

COMMITTEE ON PROSTHETICS RESEARCH AND
DEVELOPMENT
COMMITTEE ON PROSTHETIC-ORTHOTIC
EDUCATION
DIVISION OF MEDICAL SCIENCES—NATIONAL
RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES—NATIONAL
ACADEMY OF ENGINEERING
ANNUAL SUMMARY REPORT
ACTIVITIES FOR YEAR ENDED JUNE 30, 1973^a
COMMITTEE ON PROSTHETICS RESEARCH AND DEVELOPMENT
DIVISION OF MEDICAL SCIENCES, NATIONAL RESEARCH COUNCIL

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PURPOSE

The Committee on Prosthetics Research and Development (CPRD) seeks to advance knowledge and raise the level of practice in prosthetics, orthotics, and sensory aids by engaging in activities to stimulate research activity in these areas. The Committee on Prosthetic-Orthotic Education (CPOE), which was combined with CPRD in 1972, seeks to assemble and distribute information to

administrators, physicians, paramedical personnel, and other practitioners working in these fields. These tasks are undertaken within the framework of the policies and functions of the National Academy of Sciences.

Several government agencies have concern and responsibility in the care of amputees and individuals with orthopedic disabilities and sensory deprivations, notably the Social and Rehabilitation Service and the Maternal and Child Health Service within the Department of Health, Education, and Welfare; the Veterans Administration; and the Department of Defense.

Because of the relatively small total volume of business in artificial limbs, orthopedic appliances, and assistive devices for the blind and deaf, private enterprise has not engaged in extensive research in these areas. Thus, there has been a continuing need for government agencies and private foundations to support research and development so that progress commensurate with modern technology may be made. Traditionally, this support has been provided by means of research contracts with universities and industrial organizations, by intramural programs within government institutions, or by a combination of these methods.

In this total program the Committee on Prosthetics Research and Development and the Committee on Prosthetic-Orthotic Education endeavor to encourage and coordinate research and development activities. Specifically the Committees seek to:

- keep abreast of all new developments in prosthetics, orthotics, and sensory aids;
- correlate and coordinate research sponsored by the Social and Rehabilitation Service, the Veterans Administration, the National Institutes of Health, the Army, the Navy, and others;
- advise sponsors through National Academy of Sciences—National Research Council channels by means of special and periodic reports, and personal liaison, of the scope and progress of the program;
- make recommendations for needed research;
- ensure that new devices and techniques that contribute to improved treatment are made available promptly to organizations concerned with the education of medical and paramedical personnel in these fields; and
- disseminate research results nationally and internationally through publication of technical reports.

In fulfilling these functions the Committee on Prosthetics Research and Development has been supported in part by the Veterans Administration since July 1947, and by the Social and Rehabilitation Service and its antecedents (Vocational Rehabilitation Administration

and the Office of Vocational Rehabilitation) since July 1957. The Committee on Prosthetic-Orthotic Education, now combined with CPRD, has also been previously supported by the Veterans Administration and the Social and Rehabilitation Service.

ORGANIZATION

The Committee on Prosthetics Research and Development operates within the Division of Medical Sciences of the National Research Council. The Committee's membership is comprised of physicians, engineers, and representatives of other disciplines who are actively interested in furthering the development of prosthetic and orthotic

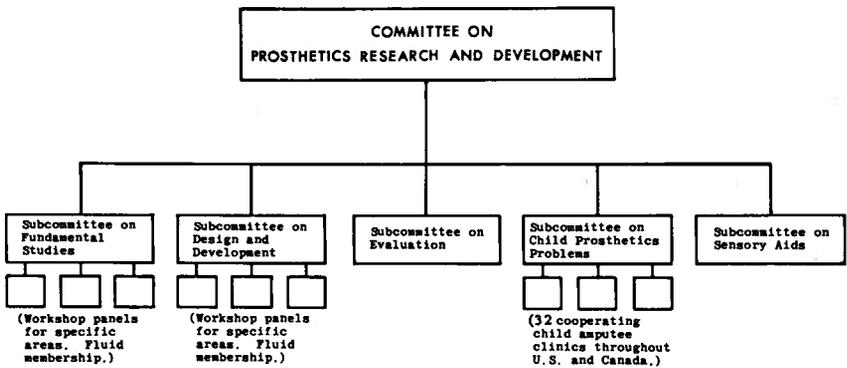


FIGURE 1

devices and sensory aids and in the expeditious utilization of these improvements. Appointments to the Committee, normally for a three-year period, are made by the Chairman of the Division of Medical Sciences with the approval of the President of the National Academy of Sciences.

In seeking to achieve its objectives, the Committee on Prosthetics Research and Development has, over the years, established five permanent subcommittees: the Subcommittee on Fundamental Studies, the Subcommittee on Design and Development, the Subcommittee on Evaluation, the Subcommittee on Child Prosthetics Problems, and the Subcommittee on Sensory Aids (Fig. 1).

The *Subcommittee on Fundamental Studies* seeks to stimulate research which will provide basic information prerequisite in the design of improved prosthetic and orthotic devices. Basic research is also directed to obtaining data which will afford a better understanding of treatment processes. The subcommittee operates through small working panels which focus on specific subject areas and involve

persons directly interested in and/or engaged in research in those areas. Identification and coordination of currently available information are correlative with the stimulation of research in areas where information is needed.

In pursuing its goal of encouraging and coordinating the design and development of improved prosthetic and orthotic devices, the *Subcommittee on Design and Development* arranges periodic meetings of individuals actively working in specific areas. The subcommittee promotes an active interchange of information between developers, provides leadership in attacking critical problems, provides a forum for the evaluation of new ideas and suggestions, and encourages the endeavors of competent designers. Much of the activity of the Subcommittee on Design and Development is effected through so-called workshop panels. These panels now cover the entire spectrum of prosthetics and orthotics in discrete segments, *viz.*, lower-limb prosthetics, upper-limb prosthetics, lower-limb orthotics, upper-limb orthotics, and spinal orthotics.

The difficult, but essential, realm of evaluation of new and revised prosthetic and orthotic devices and techniques is a major continuing concern of the Committee on Prosthetics Research and Development. The *Subcommittee on Evaluation* encourages and coordinates an orderly effort to determine the relative merits of individual items stemming from the research and development program. The findings are passed along to the education groups and clinicians.

The *Subcommittee on Child Prosthetics Problems* provides a strong stimulus for research in prosthetics related to the juvenile amputee population and disseminates the results of this research to clinicians and others engaged in the treatment of the child amputee. Under the auspices of this subcommittee, the Cooperative Child Amputee Research Program is carried on through 32 participating treatment centers which have met standards of practice established by the subcommittee. An important medium for the exchange of information within the clinic family is the *Inter-Clinic Information Bulletin* which is published monthly through New York University on behalf of the subcommittee. Material for the *Bulletin* is assembled and edited by the Assistant Executive Director of the Committee on Prosthetics Research and Development. In response to a charge from the parent committee, the Subcommittee on Child Prosthetics Problems is now in the process of enlarging its responsibilities to include orthotic needs of the juvenile patient. In this expansion of its activities, the subcommittee is focusing its attention initially on the orthotic requirements of children with cerebral palsy, spina bifida, and Legg-Perthes disease.

In fulfilling its role of providing advisory services to interested

agencies, both governmental and private, the *Subcommittee on Sensory Aids* endeavors to keep fully informed of current activities in the development of sensory aids for the blind and partially sighted, and the deaf and hard of hearing, and to encourage and coordinate meritorious research in these areas.

The Committee on Prosthetics Research and Development/Committee on Prosthetic-Orthotic Education is served by a staff of full-time personnel employed by the Academy-Research Council. It consists of an executive director, an assistant executive director, a staff engineer, a staff surgeon (1/2 time), two editorial associates, an administrative assistant, and four secretaries. (A staff engineer for sensory aids was added August 1, 1972. Dr. John Lyman from UCLA joined CPRD as a temporary consultant on February 1, 1973, and will continue to serve in this capacity until October 30, 1973.)

OPERATIONAL CONCEPT

General

The Committee on Prosthetics Research and Development/Committee on Prosthetic-Orthotic Education endeavors to achieve its objectives in a variety of ways, depending upon the requirements and circumstances of a given project. The Committee meets twice a year or as necessary to review the recommendations of its subcommittees and *ad hoc* committees. The subcommittees, whose members, like those of the parent committee, typically are appointed for a period of 3 years, also usually meet two or more times per year. Since the work of certain of the subcommittees is closely related, for example, Design and Development and Evaluation; and Design and Development and Child Prosthetics Problems, members of one subcommittee frequently attend meetings of other subcommittees.

A rewarding *modus operandi* in dealing with special topics or areas of interest, particularly under the Fundamental Studies and Design and Development subcommittees, has been the use of so-called workshop panels. However, the participants in the workshops are selected for their special or technical knowledge in the area under review and hence may vary from meeting to meeting. *Ad hoc* committees for study of special problems are also freely used. Appointments to such *ad hoc* committees, as is true also of the workshop panels, are not restricted to the membership of the Committee on Prosthetics Research and Development/Committee on Prosthetic-Orthotic Education. Persons with the specialized knowledge to serve on the workshop panels and *ad hoc* committees are selected from a large number of qualified individuals affiliated with

the Prosthetics and Orthotics Program. Personnel from the Educational Programs are included in order that the Educational Programs can be kept up to date on developments and thus effect a compression of the time required between research and education.

Governmental Relationships

Through the Academy-Research Council, CPRD/CPOE provides advisory services to the Veterans Administration, and the Social and Rehabilitation Service of the Department of Health, Education, and Welfare. Liaison representatives designated by these governmental agencies participate without vote in the deliberations of the Committee. Government laboratories cooperating with CPRD/CPOE include the Army Medical Biomechanical Research Laboratory, the Navy Prosthetics Research Laboratory, and the Veterans Administration Prosthetics Center. From time to time, individuals from these laboratories participate in the Committee's activities.

SUMMARY OF ACTIVITIES
for period
July 1, 1972—June 30, 1973

During the period covered by this report the activities of CPRD/CPOE broke new ground in various areas. At the same time the ongoing and highly productive system of workshop panels sponsored by the various subcommittees was continued.

The addition of Dr. Gustav F. Haas to the staff as a full-time specialist in sensory aids gave an additional emphasis to work in this area, while the return of Dr. E. E. Harris on a part-time basis facilitated an evaluation program of nerve and muscle stimulators. Dr. John Lyman's appointment as special consultant has permitted a comprehensive review of the status of externally powered prostheses and orthoses.

A brief description of the activities of the parent committees and of the subcommittees follows.

On March 15, 1972, the Committee on Prosthetics Research and Development was transferred from the Division of Engineering to the Division of Medical Sciences, National Research Council, National Academy of Sciences. The Committee on Prosthetic-Orthotic Education continued in the Division of Medical Sciences in which it had been located since its establishment.

In view of this new alignment the chairman of the Division of Medical Sciences appointed an *ad hoc* committee to review past and present activities of CPRD and CPOE and to develop objectives and

a plan of organization for continued activity of the two groups. The first meeting of this *ad hoc* committee was held October 13, 1972, and a second one on December 15, 1972.

Because of the organizational transition in process no individual meetings of CPRD and CPOE were held during the reporting period.

SUBCOMMITTEE ON FUNDAMENTAL STUDIES

The Subcommittee on Fundamental Studies seeks to stimulate research which will provide basic information prerequisite to the design of improved prosthetic and orthotic devices, and to provide a better understanding of treatment processes.

Panel on Locomotion and Gait Studies

The Panel on Locomotion and Gait Studies continued its efforts to standardize data-collection procedures so that data obtained by different laboratories studying gait could be compared.

SUBCOMMITTEE ON SENSORY AIDS

The Subcommittee on Sensory Aids seeks to encourage and coordinate activities directed to the blind and near-blind, the deaf, and hard of hearing. The subcommittee is increasingly being involved in the evaluation of devices designed to benefit one or more of the constituent groups.

Clinical Evaluation of Mobility Aids for the Blind

CPRD has played a major role in the evaluation of the Bionic Laser Cane developed under the auspices of the Veterans Administration and, on November 13-14, 1972, held a conference to try to develop guidelines for the conduct of future projects for evaluation of mobility aids. Present also were key figures in the evaluation of the Kay spectacles. As a result of this meeting a Task Group on the Objective Measurement of Mobility Performance has begun operation.

Clinical Evaluation of Reading Aids for the Blind

With the availability of the Optacon from Stanford Research Institute and the Stereotoner from Mauch Laboratories, Inc., it is planned to develop an orderly system for the evaluation of reading machines for the blind. The Subcommittee on Sensory Aids Panel on Evaluation of Inkprint Readers, at its first meeting on December 1, 1972, recommended an evaluation procedure to the Veterans Administration and discussed further work.

Eighth Meeting of the Subcommittee

The eighth meeting of the subcommittee was held on December 2,

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1972. The results of ongoing activities were reviewed. Other topics included a report on staff activities, discussion of the upcoming hearing-aid performance evaluation for the Veterans Administration, and evaluation methodology of sensory aids to the blind.

Hearing-Aid Performance Evaluation

The Veterans Administration has requested CPRD to form a panel of consultants to advise on hearing-aid performance criteria to be used in the selection of aids for VA purchase. In this connection, the subcommittee intends to pinpoint the areas of research that need to be pursued to identify hearing-aid characteristics that are desirable for various types of hearing impairment. At its first meeting on June 25–26, 1973, the panel arrived at FY 74 choices for VA purchase on the basis of test data and clinical experience.

Low-Vision Aids

The subcommittee is continuing to work with the American Foundation for the Blind, the National Society for the Prevention of Blindness, and the National Accreditation Council for Agencies Serving the Blind and Visually Handicapped, to improve service delivery to the large but neglected population that can benefit from low-vision aids.

Aids to the Deaf-Blind

At the request of the Social and Rehabilitation Service, the Staff Engineer for Sensory Aids is cooperating with the National Center for Deaf-Blind Youths and Adults in expediting the development of aids for this population.

Miscellaneous

The Staff Engineer for Sensory Aids has visited three Veterans Administration Blind Rehabilitation Centers, and civilian schools for the deaf, blind, and deaf-blind, to assess needs for research and development of devices. A national survey of all sensory aids research, development, and evaluation studies is being conducted.

SUBCOMMITTEE ON DESIGN AND DEVELOPMENT

Under the sponsorship of the Subcommittee on Design and Development periodic conferences are held in five areas: upper-limb prosthetics, lower-limb prosthetics, upper-limb orthotics, lower-limb orthotics, and spinal orthotics. From time to time the subcommittee also sponsors conferences and seminars on topics of special interest. During the period of this report, meetings held were:

Upper-Limb Prosthetics

The Tenth Workshop on Upper-Limb Prosthetics was held in Atlanta, Ga., Sept. 21-22, 1972. At this meeting the focus was on the immediate and early fitting of upper-limb prostheses. Surgeons and prosthetists active in this area presented papers on their techniques and results. A report which will serve as a guide for others wishing to enter this field is being prepared for publication.

Lower-Limb Orthotics

The Eighth Workshop on Lower-Limb Orthotics was held in Los Angeles, Calif., Oct. 2-4, 1972. Emphasis at this meeting was on above-knee (knee/ankle) orthoses and orthotic knee joints providing knee stability. A variety of designs in current use was presented and recommendations for future activity were prepared. A report has been distributed.

Above-Knee and Below-Knee Prostheses

A Workshop on Above-Knee and Below-Knee Prostheses was held in Seattle, Wash., Jan. 27-29, 1973. At this meeting current procedures in the construction of prostheses for above- and below-knee amputees were reviewed. Stump-casting socket fabrication and prosthetic alignment factors were examined, both with respect to "standard" practice as taught in the prosthetics educational programs and to a number of innovations developed in the field. Two advanced casting techniques for below-knee amputations were selected for evaluation, and further development of other promising techniques was encouraged. A report of the workshop has been prepared and distributed.

SUBCOMMITTEE ON CHILD PROSTHETICS PROBLEMS

The Subcommittee on Child Prosthetics Problems maintained an active research program in prosthetics for children throughout the year and took steps to initiate a research program in children's orthotics. Thirty-two clinics specializing in the treatment of the child with limb deficiencies are now participating in the cooperative research program. Three clinics have been recruited for the initial venture into orthotics. The Assistant Executive Director maintains close contact both with clinics in the program and with those which may participate in the future.

The Assistant Executive Director continued to serve as editor of the publication *Inter-Clinic Information Bulletin*, which is published in

cooperation with New York University. Approximately 3500 copies are distributed monthly to physicians, prosthetists, therapists, and others interested in the care of the child amputee.

On June 14, 1972, staff members met with a group of selected orthopedic surgeons to plan a Conference on The Child With an Orthopaedic Disability—His Orthotic Needs and How to Meet Them. This conference was subsequently held in Annapolis, Md., Nov. 19–21, 1972, under the joint sponsorship of Howard University and CPRD, with funding through Howard University by the Maternal and Child Health Service. A broad spectrum of children's orthopedic problems was examined in depth, orthotic devices available for use in these conditions were reviewed, and proposals and recommendations were made for future research and treatment programs. The report of this conference has been prepared and distributed.

An executive meeting of the subcommittee was held Nov. 20, 1972.

Clinic chiefs participating in the cooperative research program met at Henrietta Egleston Children's Hospital in Atlanta, Ga., April 25–27, 1973, at which time a symposium, which focused primarily on the delivery of services for children with limb deficiencies, was conducted. An executive meeting of the subcommittee was held on April 27, 1973.

SUBCOMMITTEE ON EVALUATION

The fourteenth meeting was held in Annapolis, Md., on Aug. 21–22, 1972. A wide variety of subjects was discussed including the results of the clinical use of the technical analysis forms (American Academy of Orthopaedic Surgeons), prescription forms (CPOE), and disability classification forms (Institute of Rehabilitation Medicine). The status of ongoing clinical evaluations was also reviewed, the items being: three ankle/foot orthoses, the Ljubljana functional electrical stimulator, and the VA externally powered upper-limb prostheses. A report on the laboratory study of 12 ankle/foot orthoses at Moss Rehabilitation Hospital was also presented.

An orientation course for the Application and Evaluation of the Medtronic-Rancho Implanted Peroneal Stimulator was held at Rancho Los Amigos Hospital, Downey, Calif., Aug. 10–11, 1972. This implant system, designated NMA (Neuromuscular Assist), will undergo clinical evaluation in a number of selected treatment centers.

The fifteenth meeting was held in Washington, D.C., Apr. 9, 1973. The main purpose of this meeting was to discuss plans for a

pending clinical evaluation of two new spinal orthoses. The status of ongoing projects and new items recommended for evaluation also was discussed. Plans were made to initiate several new studies, including three upper-limb prosthetic components.

Evaluation of Upper-Limb Prosthetic Components

At the subcommittee meeting on Apr. 9, 1973, plans were made to evaluate three upper-limb prosthetic components:

1. *Winnipeg Cable-Recovery Unit*. The Veterans Administration Prosthetics Center agreed to purchase some of these units for fitting and evaluation on VA patients in Atlanta, Ga. CPRD will monitor.

2. *Rehabilitation Institute of Montreal (RIM) Wrist-Flexion Unit*. RIM will provide some of the units for fitting and evaluation at Duke University Medical Center. CPRD will monitor.

3. *Ontario Crippled Children's Centre (OCCC) Open-Shoulder Socket*. CPRD will attempt to initiate a case study to evaluate this and other methods of suspension for above-elbow amputee sockets.

Plans are also being made to evaluate: 1. the Fillauer Three-Step Casting Technique, and 2. the Zettl/Traub Premodified Casting Technique by amputee subjects and staff at Rancho Los Amigos Hospital in Downey, Calif. The existing capability at this center for analysis of results by means of transparent sockets and temperature-recording instrumentation will be used. Both techniques are designed to facilitate the preparation of sockets for below-knee amputees.

COMMITTEE ON PROSTHETIC-ORTHOTIC EDUCATION

The Task Force on Standardization of Prosthetic-Orthotic Terminology

The prime concern of the Task Force is with standardization of prosthetic and orthotic nomenclature. However, a number of derivative considerations cannot be ignored: 1. the application of descriptive terms to the prescription of devices for patients; 2. the use of selected terminology and prescription information in the negotiation of fee schedules and contracts of third-party payees such as the Veterans Administration, the Social and Rehabilitation Service of the Department of Health, Education, and Welfare, Blue Cross—Blue Shield, and the Social Security Administration (although SSA was reported as being in the process of developing its own system); and 3. the need for a comprehensive information retrieval system based on a standardized prosthetic and orthotic terminology.

The Fourth Workshop of the Task Force on Standardization of Prosthetic-Orthotic Terminology was held on July 28, 1972, in

Washington, D.C. In prosthetics, the extensive list of terms developed and defined at earlier workshops was reviewed, and the CPRD/CPOE staff agreed to check the list for completeness and to develop definitions for all listed terms—which would then be submitted to selected members of the Task Force for further review. Prosthetic headings and flow charts developed at a previous workshop were also considered, and a prosthetics prescription similar to one produced for orthotics was drafted.

In orthotics, while considerably more work needed to be done in compiling and defining orthotic terms, a technical analysis form for the lower limb had undergone extensive clinical trials and would soon be ready for routine use. The analysis form for the upper limb was less well advanced, but the forms were being readied for clinical trials at selected centers. The previously developed orthotics prescription chart and directions for its use were reviewed and slight revisions suggested. Appropriate prescription charts are now included in the technical analysis forms for both lower and upper limbs.

Standard prosthetic and orthotic nomenclature is essential to the work of the *ad hoc* Committee on Information Retrieval. These terms are needed: 1. for inclusion in existing retrieval systems such as the Medical Literature Analysis and Retrieval System (MEDLARS) of the National Library of Medicine, and 2. for development of a complementary system to permit retrieval of literature not analyzed and included in MEDLARS. In this latter connection a list of prosthetic descriptors has been developed and a three-digit code system assigned to these terms. Work has progressed so that immediate action may now be taken to: 1. review and test the proposed terminology list, and 2. prepare definitions and cross references for the terms.

On Nov. 28, 1972, the Assistant Executive Director and the Staff Surgeon met with the Chairman of the *ad hoc* Committee on Information Retrieval and other interested parties, including a representative of the Prosthetics and Orthotics Research and Development Unit of the Sanatorium Board of Manitoba that operates a data-retrieval system in Winnipeg, Manitoba, Canada. A prime purpose of this meeting was to relate the United States effort under CPOE to activities in this area elsewhere in the world. A further meeting on data-retrieval systems was held in New York City on May 14, 1973. At this meeting a representative of the prosthetic-orthotic community of the United Kingdom was present. Steps were taken to develop a system that might be universally acceptable to the English-speaking world.

Orthotics-Prosthetics Publications

Since both CPOE and CPRD issue numerous publications reporting the results of workshops and special meetings, a meeting was held in Washington, D.C., Apr. 30, 1973, to consider possible means of making these publications more useful, particularly to the educational community. Representatives of the sponsors (SRS and VA) and of the American Orthotic and Prosthetic Association and the American Academy of Orthotists and Prosthetists attended the meeting in addition to representatives from the three universities conducting prosthetic-orthotic education programs.

Newsletter . . . Amputee Clinics

Newsletter . . . Amputee Clinics, the bimonthly publication of CPOE, has been well-received in the 3 years since its inception. A steady increase in circulation (from 1500 to approximately 4000), plus a better-than-average response to frequent survey questionnaires, evidence reader interest and enthusiasm.

The *Newsletter* is an effective vehicle for communication between amputee clinic chiefs and others involved in the care and management of amputee patients. Six issues published during the period July 1, 1972—June 30, 1973, reported on such diverse clinical problems as the psychological effects of amputee clinics on patients and the current status of immediate postsurgical prosthetic fittings.

CLINICAL EVALUATION OF PROSTHETIC AND ORTHOTIC DEVICES AND TECHNIQUES

On Sept. 1, 1966, a contract was entered into between the National Academy of Sciences and the Vocational Rehabilitation Administration to establish a program under the Committee on Prosthetics Research and Development for the clinical evaluation of prosthetic and orthotic devices and techniques. Support for this program was extended by the Social and Rehabilitation Service to the most recent period of Sept. 1, 1972—Aug. 31, 1973.

During the seven years of its operation, the clinical evaluation program has provided an effective medium of transition for prosthetic, orthotic, and sensory-aid devices and techniques from design and development into education and patient usage. Seven major projects have been completed:

1. Clinical Evaluation of the Engen Plastic Hand Orthosis
2. Clinical Evaluation of the Veterans Administration Prosthetics Center Patellar-Tendon-Bearing (VAPC PTB) Orthosis
3. Clinical Evaluation of Synthetic Balata for Fabricating Sockets for Below-Knee Amputation Stumps

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4. Clinical Evaluation of the Army Medical Biomechanical Research Laboratory (AMBRL), Boston, and Rancho Los Amigos Hospital Externally Powered Prosthetic Elbows
5. Clinical Evaluation of the University of California Biomechanics Laboratory (UC-BL) Shoe Insert, the UC-BL Dual-Axis Ankle Orthosis, the VAPC Single-Bar Above-Knee Orthosis, and the New York University (NYU) Insert Orthosis
6. Clinical Evaluation of a Comprehensive Approach to Below-Knee Orthotics
7. Clinical Evaluation of the Ljubljana Functional Electronic Peroneal Brace.

Final reports have been published on items 1—7 as National Academy of Sciences Publications E-1 through E-7. In addition, the results of these evaluations have been published in various journals for the information of people in the field.

Comparative Evaluation of Ankle-Foot Orthoses

A comparative study including biomechanical analyses of the following 12 ankle-foot orthoses (AFOs) is being performed at Moss Rehabilitation Hospital in Philadelphia with coordination from CPRD.

AMBRL Posterior-Bar AFO
AMBRL Two-Rod AFO
Conventional "Short-Leg Brace"
IRM Spiral AFO
NYU Insert AFO
Rancho Polypropylene AFO
Solid-Ankle Rigid-Laminate AFO
Teufel Ortholen AFO
TIRR Polypropylene AFO
UC-BL Dual-Axis AFO
VAPC Single-Bar AFO
VAPC Shoe-Clasp AFO

The objectives are to determine more clearly functional characteristics, prescription criteria, and relative merits of each orthosis. The study commenced in January 1971. Work on kinematic analysis has been completed, and work is now under way on force analyses of the 12 AFOs.

Clinical Evaluation of a Comprehensive Approach to Below-Knee Orthotics

This evaluation commenced in January 1972 and was completed

in September 1972. Sixty-seven patients were fitted, 11 of them bilaterally, at the following eight centers:

- New York University Prosthetics and Orthotics
- Northwestern University Prosthetic-Orthotic Center
- University of California at Los Angeles
Prosthetic-Orthotic Education
- University of Virginia Department of Orthopaedics
- Veterans Administration Hospital, Cleveland
- University of Miami Department of Orthopaedics
and Rehabilitation
- Veterans Administration Prosthetics Center Patient Clinic
- Rancho Los Amigos Hospital

The objective of the evaluation was to assess a comprehensive approach to the delivery of orthotic treatment by effectively matching the biomechanical deficits of patients with the biomechanical advantages of orthoses. Toward this end, use of the following three forms and three ankle-foot orthoses was evaluated:

- AAOS Lower-Limb Technical Analysis Form
- CPOE Orthotic Prescription Chart (Tentative)
- IRM Patient Classification for AFOs
- IRM Spiral AFO
- TIRR Polypropylene AFO
- VAPC Shoe-Clasp AFO

Results indicated that the forms are potentially very worthwhile for patient analysis and prescription but that they need some revision and more clinical exposure before recommendations can be made for their use. All three AFOs were found to be good and suitable devices for routine patient usage and their inclusion in the prosthetic-orthotic educational program is recommended. Also, a prescription guide was prepared to help delineate when each of the three orthoses should be used clinically.

Clinical Evaluation of the Ljubljana Functional Electronic Peroneal Brace

This evaluation commenced in April 1971 and was completed in November 1972. Seventy-two patients were fitted at the following five centers:

- Highland View Hospital, Cleveland
- University of Miami Department of Orthopaedics
and Rehabilitation
- Moss Rehabilitation Hospital, Philadelphia
- Northwestern University Prosthetic-Orthotic Center
- Rancho Los Amigos Hospital

Results indicated that the orthosis does work to prevent "drop-

foot" condition, i.e., it stimulates the peroneal nerve during swing phase to cause dorsiflexion of the ankle and prevent toe drag during gait. Likewise, it successfully demonstrated the potential value of using electrical stimulation clinically. However, the device itself has too many mechanical problems to be used as it is, and the Ljubljana group is now in the process of redesigning it.

Clinical Evaluation of the Rancho/Medtronic Implantable Peroneal Stimulator

Based on the demonstrated performance of the Ljubljana externally applied stimulator for the peroneal nerve, an evaluation was started in August 1972 to assess an implantable unit developed by Rancho Los Amigos Hospital and Medtronic, Inc., to accomplish the same purpose but more with the elimination of some of the problems inherent with surface electrodes. The centers participating in this study are:

George Washington University Department of Orthopedics
Highland View Hospital, Cleveland
Moss Rehabilitation Hospital, Philadelphia
Northwestern University Prosthetic-Orthotic Center
University of Miami Department of Orthopaedics
and Rehabilitation
University of Indiana Department of Orthopedics
Texas Institute for Rehabilitation and Research, Houston

Comparative Evaluation of Upper-Limb Orthoses

CPRD was asked to evaluate comparatively four upper-limb orthotic systems which are available commercially. The prosthetic-orthotic schools are not sure about the curriculum content (each school is teaching something different) and clinicians feel unsure about their prescriptions.

An *ad hoc* committee was formed and a meeting was held in August 1972 with the schools, clinicians, and developers present to discuss the situation and to help sort out the relative merits of each system.

FUTURE PLANS

Continued Comparative Evaluation of Ankle-Foot Orthoses

The kinematic analysis phase of this study has been completed, and testing has begun on the kinetic analysis phase. CPRD will continue to work with Moss Rehabilitation Hospital to make the

results of these motion and force analyses available in such a form that they will be useful clinically.

Continued Clinical Evaluation of the Rancho/Medtronic Implantable Peroneal Stimulator

About one hundred of these units are being made available for clinical trial. With time needed to select suitable patients and with a trial wear period necessary, it is anticipated that the evaluation will run through 1973. An orientation course for members of the participating clinics was held Aug. 10-11, 1972. Interim progress meetings were held Feb. 2, 1973, and June 2, 1973, to assess the results obtained thus far.

Continued Comparative Evaluation of Upper-Limb Orthoses

Further work and a second meeting are necessary before recommendations can be made on the four upper-limb orthotic systems to the prosthetic-orthotic schools and clinicians in the field. It is anticipated that the second meeting of the *ad hoc* committee will be held in the summer of 1973.

Clinical Evaluation of Two Spinal Orthoses

A clinical evaluation is planned on the VAPC Lumbo-Sacral A-P and M-L Control Orthosis and the UC-BL Laminated Semi-Flexible Body Jacket with Inflatable Pads. A planning meeting was held Dec. 8, 1972, and an orientation session for the centers involved was held on June 4-7, 1973.

Evaluation of Vacuum-Forming Techniques in Prosthetics and Orthotics

New techniques whereby thermoplastic materials are heated and vacuum-formed over models appear most promising for application in prosthetics and orthotics. Shapes, such as prosthetic sockets and orthotic shells, can be made rapidly and efficiently, saving much time and effort which now goes into the hand lay-up and lamination of thermosetting plastics.

Vacuum-forming techniques make possible the forming of transparent sockets not otherwise feasible. Clear sockets offer the possibility to observe pressure distribution on the stump. Also, by saving time and effort, the patient can be provided a device more promptly, and the prosthetist or orthotist can devote more attention to functional aspects and less to fabrication aspects of the device. All these factors have very important and useful implications for clinical practice.

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It is the goal of CPRD to explore vacuum-forming techniques, evaluate them as necessary, and assist in promulgating their use if indicated, especially in the prosthetic and orthotic schools where savings in fabrication and teaching time can be applied beneficially to instructing students more about biomechanics and function than "how to do it" shop procedures.

A Workshop on Vacuum-Forming Equipment and Techniques was held at Moss Rehabilitation Hospital on June 3. Information and experiences were discussed by participants who have been using this technique. Arrangements were made for representatives from the Education Program to attend a 2-day instructional course at Orthomedics, Downey, Calif., July 2-3, 1973.

Evaluation of Modular, Endoskeletal Protheses

As explained in the report of the CPRD Conference on Cosmesis and Modular Limb Protheses, March 3-7, 1971, endoskeletal protheses for upper- and lower-limb amputees offer some very definite advantages over existing conventional systems. New endoskeletal systems are now being developed in the United States and abroad. There is need for CPRD to undertake evaluation of these new protheses so that orderly development and introduction into clinical practice can ensue.

Evaluation of endoskeletal protheses will involve consideration of both structural and cosmetic aspects, and will have to be coordinated with efforts overseas. Also being considered is the United States changeover from English to metric units. If this can be done early in development, it should alleviate the chore later on and allow greater cooperation and usefulness internationally.

Evaluation of the Effect of Weight of Protheses on Amputee Acceptance

For many years there has existed a controversy over the effects of total weight and distribution of weight of lower-limb protheses in amputee performance and acceptance. With the availability of modular protheses, vacuum forming of sockets and other components of the prothesis, and improved methods of obtaining data, the costs of such a project now seem to be reasonable. With the assistance of the group at Moss Rehabilitation Hospital, CPRD proposes to initiate a study of this type concerning the below-knee amputee. If this study is successful, it will be expanded to include the above-knee amputee.

Lower-Limb Orthotics

The Eighth Workshop on Lower-Limb Orthotics was held in Los Angeles, Calif., Oct. 2-4, 1972. Emphasis at this meeting was on

above-knee (knee/ankle) orthoses and orthotic knee joints providing knee stability. A variety of designs in current use was presented and recommendations for future activity were prepared. A comprehensive report of the workshop was prepared and has been distributed.

SPECIAL MEETINGS AND ACTIVITIES

Rehabilitation Engineering Centers

The Executive Director and members of the Committee on Prosthetics Research and Development participated in meetings of the Rehabilitation Engineering Advisory Committee of the Social and Rehabilitation Service Oct. 12, 1972, and June 6, 1973.

On Oct. 12, 1972, CPRD personnel also participated in an orientation session for Rehabilitation Engineering Centers.

Educational Activities

The Assistant Executive Director continued to serve as honorary secretary of the University Council on Orthotics-Prosthetics Education (UCOPE) and the Conference on Orthotics-Prosthetics Education (COPE). A combined meeting of these two groups was held in St. Louis, Mo., Oct. 24, 1972, while a meeting of UCOPE alone was held in Washington, D.C., May 1, 1973. These meetings focused primarily on mutual financial problems and served to coordinate course offerings.

Hemophilia

In collaboration with the University of Miami, the Committee on Prosthetics Research and Development sponsored a Workshop on the Comprehensive Management of Musculoskeletal Disorders in Hemophilia. This meeting was held in Miami, Fla., on Oct. 12-14, 1972, and an NAS-numbered publication is in preparation.

American Orthotic and Prosthetic Association (AOPA)

Continued close liaison was maintained with AOPA, the American Board for Certification (ABC), and the newly formed American Academy of Orthotists and Prosthetists (AAOP) by personal contact and by staff participation in various Association activities. The Assistant Executive Director attended the AOPA National Assembly on Oct. 22-25, 1972, in St. Louis, Mo., and the Region I Seminar in Hartford, Conn., May 3-4, 1973.

Workshop on Injuries of Adolescents in Sports and Recreation

The Committee on Prosthetics Research and Development, in

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collaboration with the American Academy of Orthopaedic Surgeons and the Rainbow Foundation, sponsored a Workshop on Injuries of Adolescents in Sports and Recreation, held in Cleveland, Ohio, Dec. 4–5, 1972. A report is being prepared.

Postgraduate Course on the Advance in Orthotics—1972

On Dec. 11–13, 1972, the Executive Director, Assistant Executive Director, Staff Surgeon, and Staff Engineer participated in a postgraduate course entitled "The Advance in Orthotics—1972." The course was presented by the University of Miami Medical School and was co-sponsored by CPRD, the Veterans Administration, and the American Academy of Orthotists and Prosthetists.

Neural Organization and Its Relevance to Prosthetics

The Executive Director participated in a symposium on Neural Organization and its Relevance to Prosthetics on Mar. 1–3, 1973, in Houston, Tex. The symposium, whose main topic was neuromuscular stimulation, was sponsored by the University of Texas Medical School and Graduate School of Biomedical Sciences, and the Houston Neurological Society.

Workshop on the Role of Engineering in Spinal-Cord Injury Programs

Leaders from the spinal-cord injury programs sponsored or conducted by the Veterans Administration, the National Institutes of Health, and the Social and Rehabilitation Service, together with private practitioners, and representatives from the VA, NIH, SRS, and DOD, met at the Castle Point VA Hospital, Poughkeepsie, N.Y., May 3–5, 1973. Information was interchanged and ways explored by which engineering could be most helpful in research and in the management of patients with lesions of the spinal cord. More than 60 individuals participated. Present management methods and current research efforts were reviewed and recommendations for future action were made. A comprehensive report will be published.

Workshop on the Integrity of Endoskeletal Prosthesis

Because of reports by experienced prosthetists that instances of physical failure had occurred with the various types of endoskeletal lower-limb prostheses now available, a special workshop was organized. This workshop, which involved 10 prosthetists and engineers, was held on Apr. 25, 1973, in Atlanta, Ga., in conjunction with the annual conference of the chiefs of child amputee clinics. A report of the failures and suggestions for remedial action is being prepared.

and will be forwarded to appropriate manufacturers, government agencies, and others.

International Activities

The Assistant Executive Director attended the ISPO Symposium on Lower-Limb Prosthetics and Orthotics in Sydney, Australia, Aug. 20-24, 1972, and presented two papers. He also attended an ISPO committee meeting held in conjunction with the symposium.

The Assistant Executive Director also attended the ISRD Symposium held in Sydney, Aug. 27-Sept. 1, 1972. En route to and from these meetings, he visited rehabilitation centers and limb-shops in Japan, Australia, and New Zealand.

On Oct. 19-21, 1972, the Executive Director, the Chairman, and selected members of CPRD served on the faculty of the 7th Annual International Course in Prosthetics and Orthotics of the Swiss Association of Prosthetics and Orthotics (APO) held in Davos, Switzerland. They also participated in the international working group on Specifications for Lower-Limb Modular Prostheses held in Ascot, England, Oct. 29-Nov. 4, 1972.

Other international activities which involved staff and/or Committee member participation were: a meeting of the ISPO Executive Board, Davos, Switzerland, Oct. 21, 1972; a meeting on Functional Electrical Stimulators, Ljubljana, Yugoslavia, Nov. 8-12, 1972; and a Conference on Technology and the Handicapped, Ottawa, Canada, Mar. 5-7, 1973.

The Assistant Executive Director was invited to present a paper on nomenclature and classification for congenital limb deficiencies at a Workshop on Nomenclature and Classification in Congenital Limb Deficiencies held in Dundee, Scotland, on June 22-23, 1973. He also served as chairman of an international working group on the same subject which convened just prior to the workshop. In this workshop significant steps were made in the development of terminology which might be internationally acceptable.

The Assistant Executive Director served as a member of the faculty for a Course on Lower Extremity Prosthetics for Physicians and Surgeons, held in Estoril-Cascais, Portugal, July 2-7, 1973. This course, conducted under the auspices of the International Society for Prosthetics and Orthotics, was attended by 35 physicians, including five from Spain, one from France, and one from Brazil, in addition to the group from Portugal. This was the first prosthetics course held for physicians in this area.

Proposals Reviewed on Behalf of Sponsors

A total of 38 proposals in the fields of prosthetics, orthotics, and

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sensory aids were reviewed and appraised by the Committee at the request of sponsors (18 new proposals, 20 continuations).

Site Visits

At the request of sponsoring agencies staff members of CPRD, together with Committee members and experts in the pertinent fields, made the following on-site visits:

Mr. Charles N. Bengston (a manufacturer of special devices for upper-limb amputees)

University of Miami

Case Western Reserve University

Denver Research Institute

University of Utah

Vanderbilt University

Northwestern University Prosthetics Research Laboratory

University of California Biomechanics Laboratory
(Berkeley)

Texas A&M University

Harvard—Massachusetts Institute of Technology

University of Iowa

The Executive Director and the Staff Engineer for Sensory Aids visited Mauch Laboratories in Dayton, Ohio, in connection with projects on prosthetic devices and reading machines for the blind. In addition, the Staff Engineer for Sensory Aids visited American Institutes for Research in Palo Alto, Calif. (evaluation of reading aids), Haskins Laboratories in New Haven, Conn. (development of synthetic speech outputs for reading machines), and the University of Maryland in College Park, Md. (hearing-aid performance analysis).

The Assistant Executive Director also made visits to several Child Amputee Centers, some already participating in the cooperative research program coordinated by the SCPP and some prospective participants. These centers were: Georgia Juvenile Amputee Clinic, Atlanta, Ga.; Amputee Clinic, D.C. General Hospital, Washington, D.C.; Children's Health Center, San Diego, Calif.; Children's Hospital, Vancouver, Canada; Children's Hospital, Oklahoma City, Okla.; Shriners Hospitals for Crippled Children, Winnipeg, Canada, and Salt Lake City, Utah.

Miscellaneous

The staff responded to more than 1500 requests for publications and technical information.

PUBLICATIONS

- Annual Summary Report of Activities for Year Ending June 30, 1972* (Report to the Veterans Administration and the Social and Rehabilitation Service, from the Committee on Prosthetics Research and Development during the Fiscal Year 1971-1972).
- The Child with an Acquired Amputation*, NAS ISBN 0-309-02047-6. Proceedings of a symposium held June 9, 1970, under the sponsorship of the Subcommittee on Child Prosthetics Problems.
- The Cane as a Mobility Aid for the Blind*. Report of a Conference on the Long Cane, September 10-11, 1971.
- Workshop on Prosthetic-Orthotic Terminology—Interim Progress Report*, March 1972.
- Special Considerations Relating to the Child with a Limb Deficiency*, National Academy of Sciences. Proceedings of a symposium held March 23-24, 1972, under the sponsorship of the Subcommittee on Child Prosthetics Problems. (In preparation.)
- Report of Workshop on Fundamental Studies for Internal Structural Prostheses*, April 13-15, 1972.
- Report of Workshop on Functional Neuromuscular Stimulation*, April 27-28, 1972.
- Report of Fourteenth Meeting of Subcommittee on Evaluation*, August 21-22, 1972.
- Report of Ad Hoc Meeting on the Education and Use of Upper-Limb Orthotic Systems*, August 23, 1972.
- A Clinical Evaluation on Below-Knee Orthotics, Report E-6*. 1972.
- Report of Tenth Workshop on Upper-Limb Prosthetics*, September 21-22, 1972. (In preparation.)
- Report of Eighth Workshop on Lower-Limb Orthotics*, October 2-4, 1972.
- Comprehensive Management of Musculoskeletal Disorders in Hemophilia* NAS ISBN 0-309-02139-1, in press. Report of a workshop held October 12-14, 1972.
- Clinical Evaluation of the Ljubljana Functional Electrical Peroneal Brace, Report E-7*. 1973.
- The Child with an Orthopaedic Disability: His Orthotic Needs and How to Meet Them*. Report of a conference held November 19-21, 1972, under the sponsorship of the Committee on Prosthetics Research and Development and the Division of Orthopaedic Surgery, Howard University.
- Artificial Limbs*. Vol. 16, No. 1, Spring 1972.
- Inter-Clinic Information Bulletin*. (Published monthly under the sponsorship of the Subcommittee on Child Prosthetics Problems; 12 issues.)
- Newsletter . . . Amputee Clinics*. Six issues.

APPENDIX A

MAJOR PROSTHETICS AND ORTHOTICS PROJECTS

The following listing of projects active during fiscal year 1973 is expanded from last year's and includes projects not coordinated by CPRD. No claim is made for completeness, however, and suggestions for additions or corrections are invited. No attempt has been made to include the large number of foreign projects, though we are familiar with the SRS PL 480 international program and other programs overseas. (One French project is listed because it is funded directly by the Veterans Administration.) See Appendix B for an explanation of the abbreviations used below.

Organization and Responsible Investigator	Project Title	Sponsoring Agency
Area Cooperative Educational Services New Haven, Conn. Pasquale Mancino	Demonstration for Teaching of the Severely Involved Physically Handicapped Child through the Adaptive Teaching Methodist	LEI
Army Medical Biomechanical Research and Development Laboratory Fort Detrick, Mr. Orlyn C. Oestereich	Development of Prosthetic and Orthotic Materials and Devices	U.S. Army
California, University of Berkeley and San Francisco, Calif. Charles W. Radcliffe	Design of Prosthetic and Orthotic Devices and Biomechanical Studies of Locomotion	VA
California, University of Los Angeles, Calif. Harlan C. Amstutz	Prosthetic and Orthotic Evaluation Procedures	SRS
Yoshio Setoguchi (2)	Child Amputee Prosthetics Project	MCHS
John Lyman	Child Amputee Prosthetics	MCHS
	Reflex Control for Artificial Limbs	NSF
California, University of San Francisco, Calif. Verne T. Inman	Fundamental and Applied Research Related to the Design and Development of Upper-Extremity Externally Powered Prostheses	VA
	Summation of Human Locomotion	SRS
R. F. Steidel, Jr.	An Engineering Analysis of the Human Spinal Column	SRS
Case Western Reserve University Cleveland, Ohio Victor Frankel	Pathomechanics of Disorders of the Locomotor System	SRS

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Organization and Responsible Investigator	Project Title	Sponsoring Agency
Thomas Mortimer	Cybernetic Orthotic/Prosthetic Systems Development	SRS
Colorado State University Fort Collins, Colo. Daniel Graupe	Control Logic for Upper-Limb Prostheses	VA
Cyber Corporation Washington, D.C. Haig Kafafian	Procurement of Cybertype Systems	OE
Cybernetics Research Institute Washington, D.C. Haig Kafafian	Clinical Evaluation of "Cybertype" and "Cyberbrailer" for the Severely Distabled and Blind	SRS and OE
Duke University Durham, N.C. Frank W. Clippinger, Jr.	Development of a System to Provide Sensation from Upper-Extremity Prostheses	VA
George Washington University Washington, D.C. William Fortune	Clinical Evaluation in Orthotics and Prosthetics	SRS
Harvard Medical School Boston, Mass. Richard Warren	Survey of Lower-Extremity Amputations	VA
Illinois, University of Chicago, Ill. Jorge Galante	A Study of Spinal Orthotics in Idiopathic Scoliosis	SRS
Claude Lambert Lawrence E. Carlson	Study of Juvenile Amputees Research Initiation—A Multi- Mode Approach to Upper- Extremity Prosthesis Control	MCHS NSF
Johns Hopkins University Baltimore, Md. Gerhard Schmeisser, Jr. and Woodrow Seamone	Development and Evaluation of Externally Powered Upper- Limb Prostheses	VA
Massachusetts Institute of Technology Cambridge, Mass. Robert W. Mann	Rehabilitation Engineering Center	SRS
Igor L. Paul	Performance Testing of Artificial Joints	SRS
Mauch Laboratories, Inc. Dayton, Ohio Hans A. Mauch	Research and Development in the Field of Artificial Limbs	VA
McDonnell Douglas Astronautics Co., Astropower Laboratory Huntington Beach, Calif. S. Viglione	Detection and Prediction of Epileptic Seizures	SRS

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Organization and Responsible Investigator	Project Title	Sponsoring Agency
Miami, University of Coral Gables, Fla. Augusto Sarmiento	Study of the Development of Refined Fitting Procedures for Lower-Extremity Prosthetics	VA
Michigan Crippled Children Center. Grand Rapids, Mich. George T. Aitken	Evaluation of Prosthetic-Orthotic Devices Area Child Amputee Program	SRS MCHS
Mobility Engineering and Development, Inc. Plaza del Rey, Calif. Charles M. Scott	Development of Safety Appliances for Vehicles for the Handicapped	VA
Montpellier, University of Biomechanical Research Unit Montpellier, France Pierre Rabischong	Electrostimulation for Amputees and Paraplegics	VA
Moss Rehabilitation Hospital Philadelphia, Pa. Richard Herman	Upper-Extremity Prosthetics	SRS
	Rehabilitation Engineering Center	SRS
Moss—Temple University Philadelphia, Pa. Richard Herman	Neuromotor Control Systems: A Study of Physiological and Theoretical Concepts Leading to Therapeutic Application	SRS
National Academy of Sciences Washington, D.C. A. Bennet Wilson, Jr.	Research in Prosthetics, Orthotics, and Sensory Aids	VA SRS
Navy Prosthetics Research Laboratory Oakland, Calif. W. R. Applegate and Charles Asbelle	Lower-Extremity Prosthetic and Orthotic Development	U.S. Navy
New York University New York, N.Y. Leon Bennett	Stump Stress Analysis (Mathematical Model)	VA
Sidney Fishman	Child Prosthetic and Orthotic Studies	MCHS
	Clinical Evaluation of Prosthetic and Orthotic Appliances	SRS
H. Richard Lehneis	Bioengineering Design and Development of Lower Extremity Orthotic Devices	SRS
Northwestern University Chicago, Ill. Clinton Compere	Rehabilitation Engineering Center	SRS

Organization and Responsible Investigator	Project Title	Sponsoring Agency
Charles M. Fryer	Demonstration of Prosthetic and Orthotic Devices and/or Techniques	SRS
Robert G. Thompson	Prosthetic-Orthotic Research	VA
Ohio State University Columbus, Ohio	Robots, Manipulators and Powered Orthopedic Appliances	NSF
Robert McGhee	Orthotic and Prosthetic Evaluation	SRS
Rancho Los Amigos Hospital Downey, Calif. Vert Mooney		
James B. Reswick and Vernon L. Nckel	Rehabilitation Engineering Center	SRS
Roy Snelson	Feasibility Study of the Use of Transparent Sockets and Modular Prostheses in Clinical Practice	SRS
Temple University Philadelphia, Pa.	Development of Durable Prosthetic Reconstructions	VA
James W. Schweiger		
Texas A&M Research Foundation College Station, Tex. Paul H. Newell, Jr.	The Improvement of Prosthetic and Orthotic Devices through Materials Research, Analysis, Design, Clinical Testing, and Team Evaluation	VA
	Rehabilitation Engineering Center	SRS
Texas Institute for Research and Rehabilitation Houston, Tex. Thorkild J. Engen	Clinical Evaluation in Orthotics and Prosthetics	SRS
Tulane University New Orleans, La. King Liu	Structural Biomechanics of the Human Spine	NSF
USPHS Hospital Carville, La. Paul W. Brand	Study of the Prevention of Deformity in Insensitive Limbs	SRS
VA Hospital Castle Point, N.Y. Bok Y. Lee	Prosthetics Research on Hemodynamic Evaluation of Post-Operative and Preoperative Amputees	VA
VA Hospital Miami, Fla. Ross Davis	Clinical Studies of Amputees Managed by Conventional Methods	VA
Richmond, Va. Charles L. McDowell	Immediate postoperative Application of Upper-Extremity Orthoses	VA

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Organization and Responsible Investigator	Project Title	Sponsoring Agency
San Francisco, Calif. Wesley Moore	Study of Below-Knee Amputations for Vascular Insufficiency	VA
Seattle, Wash. Ernest Burgess	Immediate Postoperative Prosthesis Fitting and Ambulation	VA
Veterans Administration Research and Development Division New York City Eugene F. Murphy	Intramural and Extramural Research and Development in Prosthetics, Orthotics, and Sensory Aids	VA
Veterans Administration Prosthetics Center New York, N.Y. Anthony Staros	Research, Development, and Testing of Prosthetic and Orthotic Devices and Techniques	VA
Virginia, University of Charlottesville, Va. Warren Stamp and David Lewis	Fitting of Lower-Extremity Prosthetics	SRS

PROJECTS IN CANADA WHICH COOPERATE CLOSELY WITH THE PROSTHETICS AND ORTHOTICS PROGRAM IN THE U.S.A.

Organization and Responsible Investigator	Major Area(s) of Investigation
Prosthetic/Orthotic Research Unit, Ontario Crippled Children's Centre Toronto, Ontario Colin A. McLaurin	Development of a Wide Variety of Upper-Extremity and Lower-Extremity Body-Powered and Externally Powered Prosthetic and Orthotic Devices for Children
Rehabilitation Institute of Montreal Montreal, Que. Maurice Mongeau	Development of Externally Powered Upper-Extremity Prosthetic Devices, with Special Reference to Children
Prosthetics/Orthotics Research and Development Unit, Manitoba Rehabilitation Hospital Winnipeg, Man. F. R. Tucker and Reinhart Daher	Development of a Variety of Prosthetic Devices with Special Reference to Lower-Extremity Requirements
The University of New Brunswick Bio-Engineering Institute Fredericton, N.B. R. N. Scott	Orthotics and Prosthetics Systems Research with Special Emphasis on the Employment of Electromyographic Signals as Controls
University of British Columbia Vancouver, B.C. James Foort	Research in Lower-Limb Prosthetics and Orthotics and Study of Special Equipment for Severely Disabled Children
Shriners Hospital(s) Winnipeg, Man. David A. Winter and Douglas A. Hobson	Wide Variety of Rehabilitation Devices for Children

APPENDIX B

MAJOR SENSORY AIDS PROJECTS

The following listing of projects active during fiscal year 1973 is expanded from last year's and is based on a survey of federal and state agencies as well as private foundations and individual researchers. No claim, however, is made for completeness, and suggestions for additions or corrections are invited. Projects outside the United States were listed only as they came to our attention, and information on others would be especially welcome for future editions.

When it is known that only a portion of a project pertains to sensory aids, the word "part" appears in parentheses after the title.

Organization and Responsible Investigator	Project Title	Sponsoring Agency
Albert Einstein College of Medicine Bronx, N.Y. Isabelle Rapin	Early Diagnosis of Hearing Loss with Evoked Responses	MCHS
American Institutes for Research Palo Alto, Calif. Robert A. Weisgerber	Educational Evaluation of the Optacon (Optical-Tactile Converter) as a Reading Aid for Blind Elementary and Secondary Students	OE
	The Reading of Print Materials by the Blind	VA
American Printing House for the Blind Louisville, Ky. Carson Y. Nolan	Program for Facilitating the Education of the Visually Handicapped through Research in Communication	OE
Arkansas Enterprises for the Blind. Little Rock, Ark. Allan Ward	Evaluation of Ultrasonic Binaural Sensor (Kay device)	SRS
Bionic Instruments, Inc. Bala Cynwyd, Pa. J. Malvern Benjamin	Laser Cane Blind Mobility Aid	VA
Bolt, Beranek and Newman, Inc. Cambridge, Mass. Edward Starr	Development of a Wearable Master Hearing Aid Device for Clinical Studies	NINDS
Raymond S. Nickerson Kenneth N. Stevens	Development of Computerized Speech Training Aids for the Deaf	OE
British Columbia, University of Vancouver, Canada Michael P. Beddoes	Lexiphone—An Audible Output Reading Machine for the Blind	BCT CMRC CNRC
	Spellex—A Talking Typewriter for the Blind	VF WF
	Spelled-Speech Print-Reading Machine	

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Organization and Responsible Investigator	Project Title	Sponsoring Agency
California, University of Los Angeles, Calif. Donald D. Dirks	Loudness Discrimination and Amplification Relationships (human)	NINDS
CBS Laboratories Stamford, Conn. Emil L. Tovick	Design Concepts and Electronic Configurations for Wearable Master Hearing Aid Device for Clinical Studies	NINDS
Central Institute for the Deaf St. Louis, Mo. Ira J. Hirsh	Auditory Communication and Its Disorders	NINDS
Chicago, University of Chicago, Ill. Arnold P. Grunwald	Use Test of Braille Machines, Tape Generation Equipment and Techniques	OE
Childrens Hospital Research Foundation Washington, D.C. Ann B. Barnet	Sensory Evoked EEG and Behavioral Responses in Children	NICHD
Florida, University of Gainesville, Fla. William W. Dawson	Study Materials in Conjunction with a Sensory Prosthesis (cats)	NINDS
C. K. Adams R. D. Willis	Experimental Analysis of Visual Performance Evoked by Electrical Stimulation of Visual Cortex in Primates	NSF
Foundation for Hearing Aid Research Woodstock, N.Y. Edgar Villchur	Signal Processing to Improve Speech Intelligibility in Perceptive Deafness	FHAR
Franklin Institute Research Laboratory Philadelphia, Pa. James L. Gumnick	An Engineering Evaluation of Optacon	OE
Gallaudet College Washington, D.C. J. M. Pickett	Wearable Visual Aid for Speech Communication in the Hearing Impaired	SRS
Georgia Institute of Technology Atlanta, Ga. Thomas P. Barnwell	Research Initiation—Pitch Encoding in Speech Signals	NSF
The Hadley School for the Blind Winnetka, Ill. Donald W. Hathaway	Development of Correspondence Courses for Personal Reading Aids for the Blind	VA
Hadikappinstitutet Bromma 3, Sweden Jan-Ingvar Lindström	Laser Cane for the Blind	
Hartford, University of West Hartford, Conn. Bernard Z. Friedlander	Automated Language Tests and Enrichment for Deaf Infants	MCHS

Organization and Responsible Investigator	Project Title	Sponsoring Agency
Haskins Laboratories, Inc. New Haven, Conn. Franklin S. Cooper	Research on Audible Outputs of Reading Machines for the Blind	VA
Huntington Memorial Hospital Pasadena, Calif. Robert H. Pudenz	Study Electrical Stimulation of the Visual System (human, mammals, nonhuman)	NINDS
Illinois Department of Public Health Springfield, Ill. Phil B. Shattuck	The Application of Tympanometry for Identification of Early Middle Ear Pathology In Elementary School Children	IDPH LMCH NU
Illinois Visually Handicapped Institute Chicago, Ill. Thomas J. Murphy	Evaluation of Ultrasonic Binaural Sensor (Kay device)	SRS
Johns Hopkins University Baltimore, Md. Moise H. Goldstein	Study of Cutaneous and of Visual Patterned Stimulation Communication Aids for the Profoundly Deaf Infants (part)	NINDS
Rachael E. Seitz	New Approaches to Speech Instruction of Deaf Children (part)	NINDS
Louise Sloan	Neurosensory Interdisciplinary Research Program; Closed circuit Television Reading Aid	NINDS
Louise Sloan	Studies in Physiological Optics	NEI
Lexington School for the Deaf Jackson Heights, N.Y. Jules M. Greenstein	Methods of Fostering Language Development in Deaf Infants	OE
Marquette University Milwaukee, Wi. Russell J. Niederjohn	Research Initiation—Voiced and Continuous Speech Research	NSF
Maryland, University of College Park, Md. G. Donald Causey	Development of Improved Techniques for the Analysis of Hearing Aid Performance	VA
Massachusetts Eye and Ear Infirmary Boston, Mass. C. H. Dohlman	Intrinsic and Extrinsic Ocular Disease Investigations Cornea Research (human) (part)	NEI
Massachusetts General Hospital Boston, Mass. Daniel Pollen	Feasibility Study of a Visual Prosthesis for the Blind Utilizing Direct Electrical Stimulation of the Visual Cortex	NINDS
Massachusetts Institute of Technology	Sensory Aids Development and Evaluation	SRS

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Organization and Responsible Investigator	Project Title	Sponsoring Agency
Cambridge, Mass. George F. Dalrymple Samuel J. Mason	Bio-Engineering: Communication Sciences (part)	NIGMS
Derek Rowell	Evaluation of Ultrasonic Binaural Sensor	SEI SRS
M. Eden	Pattern Recognition of Conventional Symbol Systems (part)	NSF
Mauch Laboratories, Inc. Dayton, Ohio Hans A. Mauch	Development of Personal Reading Machines for the Blind	VA
Medical Research Council Cambridge, England D. E. Broadbent	Evaluation of Optacon (optical- tactile convertor) Reading Machine (Joint Project with St. Dunstan's and Royal National Institute for the Blind)	
Minnesota, University of Minneapolis, Minn. James J. Jenkins	Center for Research in Human Learning: Language Behavior (children, adults) (part)	NICHD
National Accreditation Council for Agencies Serving the Blind and Visually Handicapped New York, N.Y. Alexander F. Handel	Strengthening Services for the Visually Handicapped through the Application of Standards	SRS
Northwestern University Auditory Research Lab. Evanston, Ill. Raymond Carhart	Development of Test Procedures for Evaluation of Binaural Hearing Aids	VA
	Perceptual Masking in Normal and Impaired Hearers (human)	NINDS
Ohio State University Columbus, Ohio Richard M. Campbell	Research Initiation— Optimization of the Visual Vocoder for Speech Therapy	NSF
Pomorska Akademia Medyczna Szczecin-Pomorzany, Poland O. Palacz	Development of a Tactual Output Image Sensor for the Blind	
Rand Corporation Santa Monica, Calif. S. M. Genensky	Information Transfer Problems of the Partially Sighted	SRS
Rochester, University of Rochester, N.Y. Robert W. Doty	Development of a Sensory Prosthesis (human, monkeys)	NINDS

Organization and Responsible Investigator	Project Title	Sponsoring Agency
Dr. Robert	Feasibility Study of a Visual Prosthesis for the Blind Utilizing Direct Electrical Stimulation of the Visual Cortex	NINDS
Royal National Institute for the Blind London, England D. E. Broadbent	Evaluation of Optacon (optical-tactile convertor) Reading Machine (Joint Project with St. Dunstan's and Medical Research Council)	
St. Barnabas Medical Center Livingston, N.J. Gerald Fonda	Evaluate Closed Circuit TV as a Low Vision Aid	SEI
St. Dunstan's London, England D. E. Broadbent	Evaluation of Optacon (optical-tactile convertor) Reading Machine (Joint Project with Medical Research Council and Royal National Institute for the Blind)	
San Diego State College San Diego, Calif. Carol A. Galambos	Study of Auditory and Visual Systems in Infants	NICHD
Smith-Kettlewell Institute San Francisco, Calif. Carter C. Collins	Portable Seeing Eye	NEI
Paul Bach-y-Rita	Tactile Vision Prosthesis	SEI
	Tactile Television System for the Blind	SRS
	Development of The Neurophysiological Basis for Design of Portable Seeing Aid	NEI
Frank A. Saunders	An Electrotactile Sound Detector for the Deaf (human)	NINDS
Stanford Research Institute Menlo Park, Calif. J. W. Hill	Tactile Perception of Dynamic Spatial Patterns	NSF
Stanford University Stanford, Calif. John G. Linvill	Integrated Electronics for Medical Applications; Large Scale Integration (part)	NIGMS
The Swedish Association of the Blind Stockholm, Sweden B. Linqvist	Evaluation of Optacon (Optical-Tactile Converter) Reading Machine	SAB
Syracuse University Syracuse, N.Y. Martin Rothenberg	Voice Quality and Laryngeal Frequency	NINDS

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Organization and Responsible Investigator	Project Title	Sponsoring Agency
Telesensory Systems, Inc. Palo Alto, Calif. James C. Bliss	Manufacture of Optacons for a Field Trial Within Elementary and Secondary Schools	OE
Tennessee, University of Knoxville, Tn. Carl W. Asp	The Effectiveness of Low-Frequency Amplification and Filtered Speech Testing for Preschool Deaf Children	OE
VA Hospital, Central Blind Rehabilitation Center Hines, Ill. John D. Malamazian	Clinical Application Program in Reading and Mobility Aids for the Blind	VA
VA Hospital, Eastern Blind Rehabilitation Center West Haven, Conn. G. M. Gillispie	Clinical Application Program in Reading and Mobility Aids for the Blind	VA
VA Hospital, Western Blind Rehabilitation Center Palo Alto, Calif. Loyal E. Apple	Clinical Application Program in Reading and Mobility Aids for the Blind	VA
Wayne State University Detroit, Mi. John H. Gaeth	Joint Project for the measurement of Hearing Aids and the Advisement and Counseling of Children and their Parents	MMCH WSU RI
Western Michigan University Kalamazoo, Mi. Donald Blasch	Evaluation of Ultrasonic Binaural Sensor (Kay device)	SRS

ABBREVIATIONS:

BCT	—	The B. C. Telephone Company 768 Seymour Street, Vancouver, British Columbia, Canada
CMRC	—	The Medical Research Council of Canada National Research Bldg., M-58—Montreal Road Ottawa 7, Ontario, Canada
CNRC	—	The National Research Council of Canada Ottawa 7, Ontario, Canada
FHAR	—	Foundation for Hearing Aid Research Woodstock, N.Y. 12498
HEW	—	U.S. Department of Health, Education, and Welfare
IDPH	—	Illinois Department of Public Health 535 West Jefferson Street, Springfield, IL 62706
LEI	—	Lilly Endowment, Incorporated 914 Merchants Bank Building, Indianapolis, IN 46204
LMCH	—	Lake-McHenry Regional Program for the Hearing Impaired Title VI 440 West Old Grand Avenue, Gurnee, IL 60031

- MCHS — Maternal and Child Health Service—Health Services and Mental Health Administration, H.E.W.
5600 Fishers Lane, Rockville, MD 20852
- MMCH — Bureau of Maternal & Child Health
Michigan Department of Public Health
252 Hollister Building, Lansing MI 48904
- NEI — National Eye Institute, National Institutes of Health, H.E.W.
9000 Rockville Pike, Bethesda MD 20010
- NICHHD — National Institute of Child Health and Human Development,
National Institutes of Health, H.E.W.
9000 Rockville Pike, Bethesda, MD 20010
- NIGMS — National Institute of General Medical Sciences, National Institutes of Health, H.E.W.
9000 Rockville Pike, Bethesda, MD 20010
- NINDS — National Institute of Neurological Diseases and Stroke, National Institutes of Health, H.E.W.
9000 Rockville Pike, Bethesda, MD 20010
- NSF — National Science Foundation
1800 G Street, N.W., Washington, DC 20550
- NU — Northwestern University, Department of Communicative Disorders
2299 Sheridan Road, Evanston, IL 60201
- OE — United States Office of Education, H.E.W.
400 Maryland Avenue, S.W., Washington, DC 20202
- RI — Rehabilitation Institute
261 Mack Boulevard, Detroit, MI 48201
- SAB — The Swedish Association of the Blind—De Blindas Förening
Gotlandsgatan 46, 116 65 Stockholm, Sweden
- SEI — The Seeing Eye, Incorporated
P.O. Box 375, Morristown, NJ 07960
- SRS — Social and Rehabilitation Service, H.E.W.
330 C Street, S.W., Washington, DC 20201
- VA — U.S. Veterans Administration
Prosthetic and Sensory Aids Service
Vermont Avenue & I Street, N.W., Washington, DC 20420
- VF — The Vancouver Foundation, 2211-A
1177 West Hasting Street, Vancouver 1, British Columbia, Canada
- WF — Mr. and Mrs. P. A. Woodward Foundation, c/o H. Scarlett Woodward
Stores Limited
101 West Hasting Street, Vancouver 3, British Columbia, Canada
- WSU — Wayne State University
Department of Audiology, School of Medicine
261 Mack Boulevard, Detroit, MI 48201

APPENDIX C

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