAL CONTROLS

EXPERIENCE WITH THE UNICOM BY A PERSON WHO IS QUADRIPLEGIC: FROM THE ACUTE CARE SETTING THROUGH REHABILITATION TO COLLEGE — Dalrymple, George F.; Drinker, Philip A.; Folsom, Cynthia; Lee, Ellen L.; Rowell, Derek

The UNICOM is a microprocessor communication system with video display originally designed for use by cerebral palsied children who were non-vocal. The UNICOM printer allows the system to be used as a typing device by persons able to speak but deprived of normal written communication. This report describes 17 months of experience with the UNICOM in such an application.

During the summer of 1977 one of the authors was injured in a driving accident which left her quadriplegic, (C_1 - C_2). The level of the injury was such that the acute care phase of the postinjury course was long and complex — and fulltime respiratory assistance is still necessary. The opportunity to use and test a new typing system during the various stages of the hospital course was an incentive to rehabilitation; it also provided invaluable insights into the many basic design aspects of the system. She joined the UNICOM development project as a consultant in 1977.

Initially Range Of Motion (ROM) was severely limited because of the cervical brace she needed. Therefore, the first testing of the UNICOM was in the scanning mode with a single bite switch. Nearly 10 weeks were spent with this control system during which she became completely familiar with the machine and was able to summarize the good and bad features of the scanning mode. The main drawbacks were its slow speed (approximately 2 words/min.) and the demoralizing fatigue associated with the scanning control. The UNICOM scans at a constant speed; although the speed is user adjustable, this mode demands full attention to follow the moving cursor and "pounce" at the right time. When the cervical brace was removed, ROM had improved, and we constructed an encoding control system consisting of 5 single-pole double-throw sip/puff switches with the tubes connected to a mouthpiece shaped somewhat like a curved harmonica or panpipe in configuration. Each tube terminates in a raised nub on a curved bar supported near the mouth.

Both positions and the functions of each tube (each tube transmits either of 2 commands) were quickly learned; from the outset the encoding mode was much preferred. This subjective preference was supported objectively by performance: typing speed with the encoding mode increased to 3.4 words/min. (20.6 commands/min.).

This application of the UNICOM has focused on design, development and testing of various accessing and control configurations for use by a person who is quadriplegic. The work has included an appropriate review of the human factors aspect of the design with a view toward making the UNICOM accessible and acceptable for persons who are quadriplegic.

IMPROVEMENTS IN MYOELECTRIC CONTROLLERS FOR ASSISTIVE DEVICES — Hogan, Neville

Myoelectric activity or EMG is the natural electrical activity which accompanies

muscle contraction. Because it can be easily detected from the surface of the skin, it has many clinical, particularly diagnostic uses. In addition, it is a good signal to use for controlling externally-powered assistive devices, such as prostheses, orthoses, manipulators, and powered wheelchairs. It is particularly attractive as a control signal for prostheses because in principle it can be used to measure the pattern of coordinated activity in the healthy but non-functional muscles in an amputee's stump. From the anatomy and physiology of the limb, we calculate what the natural limb would have done in response and command a prosthesis to do the same. Thus we can restore function to the amputee's stump muscles, and he should be able to operate the prosthesis with minimal retraining.

Practical myoelectric control as yet falls somewhat short of this ideal. Sophisticated externally powered prostheses have been developed and are in use, but the ability to control them leaves much room for improvement. There are many reasons for this, but one of the major reasons is the inaccuracy of the usual myoelectric signal processor. If the amputee-operator maintains a fixed muscle force, the output of the usual signal processor will vary at random anywhere between plus or minus 30 to 40 percent of the true value of the muscle force. For many applications it is only necessary to know whether the muscle is on or off, so this is not a problem, but if this signal is to be used to control a prosthesis, the performance of the control system must be restricted — for example, the prosthesis may be restricted to on/off control. The prosthesis either flexes at fixed speed, extends at fixed speed, or remains in a fixed position.

Clearly, there is room to improve myoelectric signal processing. Recent work has aimed at making the assistive device more complex — i.e., provide multiple functions. This work is necessary and valuable, but complexity has its price — less reliability, more difficult control. It is important to remember that even the simplest myoelectrically controlled assistive device has by no means been perfected. An important contribution to the needs of persons with disabilities can be made not by developing more complex devices but by improving the control and reliability of the simpler, more functional device.

Recent work at the Harvard-MIT Rehabilitation Engineering Center has addressed this problem by improving the accuracy of the equipment for processing the myoelectric signal. An examination of the physiology of the situation combined with mathematical analysis was performed; the outcome gave the specification of the best way to process the signal with the contraints under which the system must operate. The net result was a processor whose accuracy and fidelity were improved by more than a factor of five. This is being applied to an electromechanical elbow prosthesis.

A DAMPED JOYSTICK: ADAPTIVE CONTROL FOR THE TREMOR-DISABLED — Rosen, Michael J.; Sloan, Mark H.

Neuromuscular conditions including cerebral palsy, multiple sclerosis, Freidreich's ataxia and cerebellar injury may produce functional disability due to abnormal involuntary movement in spite of useable levels of residual strength and voluntary control. For example, the large amplitude intention tremor seen in people with cerebellar or midbrain lesions may make activities of daily living requiring accurate limb positioning difficult or impossible. Uncontrollable shaking not only complicates conventional activities but also makes it difficult to design adaptive interfaces for activating assistive devices such as non-vocal communication systems, feeders, page turners and environmental control devices.

For many people with such a disability, current therapeutic modes are inadequate or ineffective. With this in mind a research project was initiated at the Harvard Medical School-MIT Rehabilitation Engineering Center to test the effectiveness of mechanical loading for suppression of abnormal tremor. Specifically, subjects whose arms are restrained to the wrist are asked to perform wrist extension/flexion cycles to track a visually presented target. The effect on the accuracy of their performance

(and especially on tremor amplitude) of a viscous damping force applied by a brake in opposition to their movement is measured objectively. While substantial series of subjects and a variety of loading functions are planned, the results of this simple "shock-absorber-like" resistance to movement have been consistently impressive during lengthy testing of our first three subjects. These individuals, whose unaided tremor averaged ten times normal values, had reliably reduced tremor in some trials to levels functionally indistinguishable from normal, this by the application of damping forces low enough that the voluntary component of the movement was unattenuated.

While the long range development goal of this project is a clinically useful "damping orthosis" or compliant restraint system, the design of such a device must be delayed until substantial numbers of subjects have been tested in the relatively abstract manner outlined above. Nevertheless, the positive early data and our involvement in the area of non-vocal communication systems for persons with severe disabilities have led to the design of a more limited practical damping device described here. In conceptual terms, we have built a damped joystick, i.e., a control lever movable in two dimensions which selectively resists the rapid abnormal oscillatory forces applied by the user in order to allow more accurate performance of his/her intended movement. The rationale is, of course, that x and y position signals which the device generates may be used to control a variety of devices, for example, the position of a selection pointer on the vocabulary display of a non-vocal communication device.

Our x-y controller is based on inexpensive, commercially available hydraulic cylinders with readily adjustable flow valves to permit variation of the resistance to movements. There is no return spring at present, and the lever remains where it is placed. The housing is approximately one foot square and permits lever travel within a four-inch square. Standard precision potentiometers are used to sense the position of the lever and a variety of handles for differing degrees of hand weakness and deformity may be fitted. The device weighs about 5 lbs., and the parts and materials cost is under $100. Clinical testing of the performance improvement afforded by the system will be undertaken shortly by a person who is non-vocal after midbrain stroke; his single useable arm presents severe intention tremor. Our success to date with this approach should encourage other adaptive equipment designers to incorporate viscious damping in other adaptive devices such as feeders, writing aids and wheelchair controls for use by people in whom tremor would otherwise be disabling.

NEW DIRECT ACCESS CONTROL INTERFACE — Hodgetts, M.J.

A new control interface has been developed for a person with good control of head position. This device permits faster operation than many previous systems because the user directly selects the function to be activated by pointing a head-mounted sensor at a light on a panel corresponding to the desired function. The light at which the sensor is pointed turns on. If it is held on long enough to distinguish it from ones passed in transit, a feedback sound will be generated and the function will be activated.

This type of interface may be used for many devices. The unit is portable, draws little power, and is inexpensive to build. Nevertheless it is quite rugged. The sensor does not send out any light and therefore does not get hot; it does not employ any high voltage. The total power consumed by the interface system is about one tenth of the power consumed by a flashlight bulb.

Using this device for communication, one child has more than doubled her speed in comparison to a scanning communicator.

A ROBOTIC AID FOR PERSONS WHO ARE SEVERELY DISABLED, THE HUMAN INTERFACE — Leifer, Larry; Sachs, James; Sun, Rickson

The Robotic Aid is a collection of subsystems whose cardinal feature is the use of microprocessors to perform and coordinate operations within an asynchronus

multiprocessor network. It is built around the Unimate-250 electromechanical arm but the terminal device is replaced with a "smart-hand" design. Utilization of contemporary robotics technology by persons with severe disabilities will give them some degree of physical control over their environment. The principal concern is the development of means through which already burdened sensory/motor capabilities can be adapted to the control and supervision of mechanical limbs.

Whereas most persons experience diadic interactions with their environment, the Robotic Aid user is involved in an asymetric triadic relationship with his environment. While the Aid is controlled and supervised by the user it is physically separated from him. The Aid possesses sensors and actuators which interact with the environment. As far as is possible, the user's sensory-motor capabilities are left free for ordinary environmental interactions rather than being dedicated to command or supervision of the Robotic Aid. A range of control modes is possible. At one extreme, all actions are preprogrammed by non-users. At the other extreme, the user must directly control every movement of the device. These and two intermediate modes of interaction are defined: (1) selection from a menu of preprogrammed functions; (2) program entry to create one's own library of special functions; (3) interactive supervision of executing programs; and (4) direct control of electromechanical functions. In attempting to design the best possible interface for each of these control modes it is important to distinguish control from information requirements.

A VIBRATING PLATFORM FOR PERSONS WHO ARE SEVERELY AND PROFOUNDLY RETARDED — Marshek, Kurt M.; Gartner, Joseph R.; Lytle, Robert H.

The use of an enriched environment to act as a catalytic agent in eliciting more appropriate and productive behaviors from children in institutions has significant treatment potential. In an effort to improve a dayhall environment for 552 clients who were severely and profoundly retarded (90% were children) a special vibrating platform was designed as part of an enrichment program. The platform was activated when an individual stepped on a pressure-sensitive mat switch located on the top surface of the platform, and for the correct input, the person received a gentle body vibration as a reward.

A design which produces the correct platform vibration is important as certain types of vibration can cause harmful physiological effects. The simultaneous vibration of several antagonists of spastic muscles may result in a reduction in the activity of these muscles and therefore may prevent prolonged spasticities which induce gross deformities of the involved joints. Furthermore, vibration can be used to reinforce weak voluntary efforts and improve the control of paretic muscles. Overall constraints included in the design criteria for the platform were quiet operation, gentle vibration, safety and nondestructibility, ability to start with child input, and sufficient platform area for a recumbent child. The platform has been designed and constructed, and has been operating at the Hartford Regional Center in Newington, Connecticut.

Experimental studies revealed that the analytical model used computes the actual platform magnification ratio within 10%. The low amplitude vibratory system is inexpensive to build and should be easy to duplicate.

CONCEALABLE HELMET FOR SEIZURE-PRONE INDIVIDUALS — Mueller, James L.; Mallik, Kalisanker

The need for head protection during uncontrolled seizures is evident in facilities for the developmentally disabled. This need is especially acute among noninstitutionalized persons who require protection from seizures but refuse to wear the sports-type headgear commonly used in institutions. By refusing to wear any head protection for cosmetic reasons, these people face the risk of serious head injury.

Some parameters for a protective helmet were obvious: minimum weight, natural

balance, minimum bulk, maximum ventilation, secure fit. Using resources in the District of Columbia area, we were able to compare the impact absorbtion of a variety of material combinations and thicknesses against a hockey helmet commonly used in institutions. The most effective materials were a ¼" A-20 Pelite (a polyethylene foam used for prosthesis sockets) and ¼" Temper Foam, a NASA-developed urethane impregnated with silicone resin. Due to the delicate properties of the Temper Foam, the Pelite was vacuum-formed for the inner and outer shells, with pads of Temper Foam sandwiched between.

The fabrication process starts with a plaster bandage impression of the subject's head, protected with a bathing cap. A plaster mold is made from the impression. Ventilation tunnels are added to provide cooling. The plaster mold is covered with two ordinary stocking caps to provide a comfortable fit in the final helmet. Using ¼" Pelite, a liner is vacuum-formed over the form with the ventilation tunnels and stocking cap covering. The Pelite liner is trimmed to the hairline. One-fourth inch Temper Foam pads are glued in place over the liner. A final outer liner is vacuum-formed over the form to seal the "sandwich." The inner and outer liner edges are sealed with contact cement, and all edges are trimmed. A disc of about 3" to 4" diameter is cut from the apex to allow ventilation through tunnels; these edges are then sealed with contact cement.

A device as critical as head protection deserves intensive research to maximize safety. Physicians, prothetists, orthotists, and therapists are becoming interested in further development of this helmet. To date, project staff have corresponded with professionals, consumers, and families in twenty-five states, England and Denmark. Feedback has come from prosthetic/orthotic laboratories and universities where helmets have been fabricated from our instructions with successful results. Extended feedback was received from two clients for whom we made helmets; neither has had head injury since acquiring the helmet.

These data indicate that this rather simple, inexpensive device might be effective in offering some measure of protection from seizure-related head injury.

MOBILITY AIDS

A TRAINING PROGRAM IN THE UTILIZATION OF LIFT-EQUIPPED AND KNEELING BUSES IN THE WASHINGTON METROPOLITAN AREA — Dew, Donald W.

Transit personnel, people in the allied health professions and consumers are being trained in the use of lift-equipped and kneeling buses. The training and evaluation components of the program, their implementation, and the feedback to date are presented.

A major problem for persons who are disabled and striving to live independently is accessible public transportation. In the Washington, D.C. area, advances have been made in solving this problem with the accessible subway system and with the purchase of lift-equipped and kneeling buses. In order to implement effective usage of these vehicles, the George Washington University Rehabilitation Research and Training Center and the Washington Metropolitan Area Transit Authority were awarded a grant to develop and implement a comprehensive training and evaluation program.

There are two "training the trainer" components in this program, as well as direct training of persons who are disabled in the use of the buses. The first component involves training the bus operator-trainers in awareness of the needs of persons with disabilities. Bus operators and bus operator trainers have expressed the need for information on handicapping conditions that they might encounter while operating lift-equipped and kneeling buses. For instance, what is the best way to help a passenger who is blind to his/her seat? A workshop with persons who are disabled has been arranged for the operator-trainers, and printed and audiovisual materials are being designed to supplement this program.

The difficulties in designing an awareness program for bus operator-trainers will

be discussed. For example, the trainers are available for a limited time for training, and only half of the trainers can be released at one time to attend the training.

The second component involves training allied health personnel, such as physical therapists and nursing home employees, who work with persons who are disabled and might want to make use of the accessible transportation system. These trainees will learn how to help a person who is disabled use the lift-equipped and kneeling buses.

The training program also includes direct training of persons who are disabled in the use of the buses, evaluation of the bus equipment by rehabilitation engineers, and evaluation of all training to determine effectiveness of the program. Difficulties which arise as a result of the equipment and possible recommendations for equipment design are also discussed.

HANDICAPPED DRIVER PERFORMANCE — Reger, Steven I.; Claus, Cynthia; O'Reagan, James; Brown, Barbara

An indoor driving evaluator-trainer vehicle was developed at Woodrow Wilson Rehabilitation Center to measure a disabled person's ability to control an automobile. The control instrumentation measures operating force and elapsed time in completing a simulated driving task. The system, built into an AMC Pacer, consists of functional ignition and gear shift controls, instrumented steering wheel, hand controls for brake and acceleration, and elapsed time meters for control response. The system provides a quantitative record of the patient's performance using the major driving functions in their interactive mode against adjustable mechanical resistance elements. Another Pacer has been used to validate results on the road.

Fifty-eight patients from four disability groups have been tested on the driver evaluator. Thirty-one persons with spinal cord injuries, 12 persons with brain damage and 6 patients with cerebral palsy have been examined. A group of 9 other patients with various disabilities were also tested.

From prior results the minimum performance criteria were selected to be a reaction time within 0.4-0.8 sec., the ability to apply 40 lbs. of force on the brake pedal within 2.5 sec., and a complete turn of the steering wheel in less than 1.1 sec. Poorer performance than these standards was believed to be less than adequate for on-road driver training.

The measured values of performance were associated with muscle graded shoulder and elbow strength. The data was also correlated with on-the-road instruction time and the results of the driving test for licensing.

Patient testing and data collection continue to provide results with a larger sample. The data may then be used to indicate therapy goals, functional capacity and future progress in driver training.

DIGITAL SIMULATION TECHNIQUES FOR DRIVER TRAINING AND SKILL EVALUATION — Boydstun, Louis E.; Kessel, David; Langolf, Gary D.; Miller, James M.

Digital simulation techniques may provide a safe and flexible method for the training and evaluation of potential drivers. Other advantages of this approach include unsupervised training sessions and objective data collection for quantitative analysis. Disadvantages of the technique center around the validity of simulator versus automobile training procedures.

A driving simulator has been developed at The University of Michigan Human Performance Center to evaluate the potential use of the driving simulator for driver training and evaluation. An experimental program has been designed to evaluate the simulator's utility as a training aid for persons with perceptual disabilities. Preliminary experiments seek to establish norms for comparison with licensed drivers now on the highway. Additional driving tasks such as car passing and obstacle avoidance will be developed based on the results of preliminary data. Preliminary ex-

perimental results about skills acquisition and possible training methods are discussed.

AN ENGINE-GENERATOR POWER SOURCE FOR ELECTRIC WHEELCHAIRS — O'Reagan, James R.; Kauzlarich, James J.

A commercial ½ horsepower engine-generator was modified to serve as an auxiliary power source for electric wheelchairs. The engine was converted from gasoline to liquid propane gas as the fuel source. An electric starter was added to the engine, and the generator was modified to produce 24-volt direct-current power. This auxiliary power plant significantly extended the operating range of a standard, battery-powered wheelchair.

THE PIVOT AMBULATING CRUTCHLESS ORTHOSIS (PACO): A MOBILITY CONCEPT FOR PERSONS WHO ARE PARAPLEGIC — Carlson, Lawrence E.; Prast, Martin T.

PACO, an acronym for "Pivot Ambulating Crutchless Orthosis," was designed to be one component of a complete mobility system for adults who are paraplegic. The system incorporates a wheelchair for long distance travel and an orthosis with crutchless support for standing and short-range pivot ambulation. Pivot ambulation provides forward locomotion through successive body rotations about vertical axes lateral to the knee.

For short distances (50M), the PACO unit provides mobility and upright support. To travel up to one kilometer, a conventional wheelchair is an efficient, practical solution, while longer trips necessitate a motorized vehicle. The goals of the system are (1) support and balance in an upright position without use of hands; (2) limited ambulation in the upright position; (3) unaided standing and sitting; (4) compatability with wheelchairs; (5) easy to don and doff; and (6) easily adjusted by an orthotist for various patients. The complete system provides a method to capitalize on the medical, psychological and functional advantages of standing upright.

PACO III was designed to retain the advantages of previous units while satisfying all of the stated design goals. The first step toward independent standing was the design of wheelchair armrests which can be turned around so that they project forward of the chair. Telescoping tubes are then lowered to the floor to prevent tipping forward, and the armrests are raised as much as 40 cm. The result is a pair of stable parallel bars attached to the wheelchair. Once the unit is donned the person grasps the raised armrests and rises into a standing position. When fully erect, preset latches at the knees and hips automatically engage and create a rigid structure from base to torso. To sit, the hip and knee latches are disengaged, and the patient lowers himself back down onto the wheelchair. A report of a limited clinical trial of the PACO III, undertaken in May 1978, is presented.

GAIT ANALYSIS AND THE CARS-UBC ELECTROGONIOMETER — Hannah, R.; Cousins, S.J.; Foort, J.

Routine objective evaluation of human locomotion in a clinic is needed. The CARS-UBC electrogoniometer will measure the 3 orthogonal rotations at the hips and knees bilaterally. A self-aligning capability was achieved on this device by using a moulded parallelogram chain and a vertical slider to allow the device to follow the joint's complex motions without interference.

After recording the gait at the knees, the measuring module can be quickly unclipped from the shank frame and repositioned at the hip. Clinically useful information can be produced in 15 minutes if the electrogoniometer is used in conjunction with a strip-chart recorder.

This device has been used to measure the gait of more than 100 patients at the Arthritis Center, meeting the rigors of clinical gait analysis. Problems such as skin sen-

sitivity, the need for fast application with minimum encumbrance and the accommodation of differing limb sizes have been overcome. The results of measurements are highlighted. The CARS-UBC electrogoniometer, which can be used in several clinical situations, is compared with goniometers developed at other institutions.

SEATING AND PRESSURE CONTROL & REHABILITATION ENGINEERING PHILOSOPHY

A SHAPEABLE MATRIX FOR SEATING CHILDREN WITH DISABILITIES — Cousins, S.J.; Tredwell, S.J.; Hannah, R.; Foort, J.

Many children with moderate to severe disabilities need stabilizing back and buttocks support. Without such support the ability to communicate, to play or to eat is severely limited. Improperly seated children develop pressure sores and spinal deformity which may require surgery. With a properly designed supporting surface, respiration may be improved, spasticity may be better controlled, and the activities of daily living can be carried out with greater independence.

The shapeable matrix, developed at the Medical Engineering Resource Unit at the University of British Columbia with collaborative work at the Biomechanical Research and Development Unit, Roehampton, London, England, is, in one sense, a modular system. However it is not a system of components to be assembled into predefined devices, but the modules are assembled as an elemental system consisting of two small elements repeated in a matrix to form an adjustable surface. Spheres and cylinders are used. Cables (7 strand stainless steel, 1 mm O.D.) run at right angles through each sphere. When the cables are under tension an equal compressive force is applied to the sphere-cylinder combination. Under moderate cable tension the structure is stiff and can be formed to fit an appropriate shape because each sphere-cylinder interface has three degrees of freedom. When the finished shape is obtained the cable tension is increased to a predetermined maximum and the surface becomes rigid (within material property limits). Temper foam is then heat formed to this surface with a heat gun; the T foam has a thin waterproof layer of PVC bonded to it. Over this is placed lambswool to allow the patient's skin to breathe. This cover can be easily removed for cleaning.

The advantages of this device are (1) no expensive machinery need be purchased by the fitting team; (2) fitting can be done in a fraction of the time now needed for other methods; (3) adjustments can be made and the seat can "grow" with the child; (4) physical and occupational therapists can do the fitting; and (5) cost per patient would be low and delivery would be expedited and more individualized.

Clinical trials are now being carried out and preliminary results will be available in the summer of 1979.

AN ACTIVE SEATING SYSTEM FOR THE PREVENTION OF PRESSURE SORES — Drew, William E.

The problem of pressure sores severely limits the degree of independence which is achieved by many persons who use wheelchairs. Gainful employment often requires an individual to remain seated for ten or more hours a day. To prevent decubitus ulcers however, continuous sitting may be limited to two hours or less. Thus, employment becomes impossible for many of these individuals.

A great deal of effort has been made in developing wheelchair cushions which are effective in distributing pressure, but in practice these have not always been effective. In the seated position, the surface area available for support is small in relation to the amount of weight which must be supported. Thus, even a uniform distribution of pressure often results in excessive pressure on the tissues. When an individual can periodically relieve pressure, either by shifting weight or lifting himself off the chair,

conventional wheelchair cushions may be effective, but when an individual cannot or will not periodically relieve pressure, these cushions are not suitable.

An alternative to conventional wheelchair cushions is a seating system which actively changes the location of body support, thereby periodically relieving pressure. The seat developed consists of an air-filled cushion which is connected to a small pneumatic pump. Pressure is varied by sequencing air flow to each of the pneumatically isolated compartments of the seat, simulating the shifting of weight done by healthy individuals during prolonged periods of sitting.

Several design features of the seat control the other physical factors which contribute to the development of pressure sores. These factors, in addition to pressure are shear, humidity and heat. Shear stress is minimized by the shape of the cell membranes which form the seat surface. Humidity and heat are controlled by a ventilating system which circulates cooled air below the ischia, resulting in evaporation of perspiration and suppression of skin temperature.

The system is powered by a rechargeable, nickel-cadmium battery. The pump and battery are contained in a 20cm x 11cm x 6cm plastic box attached to the side of the wheelchair. The seat may also be powered by any 12-Volt battery. Power from a car battery is obtained by connection to the cigarette lighter receptacle; power from a wheelchair is obtained by connection to the battery terminals. All connectors are designed to be used by a person who is quadriplegic.

A NEW BED AND MATTRESS SYSTEM TO PREVENT BEDREST COMPLICATIONS AND TO INCREASE MOBILITY — Redford, J.B.

Standard hospital beds, whether used in the hospital or at home, create many potentially hazardous conditions for persons who are immobile. Common pathological problems from immobility in bed could be prevented by better bed design and improved mattress surfaces.

The Burke long-term care mattress provides patient comfort and a solution to these problems. Highly compliant polyurethane layers relieve uneven pressure. Split sections of foam allow separate, independent support of the patient's trunk and legs, and result in less shearing and friction. The top layer of articulated open-cell foam allows air circulation under the patient and permits perspiration to evaporate. A soft and absorbent fitted bed sheet of a special two-way stretch material acts as a wicking layer to draw moisture away from the body. A waterproof covering of highly stretchable latex rubber keeps the foam layer dry and conforms to body contours, thus preventing hammmocking, and high pressure points and lessening friction. All layers are completely washable. The density of the foam can be varied depending on the weight of the patient. This system adjusts to a true vertical (sitting) position which helps increase circulation and improves respiration and cardiac function. An adjustable padded footboard helps prevent footdrop and also permits exercise to prevent venous thrombosis in the calf muscles.

The bed can be adjusted to a tilt position of 45° without transferring the occupant from the bed. Finally, this system makes nursing care easier and encourages nurses to assist patients in regaining mobility. High-low positions have a full 16-inch variation with a low position 10½ inches from the floor which makes transfer into the bed easier. This bed can be utilized by persons with severe disabilities when equipped with a joy stick or breath controls. The pivot point of the head gatch hinge is close to the pivot point of the patient's hip joint. This reduces shearing between the skin and the surface of the mattress and further prevents skin complications. The system utilizes the principle of ball-screw actuators with plug-in components which makes maintenance easier and provides reliability.

Reports from limited experience in a general hospital with patients who have neurological disabilities show definite advantages with the use of this system.

TECHNOLOGY FOR HANDICAPPED CHILDREN — ROLES OF THE PROFESSIONALS — Trefler, Elaine; Mitchell, Jeryl

Technology for disabled children is now reaching the marketplace. Special seats, communication aids, electric wheelchairs, and prone standers are among the devices beginning to become available for the child with a handicap. The challenge at this point is to recommend and then provide the appropriate technology at the appropriate time with the proper training.

We are all aware of the team approach. Once again it is valid. Physicians examine the children, usually prescribe the technology, and evaluate its success. Therapists of all disciplines are very aware of the technical needs and often either help design and fabricate equipment or at least provide design criteria. The therapists also usually know what is commercially available. The rehabilitation engineer actually designs the equipment, modifies commercially available items and creates systems rather than individual devices. The child and his parents are at the center of this delivery system in that they require the technology and often rely on the advice of the professional person. The parents are also the ones who indicate whether the solution is appropriate.

Memphis City Schools in an effort to provide technology to children who are severely handicapped, requested and received a three-year grant from the Bureau of Education for the Handicapped. Project TEACH (Technical Educational Aids for Children with Handicaps) was funded in the summer of 1978 to demonstrate how technology can enhance the educational potential of children who are severely handicapped physically, both by enabling them to participate more fully and by enabling them to become more independent. Ten children will be served in the Memphis City Schools, Division of Special Education. Technical/therapy services will be contracted from the Rehabilitation Engineering Center in Memphis.

The concept of technology as it is being integrated into a school system to assist with the implementation of Public Law 94-142 will be discussed. This project also serves as an example of how various professions combine their efforts on behalf of the child who is physically handicapped.

DEVELOPMENT OF A USER-VALIDATED REHABILITATION DEVICES PRESCRIPTION METHOD — Laenger, Sr., Charles J.; McFarland R. Samuel

Informed selection and prescription of adaptive devices have been confounded by rapidly proliferating technology. Microprocessor-based electric aids, complicated powered mobility devices, and sophisticated vehicle conversions are a few of the expensive products which must be applied to aid the independence of the consumer who is disabled.

To assure the maximum accuracy and cost-savings in selecting from available products and designing interface equipment, the Rehabilitation Engineering Section at the Southwest Research Institute is developing a user-validation methodology. The basis for the method is simple: the user tries out the equipment, the technician (therapist) evaluates the combined performance, the engineer designs or specifies any needed modifications, and the team agrees on a prescription for items to be purchased. A common product is the demonstration of performance to a prospective employer or other concerned observers. To support the method, it is imperative that a wide assortment of equipment be on hand. Case histories with adaptive device prescriptions for vocational, home, communication, and mobility needs are presented.

A COMPARATIVE LOOK AT THE FUNDING AND PHILOSOPHY OF A REHABILITATION ENGINEERING CENTER — Bretz, Jonathan C.; Hulseberg, Debra A.

Rehabilitation engineering services as provided by the Rehabilitation Engineering Center at Tufts-New England Medical Center encompass the Client Service Program.

Originally established under an Innovation and Expansion Grant from the Massachusetts Rehabilitation Commission, the program allowed qualified department staff members to act as technology advisors to clients and counselors of the Commission.

This service provided clients with custom-made or modified equipment for the functional independence needed for daily activities; it thus helped to narrow the gap between the abilities of the client and that which is necessary to complete a task.

With the end of the grant came a new beginning for client service but as a fee-for-service program. The change in funding did not result in a change in philosophy but actually continued its development.

This presentation examines that growth in the program's philosophy and compares it with others. Having both grant and fee-for-service funding experiences allows us to contrast these areas drawing some conclusions based on our own problems and their solutions, and the techniques we developed. Included will be ideas and suggestions for the future of rehabilitation engineering service.

USE OF SEMI-CUSTOM TECHNOLOGY FOR REDUCING COSTS AND INCREASING APPLICABILITY OF REHABILITATION ENGINEERING — Vanderheiden, Gregg C.; Kelso, David P.

In the past, persons with severe physical disabilities were rarely if ever considered for vocational rehabilitation efforts. This was mostly due to the absence of effective tools or even when available, the means for interfacing them to the job site or providing them with the indepedent control needed for employment or daily living.

In recent years, rehabilitation engineering projects in several areas of the country have demonstrated that these barriers are not insurmountable, that even persons with severe disabilities can secure mainstream jobs.

Persons with multiple disabilities (non-vocal, non-ambulatory, and non-manipulative) are currently being offered and are accepting such jobs. Efforts to date, however, have usually involved custom modification or development of custom control systems for specific clients. "Standard" devices have usually proven to be too expensive, off target, too bulky, or incapable of providing the adaptability needed to accommodate the user's needs. The "custom" approach to rehabilitation engineering, however, has several problems: it is very expensive; it requires specialized technical personnel familiar with both the problems of persons with physical disabilities and the specific technologies involved and it is difficult to document and disseminate individual solutions effectively due to the high costs.

As a result, most successful efforts to date have been restricted to rehabilitation efforts carried out in conjunction with large federally-funded rehabilitation engineering programs, where the resources and personnel are available to develop such custom adaptations. Although very useful for exploring the problems and demonstrating feasibility, the "custom" approach is difficult to export to rehabilitation programs at large due to the lack of specialized technical personnel (specialized rehabilitation engineers) at most rehabilitative program sites and the limited client service dollars. In order to make the benefits of rehabilitation engineering more generally available, other approaches should be explored.

The method proposed here is to develop "semi-custom" technologies to help meet these needs. A semi-custom technology is not a piece of hardware but a generalized solution to a set or class of rehabilitation problems. The semi-custom technology would consist of specially designed but flexible hardware combined with detailed application information, covering application to a range (set) of problems or situations. Such an approach could reduce the high costs of custom design, fabrication, and maintenance; reduce the need for special technical personnel; and facilitate dissemination of technologies while still maintaining the ability to custom fit or adapt the system to the individual's particular handicap, abilities, environment, and needs.

Two early examples, a communication and control aid now entering production and a control interface system proposed to NASA/NSF for development will be presented.

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Please use this page for suggestions and constructive criticism.

The Rehabilitation Engineering conference program presented this year required a great amount of thought and work, on the part of your Program Committee and participants in the Instructional Courses, Technical Workshops, Plenary Sessions, and the Research and Development Paper part of the Conference. So that we may improve the management and the content of the Annual ICRE meeting, we are asking for your comments and suggestions to assist us in our evaluation of this 1979 Conference.

Please comment on the following:

Conference Registration:_____

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Meeting Facilities:_____

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Instructional Courses:
Selection of Material Presented:_____

Teaching Value:_____

Overall Judgment:_____

Any Outstanding Instructional Course?_____

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