HIGHLIGHTS OF VA CONTRACTUAL RESEARCH PROGRAM

PROSTHETICS

John O. Esslinger, M.D.
Birmingham, Michigan

This project continued its research on the attachment of an external prosthesis by semiburied attachment and of plugging the amputated bone to increase tolerance to end-weight bearing. If present dog experiments are successful, the technique eventually may have application for human amputees.

Dr. Esslinger's procedures with dogs consist of:

1. Continuing study of acceptability of different materials.
2. Continuing study of the effects of plugging amputated bone with Teflon or in combination with other materials, using multiple designs.
3. Use of semiburied implants alone or attached to the end of bone plugs by which direct end bearing can be attained.
4. Ultimately, developing external prosthesis for successful cases in methods 2 and 3, above.

Gilmatic, Northridge, California
Gilbert M. Motis

Since this project is a relatively new one under the sponsorship of the Prosthetic and Sensory Aids Service, it may be well to list the areas of investigation conducted at Gilmatic in a long-range plan.

1. Development of a completely electrically powered prosthesis, including prehension, wrist rotation, elbow flexion, and shoulder motion, to simulate near normal operation, from body or muscle-controlled sources. Components for each area of motion would be separately developed but coordinated with those for other motions, so that units may be provided to accommodate amputees at any level. Initial emphasis is on wrist rotation.
2. Development of a series of body or muscle-operated switching or transducer-type control systems. Each system would provide control from an independent source so that multiple controls may be produced without undue interference.
3. Research with a view to providing a variable "rate" in the control system to permit the amputee to select speed of motion and hence "time into working position" of the prosthesis in all important areas of operation.
4. Further development of a mechanical feedback sensing device.

Mauch Laboratories, Inc., Dayton, Ohio
Hans A. Mauch

In preparation for a clinical application study to be conducted by the Veterans Administration, assembly has been taking place of a number of Model A, Swing and Stance Control Systems.

The design of a pre-production prototype of a hydraulic ankle control unit has been completed with very satisfactory results. It is hoped that castings and component parts will soon become available for the assembly of the first pre-production unit.

The project is studying the use of a myo-electric control unit produced by the University of New Brunswick for the voluntary actuation of swing and stance control. Also under study is the use of ultrasonic energy for control of the prosthesis. Reflex-like control with voluntary override has always been considered more desirable than mere reliance on a signal like pressure on the heel, or even a sophisticated control like that in the Model A. One problem has been use of remaining stump muscles without unduly complicating the fitting process.

National Academy of Sciences-National Research Council
Washington, D.C.

A significant undertaking of the Committee on Prosthetics Research and Development during this period has been the preparation of a draft manual on immediate post-surgical management. Various research teams and others involved in immediate post-surgical fitting will meet in Chicago on July 13–14, 1966 with the prosthetics education groups to discuss plans for the conduct of educational programs to introduce the techniques on a wider scale. After trial at a pilot school, the manual probably will be further revised for wider publication.

Panel meetings on upper- and lower-extremity prosthetic fitting and on lower-extremity orthotics were held during the past few months.

The Committee on Prosthetic-Orthotic Education held its annual meeting in Washington, D.C. on April 7, 1966. Reports by the several subcommittees which had been active throughout the year were presented and discussed.

New York University, New York
Renato Contini

Dynamic pressure data are being collected and reduced. Peak pressure readings are being analyzed to determine how much variation can be expected for a variety of test conditions, e.g., variations at a particular site on a day-to-day basis. During successive runs, a gradual change in peak pressures had been noticed. It had been suggested that the Micro Systems transducers would produce such results if certain units were temperature, sensitive rather than fully temperature-compensated as claimed. Bench tests of the trans-

ducers revealed that a small change in temperature did produce a detectable proportional shift in electrical balance. Temperature recordings by a thermistor at the transducer location inside the socket indicated a paradoxical *drop* in temperature of a few degrees when the amputee began activity, presumably as a result of ventilation from pumping action causing evaporation of prespiration, rather than an increase in temperature from muscular activity.

The project also continued to follow the maintenance experience of 12 wearers of the Henschke-Mauch "HYDRAULIK" Model A, Swing and Stance Control System.

Northwestern University, Chicago, Illinois
Clinton L. Compere, M.D.

Two reports prepared by this project are published elsewhere in this issue: Lift Tab Positioning Jig and Adult Center Control Hook.

Development activities continued in both the upper- and lower-extremity fields. Project personnel continued to participate in panel sessions of the CPRD and in teaching assignments at Northwestern University.

An electric power assist, fitted to a bilateral amputee with a left above-elbow amputation and a right shoulder disarticulation, has been functioning well after some three months use. A long above-elbow amputee and a forequarter amputee will also be fitted. Further work is being done to make the unit more compact.

Lightweight flexible polyester laminate retaining sockets have been used with hemipelvectomy cases when the prosthesis is removed, apparently with good results.

Under the supervision of Dr. Compere, the Seattle techniques of immediate post-surgical fitting have been tried, with very successful results. The Northwestern University adjustable pylon has been adapted to the immediate post-surgical technique by the addition of expanded stainless steel straps for incorporation into the cast and by provision for a push-button quick disconnect between cast and pylon.

University of California at Los Angeles
Biotechnology Laboratory
John Lyman, Ph.D.

Elsewhere in this issue will be found the UCLA report on the Heidelberg pneumatic prosthesis. The project has also submitted its report on The Evaluation of the Northwestern University Attitudinally-Controlled Electric Elbow for possible publication in a future issue of the Bulletin. In process is the rewriting of a technical report on the French electric hand.

The project is exploring minor surgical methods for developing new body control sites, and experimental results are being evaluated. A report sum-

marizing the tentative criteria for externally powered prostheses is being prepared.

University of California at San Francisco and Berkeley
Charles W. Radcliffe and Howard D. Eberhart

Testing of the pneumatic swing-control units has continued at the Biomechanics Laboratory and in cooperation with the VA Prosthetics Center, New York. After correction of the original design to provide proper piston-cylinder clearance these units have proved to be effective and durable units requiring a minimum of adjustment over extended periods of use.

Thirty metal knee-shank assemblies for use with the pneumatic swing-control units have been delivered by the Hosmer Corporation. The metal assemblies will replace the present wooden knee-shank units which are currently being amputee-tested in San Francisco. These units are also adaptable to use by knee-disarticulation cases and spare units are available for this purpose.

The four-bar linkage polycentric knee has been completely redesigned to improve its range of motion, swing-phase control, and cosmesis when used with a piston-cylinder pneumatic swing control. The redesign made extensive use of a new mathematical method for linkage design developed by the biomechanics study group.

A study of the biomechanics of joint motion in the lower-extremity is being carried out in two parts: design of an instrumentation system for precise measurement of relative motion components at the ankle, knee, and hip joints and development of mathematical methods of synthesis of three-dimensional linkages which could be used as orthotic devices. The mathematical methods are of general engineering interest and two papers on these methods have been accepted for presentation at the Second ASME Conference on Mechanisms, November 1966.

An improved SACH foot was designed by an engineering graduate student and included provision for inversion-eversion, ankle rotation, and adjustable heel height. A simplified model incorporating inversion-eversion and adjustable heel height was constructed and tested. Based upon results of these tests, a second model has been constructed which incorporated an inclined inversion-eversion axis at 30 deg. to correspond to the keel angle of the SACH foot. Preliminary tests indicate that the inclination of the inversion-eversion axis may minimize the need for an ankle rotator in some cases.

VA Hospital, Seattle, Washington
Ernest M. Burgess, M.D.

Results of this project on immediate post-surgical prosthetic fitting continue to be highly gratifying.

Dr. Burgess presented a paper at the Annual Meeting of the American Academy of Orthopaedic Surgeons in January 1966. In connection with a panel meeting of the Committee on Prosthetics Research and Development program, Dr. Marian Weiss of Poland and other surgeons and research workers visited the project and reviewed a series of cases.

A film describing the technique has been completed and will shortly become available on a loan basis. The project has also worked closely with the Executive Director of the Committee on Prosthetics Research and Development in the drafting of a comprehensive manual covering the various aspects of immediate post-surgical management.

Dr. Burgess and his staff will participate in plans for the teaching of the technique by the three universities offering prosthetics educational programs, namely New York University, Northwestern University, and the University of California at Los Angeles.

SENSORY AIDS

Fabrication of Obstacle Detectors for the Blind

Bionic Instruments, Inc., Bala Cynwyd, Pennsylvania
J. Malvern Benjamin, Jr. and D. Ridgeley Bolgiano

Work continues on the cane-mounted electronic aid for the blind mentioned and illustrated in BPR 10–4 Fall 1965, the preceding issue of this Bulletin. The feature presenting the most difficulty to the researchers is detection of curbs or step-downs several steps ahead of mechanical contact of the cane tip. Solution of this problem through optical means has proved sufficiently difficult that one channel of the three in the cane is reserved exclusively for this function. The recent advent of semiconductor injection lasers operable at room temperatures promises to allow for significant advances in reaching a solution to the curb detection problem. Gallium arsenide laser-like material of slightly different composition has been used in a noncoherent or "nonlasing" mode for about two years as a much brighter source than previously available flash lamps, but was only marginally bright enough on poor targets, especially at the oblique angles needed for early warning of curbs.

Along with staff members in the contractor's organization, Dr. Murphy and Mr. Freiberger of the VA Research and Development Division, PSAS, have been actively seeking out appropriate lasers for use as light sources in the cane. Government, University, and industrial sources have been very cooperative. Because of the recency of the laser's development, its superb light production capabilities, and the relatively simple associated optics and electronics, some of the manufacturers of the material, though sympathetic to the needs of the blind, have been guarded in revealing certain trade secrets or even coming to reasonable sales agreements. A tiny chip of

specially doped [a] gallium arsenide, about 4 x 4 x 10 mil rectangular prisms, cleaved to length on the natural cleavage planes of the material, comprise the actual laser. The cleaved surfaces serve as the "mirrors" at the ends of the laser, reflecting the infrared radiation back and forth in a resonant cavity. Fed with an appropriate pulse of current through mounting electrodes, this laser emits an extremely bright flash, concentrated in a narrow cone easily captured by a small lens. It is believed this source will greatly improve the functioning of optical mobility aids for the blind, such as the cane under development at Bionic Instruments, Inc.

Spelled-Speech for Automatic Readers Usable by the Blind
Metfessel Laboratories, Inc., Los Angeles, California
Milton Metfessel, Ph. D. and Constance Lovell, Ph. D.

As indicated in the report on the Sixth Reading Machine Conference, published in this issue of the Bulletin, Professor Metfessel is currently engaged in reducing his long experience with spelled-speech to a set of rules usable by any researcher to produce a set of spelled-speech sounds. This information will be included in a final report on this project scheduled for publication about July 1966.

Research on Audible Outputs of Reading Machines for the Blind
Haskins Laboratories, Inc., New York, N.Y.
Franklin S. Cooper, Ph. D. and Jane Gaitenby

The aim of the research at Haskins Laboratories has been and still is to find out how to generate acceptable speech in the best and simplest way. Such speech generation is required because of a fundamental assumption that only spoken English will prove acceptable for a truly high-performance reading machine. The man-made speech will be produced on the basis of letter or word knowledge taken from the printed page by optical character recognition equipment.

Activities at the Laboratories continue in several areas including refinement of rules for synthesis, study of speech cues in various contexts, intonation and stress, voice recording for compiled-speech reference words, word-by-word synthesis from control signals (re-formed speech), studies of the rules of prosody, and plans for field tests with compiled speech.

Technical details of much of the research in speech at Haskins Laboratories may be found in the four issues of their Status Report on Speech Research, a publication that first appeared in January 1965.

[a] Addition of a small amount of some other substance.

Output Characteristics and Construction of an Interim Word-Reading Machine

Haskins Laboratories, Inc., New York, N.Y.
Franklin S. Cooper, Ph. D. and Paul Brubaker

At a demonstration of this machine, compiled speech was automatically produced from a locally prepared "Teletypesetter" tape used as "input." The demonstration proved the workability of the concept.

During the period of this fixed-price contract (1957–1966), there have been extraordinary advances both in machine technology and in understanding of speech synthesis. The original concept of stringing prerecorded words together using the hardware first contemplated, today seems a largely obsolete approach. For this reason, steps are being taken to terminate this contract and to transfer equipment and knowledge resulting from the work to the other VA contract with Haskins Laboratories.

The Development and Evaluation of a Personal Reading Machine for the Blind

Mauch Laboratories, Inc., Dayton, Ohio
Hans A. Mauch and Glendon C. Smith

Since the last issue of the Bulletin, work at Mauch Laboratories has been concentrated on the evaluation of the Visotactor B, construction of a Multicolumn Visotactor, evaluation of the Visotoner, and initiation of construction of 4 new Visotactors B, 6 Visotoners, and 10 Colineators. Messrs. Mauch and Smith presented several papers at the Sixth Reading Machine Conference (reported elsewhere in this issue of the Bulletin). Mr. Smith presented a paper, "A Family of Portable Reading Machines for the Blind," at the 50th Anniversary Meeting of the Optical Society of America, and Mr. Mauch appeared on network television in the "I've Got a Secret" program, March 21, 1966.

During January 1966, Miss Reinicke, the blind subject in Dayton, began reading a book of mystery stories, *Alfred Hitchcock's Ghostly Gallery,* with the Visotactor B and Colineator. After several hours of practice, she became accustomed to the new type style and the techniques involved in reading a book. The first test was taken from page 13. Miss Reinicke read for twenty minutes at an average speed, including line change time, of 7.0 words per minute.

On February 3, 1966, Miss Reinicke read page 33 of the Hitchcock book at an average rate of 8.0 words per minute and on February 15, 1966, she read page 47 at an average rate of 8.1 words per minute. On February 17, the Visotactor B used by Miss Reinicke was modified to produce less energetic tactile stimuli. The voltage applied to the stimulator coils was reduced from 6.0 volts to 4.5 volts. Miss Reinicke reported that the reduced stimulator voltage in the Visotactor B seems to allow reading for longer periods without fatigue. On March 1, 1966 and March 22, 1966, Miss

Reinicke read from her book at average rates, including line change time, of 6.9 and 6.4 words per minute, respectively.

The completed Multicolumn Visotactor was first tested on January 26, 1966 and performed satisfactorily. The tactile display is somewhat confusing at first for a person accustomed to a single column device. In a short time, however, the user begins to recognize letters and shapes.

Further experiments with the Multicolumn Visotactor prototype indicated that the circular cells first used in the photocell array result in a tactile pattern sufficiently different from that produced by narrow, tall cells from the same printed character to confuse a person accustomed to the narrow, tall cells. To eliminate this effect as a variable in later testing, the array of circular cells first used in the Multicolumn Visotactor will be replaced with an array of 24 rectangular cells each .010 in. wide and .050 in. high. Drawings and mask negatives for such an array were made and copper masks were etched. Several arrays have already been completed.

Mr. Harvey Lauer, a VA staff member at Hines, Illinois, originally trained on the VA-Battelle Optophone, demonstrated the Visotoner at the Sixth Technical Session on Reading Machines, Washington, D.C., January 1966, and indicated that he was already using it to read labels on cans and boxes in addition to letters, signatures, paper money, bank statements, etc. He had carried the Visotoner and its battery in the leather case to a supermarket where he scanned the labels of possible purchases. Mr. Lauer also stated that rotating the optical barrel to correct for italics did in fact make italics readable.

The special manufactured parts for the construction of 4 Visotactors B, 6 Visotoners, 10 Colineators, 10 battery chargers, 20 rechargeable batteries, 10 spare lamp assemblies, and 5 spare optical barrel assemblies were ordered during January 1966. The gages needed for manufacturing and inspection were ordered also. Many of the temporary assembly tools used at Mauch Laboratories were improved, and several new tools were made.

The photocell arrays used in earlier prototypes were made by cutting standard photocell substrates with a diamond wheel to fit the array barrel. Considerable savings in labor would result by having an alumina substrate manufactured in the final shape needed. Three manufacturers of high alumina ceramics were requested to bid on making the photocell substrate to our specifications.

During March 1966, the electronic parts for the Visotactor and Visotoner prototypes were ordered. Most of the manufacturing and inspection gages were received and accepted by Mauch Laboratories. The aluminum castings for the Visotactor-Visotoner handles and bases and the Colineator cross slides were completed during March and given to the parts manufacturer for the required machining.

Determination of Performance Attainable with the Battelle Optophone
American Center for Research in Blindness and Rehabilitation, Newton, Massachusetts
Leo H. Riley, M.D.

The two subjects in this program reported on in BPR 10–4 have temporarily withdrawn, one because of illness, the other as a result of obtaining short-term employment in another city. The tests were thus brought to a halt. Project operations are now being revised to allow for the training of new subjects in the evenings and on weekends. These more convenient hours for instruction should provide for a more stable retention of subjects in the program.

Evaluation of Ultrasonic Aid for the Blind
American Center for Research in Blindness and Rehabilitation, Newton, Massachusetts
Leo H. Riley, M.D. and Gunther Weil, Ph. D.

Since October 1965, a total of fourteen subjects have been trained and tested in the use of the Kay guidance device. Progress of the work has been hampered by instrument failures necessitating the return of several instruments to England for replacement and by the loss of four subjects who dropped out of the program during the Christmas recess.

Project training began with an introduction to the physical structure of the device and to principles of operation, emphasizing the carrying, packing, and unpacking of the device. Elementary ranging experiments then followed, and by December 1965, all subjects were estimating the distance to a wall as subjects moved back from the wall as well as estimating distances to a moving trainer. All subjects also practiced in determining range limits for the device.

Four subjects who dropped the program during the Christmas recess were replaced in January 1966. The new subjects were put through intensive ranging procedures. By January, the subjects were attempting to maintain a constant distance between themselves and a moving trainer, and evaluation of their static ranging skills was carried out.

By February, dynamic ranging skills were evaluated and training on static scanning was begun. Subjects were trained to locate the trainer in a 180-deg. arc, to estimate the range, and then to locate the trainer by touch. Following this, subjects were trained to scan on a 360-deg. pattern with the trainer moving in and out of the arc at varying distances. This task involved both scanning and ranging skills.

In object location experiments, the subjects were required to determine the number of objects in a room and find each object in turn. Training in indoor navigation involved stairs and doors.

With the advent of spring, outdoor training commenced, and indoor testing was completed. Emphasis was placed on obstacle detection, safety,

finding of landmarks, and the following of paths. A film was made of the subjects using the device. Subjects were tested in these areas and the data are being analyzed.

A paper on this research was presented at St. Dunstan's International Conference on Sensory Devices for the Blind, June 1966.

Development of Test Procedures for Evaluation of Binaural Hearing Aids
Northwestern University, Evanston, Illinois
Raymond Carhart, Ph. D.

One line of current investigation has been the study of the influence of head movement on monaural and binaural reception of speech materials. Monaural and binaural reception of speech materials in the presence of competition was tested under: (1) a condition in which the human head was held immobile by mechanical means, (2) a condition in which the listener could move his head slightly, and (3) a condition in which the subject was permitted substantial head movement. The competing signal in the first part consisted of a second talker reading sentences, while speech spectrum noise served as the competing signal in the second part of the experiment. Results revealed no important differences between the condition for which the head was held immobile and the condition analogous to that used in previous work under this contract, namely, the situation permitting slight head movement. Moreover, substantial head movement reduced the head shadow effect only slightly. Also, binaural listening was consistently superior to the best monaural situation regardless of whether the head was held immobile or permitted slight or substantial movement.

A second investigation deals with hearing aids from three manufacturers with different degrees of harmonic distortion. Two instruments of each hearing aid from each manufacturer have been purchased and tested repeatedly with various inputs and gain settings. In one instance, sharp differences in harmonic distortion were found between two instruments of the same model and manufacture. There is some indication that the differences observed may be attributable to the insert receiver of the hearing aids, at least for the particular instruments purchased. Various procedures for measuring harmonic distortion are being tested in an effort to determine the effect of the test condition on the amount of harmonic distortion observed in the hearing aid.

The performance of hearing-impaired persons while receiving speech through these different hearing aids is currently being studied. Speech reception thresholds, speech discrimination in quiet, and speech discrimination in the presence of competing signals are being tested. Monaural direct, monaural indirect, and binaural listening conditions are employed when testing speech discrimination in the presence of competition.

Electroacoustic Characteristics of Hearing Aids

Houston Speech and Hearing Center, Houston, Texas
James Jerger, Ph. D.

Recent research on this project has shown that physical differences between hearing aids can be reflected by a suitable sentence intelligibility test. In order to achieve such results it was necessary to make the listening task complex, to control for learning, and to minimize error by repeating the same materials several times. When this test was employed to evaluate individual hearing-impaired subjects, the rank-ordering of aids was reasonably constant. In other words, the best hearing aid for *any* subject was apparently the best hearing aid for *every* subject, at least in the small selection of aids tested.

Although this test consistently differentiated among hearing aids differing widely in their acoustic characteristics, previous experiments have indicated that the magnitude of the differences can be altered appreciably by simply varying the nature of the instruction given to the listener. The contractor proposes, therefore, to continue development on a new battery of speech materials that will discriminate among hearing aids, but that will also be resistant to the kinds of subject variability that have been previously demonstrated.

For this purpose, a new sentence intelligibility test has been developed. The message sets for this test consist of artificial or synthetic sentences of actual English words. The sentences were constructed on the basis of specific linguistic rules. In this way, both the length and relative informational content of each sentence in a message set can be precisely controlled. The use of artificial sentences in place of actual English sentences permits the construction of many equivalent forms. The ease with which these materials can be generated provides a new and exciting technique for manipulating several variables of hearing aid performance on the same listeners.

The Effects of Distortion on Hearing-Aid Performance

Auditory Research Laboratory, VA Hospital, Washington, D.C.
Roger N. Kasten, Ph. D. and Stephen H. Lotterman, Ph. D.

For many audiologists, the only method by which they may determine the electroacoustic characteristics of a given hearing aid is to consult the manufacturer's specifications for that instrument. To determine the accuracy and reliability of these published characteristics, a representative group of eyeglass, behind-the-ear, and body-type aids were selected with 15 instruments of each model being tested. All testing was accomplished in a miniature anechoic chamber, and with each instrument, measurements were made of full-on gain, gain versus frequency response at the full-on gain setting, and total harmonic distortion at approximately 12 discrete frequency points.

The results revealed a great deal of variability between the manufacturer's specifications and the actual performance of the groups of aids. The vari-

ability within groups was also quite large. For most models, there was a wide range of gain values and distortion levels among the 15 aids of the group. The gain versus frequency tracings often revealed markedly different patterns.

These results indicate that the actual aid tested should be issued as in VA practice, or that a follow-up visit should ensure that an externally purchased aid of the same make and model tested is actually appropriate for the hearing aid user.

Intermodulation test tapes prepared at the National Bureau of Standards are being used with a group of hard-of-hearing subjects to gain knowledge of the psychoacoustic reaction to this particular form of equipment deficiency.