VA Hospital, Seattle, Washington
Ernest M. Burgess, M.D., and Joseph H. Zettl

Clinical research of immediate postsurgical prosthetics management and application of this concept of amputee management and rehabilitation continued.

Efforts were directed to develop further and improve present surgical techniques, specifically in our investigation of the geriatric amputee with ischemia. Various preoperative assessment techniques of extremity blood flow are being studied to allow for more accurate amputation level selection.

Technical refinements consisted of clinical evaluations of new interface materials, such as Silastic foam pads. Polyurethane foam will be considered for the same purpose as soon as contouring difficulties can be overcome. The above-knee suspension system is under study for possible improvement of its effectiveness. Also preformed adjustable quadrilateral above-knee socket brims of plaster of paris are being evaluated further and clinically tested.

Follow-up data and pertinent information on all available patients are carefully gathered, recorded, and maintained.

Major educational activities were conducted in cooperation with the Veterans Administration. Two seminars on Immediate Postsurgical Prosthetics Management were held in Miami and in Houston.

SENSORY AIDS

Howard Freiberger, A.M.

Electronics Engineer, Research and Development Division
Prosthetic and Sensory Aids Service, Veterans Administration
New York, N.Y. 10001

Fabrication of Obstacle Detectors for the Blind

Bionic Instruments, Inc., Bala Cynwyd, Pennsylvania 19004
Thomas A. Benham, J. Malvern Benjamin, Jr., D. Ridgeley Bolgiano, and E. Donnel Meeks, Jr.

An article was submitted to the Bulletin entitled "A Review of the Veterans Administration Blind Guidance Device Project." This article, which appears elsewhere in this issue, covers the development of the C4 laser cane from its inception. Also included is a review of various other guidance devices for the blind that have been suggested and tried.

New developments have evolved around the construction of C4 canes. There was also some development work in one-piece and collapsible boron-stiffened canes.

Research on Audible Outputs of Reading Machines for the Blind

Haskins Laboratories, Inc., New York, N.Y. 10017
Franklin S. Cooper, Ph. D., and Jane Gaitenby

The objective of the work at Haskins Laboratories is to find practical methods for generating spoken English from literal text as the output of a reading machine for the blind. Three different types of spoken output are being investigated, each offering individual advantages (in voice quality, for example) and disadvantages (operating cost, additional development time, etc.).

The simplest of these methods generates *compiled speech* from a vocabulary of spoken words. The words were recorded originally on magnetic material striped on cards, one word per card. These word recordings, transferred to digital storage, can be reassembled, i.e., compiled, into the sequence required by the message at hand. The resulting speech is quite intelligible and realistic; reading speeds of 120 words per minute pose no problem. Recent work on this system has been the completion and testing of the PCM equipment for converting the word recordings into digital form for storage on magnetic tape, and for the reverse process of reading the magnetic tapes back into speech. A paragraph-length test passage constructed in this way was converted into speech at different rates (with minor distortions of pitch and formant frequencies) in order to find the optimum choice of playback speed, which seems to be about 10–15 percent faster than the original recording rate. The programing necessary for automating the system and generating page-length readings is underway.

A second type of audible output is *re-formed speech*. This also uses information stored on a word-by-word basis, but the items stored are the control parameters for a formant-type speech synthesizer. Advantages are better, faster, and more natural speech and a much reduced storage requirement—which allows lower operating costs as well as a larger vocabulary without need to spell missing words. A penalty is that, for each word in the vocabulary, the control parameters must be obtained by measuring spectrograms of the spoken word and storing them in the computer—a lengthy task. Current work on re-formed speech is aimed at mechanizing these measurements. The sound spectrogram of a word will be optically superimposed on the screen of our computer display tube and the formants can then be tracked (with the cathode-ray spot) by a hand-held "mouse" that controls the computer while entering measurements directly into its memory. The display equipment is on hand, the mouse is essentially complete, and the programs for tracking and entering data are being written.

The third method of generating speech is *synthesis-by-rule*. This has moved much nearer realization than seemed likely as little as a year ago. Synthesis-by-rule has many inherent advantages, but it also involves much more research to achieve speech naturalness. Three stages are involved in

going from the letter identities of the printed text to spoken output: one is to convert the graphemes into phonemes, then phonemes to control parameters, and finally control parameters into synthetic speech with a formant-type synthesizer. During the past year, Dr. Mattingly has completed his rules for sentence synthesis and his tables of parameters for general American phonemes. These have been used with a computer-driven synthesizer to produce an output of highly intelligible, if not totally natural, synthetic speech for numerous randomly chosen texts. Further improvements are certainly anticipated, but already the second and third stages of synthesis-by-rule are sufficiently operational to deserve serious testing. Progress has been made also on the first stage of the process, the grapheme-to-phoneme conversion. A pilot program was prepared by Miss Gaitenby for converting the letter sequences of words into phoneme sequences including syllabification and word stress prescription by rule. Tests of various texts, not extensive, but probably representative of popular periodicals, indicate that at least 85 percent of the words of normal sentences are acceptably converted to sound by these rules, used in concert with Dr. Mattingly's synthesis program. The rules, thus far, have been simulated rather than programed for automatic computation. They are, nevertheless, fully explicit and so can be converted into a computer program in due course. The present rules deal primarily with lexical stress and make their phonemic and word stress assignments either on the basis of number of syllables in a word or on the basis of affixes. (A mere handful of suffixes—and a few prefixes—play a dominant role in English vocabulary, and often serve to predict stress in the words in which they occur.)

In summary, work is progressing on all three types of speech output for a reading machine, with pilot tests imminent for compiled speech and reasonably near for speech synthesized by rule, provided unexpected difficulties do not arise in converting the grapheme-to-phoneme prescriptions into an operating computer program. [The work on reading machines is closely related to other research on speech perception and production underway at Haskins Laboratories. A summary account of this work, and other research in the Laboratories, was published during the period under review.]

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

Mauch Laboratories, Inc., Dayton, Ohio 45439
Hans A. Mauch and Glendon C. Smith

The production version of Mauch Laboratories' Recognition Machine has been given the name "Cognodictor" to distinguish it from the earlier bench model (Recognition Prototype II). The Cognodictor design is progressing smoothly and two major sections, the Word Synthesizer electronics and a new design Word Storage Unit, have been built and tested.

The Word Synthesizer electronic circuit uses seven transistors and nine integrated circuits on a single printed circuit board (4½ x 4½ in.) to select and amplify one out of 31 spelled-speech letters recorded on optical sound tracks of the rotating drum-type audio memory. The commercial circuit this section replaced used 47 transistors and 160 diodes located on seven circuit boards.

The new Word Storage Unit uses 25 complex function integrated circuits on one 4½ x 4½ in. board to provide storage for up to eight binary signals representing the letters being recognized by the machine. Additional storage capacity can be provided by using a second card, if required. The new Word Storage Unit also replaces up to seven printed circuit boards with one board the same size. These two sections designed for the Cognodictor will contribute to meeting the cost and size objectives for the production version of the recognition machine. The remainder of the circuitry will be redesigned to use integrated circuits, and three Cognodictor prototypes will be assembled for use by blind subjects.

The Visotactor B and Visotoner direct translation reading aids in the field were improved by adding a speed dependent viscous damping device to the axle of the proximal roller. This miniaturized device takes the place of the line change knob and enables the user to "pace" his scanning speed by maintaining a steady pulling force.

A thumbwheel control for the tactile stimulator driving voltage was designed and added to one Visotactor B prototype. This control can be adjusted by the user to vary the intensity of the fingertip stimulators over a wide range. Users of the Visotactor have said that such a control would help compensate for fatigue and difficult reading material.

The experience of blind users of the six Visotoners and four Visotactor B's has resulted in several design changes in addition to the two discussed above. The lamp assembly was redesigned to replace the clip-in mounting by a more secure attachment using machine screws. The lamp life is expected to be 10,000 hours or more so that user replacement is less necessary. Improvements in the printed circuit design of both aids were made to reduce the incidence of faulty connections. The Visotoner circuit specifications were changed to facilitate recording its output.

Determination of Performance Attainable with the Battelle Optophone

American Center for Research in Blindness and Rehabilitation, Newton, Massachusetts 02158

Leo H. Riley, M.D., and Mrs. Ruth Morris

A three-speed, motor-driven, mechanical tracker was developed by Mr. Edward Luttropp and finished by November 1967. Meanwhile, both of the Center's optophones developed electronic problems which were finally corrected.

Miss B. F. resumed training on November 29, 1967. She remembered what she had learned 2 years previously and required no teaching. She read 8.0 words per minute on her first test. (She originally scored 2.0 words per minute on the same test three years ago.) She found the mechanically driven board a great advantage. She appreciated the "pacing" which it provided, pointing out that she could concentrate better when she did not have to use her hands so much and that the mechanical device produced a much more "constant, smooth speed."

Miss B. F. died February 13, 1968, after a brief illness. Her optophone was assigned to Miss C. C. on February 27, 1968. By the end of March, she had finished Lesson 3. The demands of her school work made it difficult for her to find sufficient time to practice on the optophone. She is being assisted by her mother in her home.

Miss F. B. started with the other optophone on January 14, 1968. She has finished Lesson 12, having done two lessons a week by herself with constant teaching from Mrs. Morris through Lesson 8. After Lesson 8, she spent more time studying the tapes by herself and now reads more easily. On Test 1, she read 5.9 words per minute on March 27, 1968. Her problems have been principally mechanical. Mrs. Morris and Mr. Luttropp have solved these as they occurred, but progress in learning is still hampered by frequent inconsistencies in the taped lessons, especially in the spacing of words or lessons on the tapes, and also by less frequent distortions of the taped tonal quality.

We plan to have the Misses F. B. and C. C. continue this same program, using Mr. Luttropp's mechanical tracker under the guidance of Mrs. Morris. Both these subjects seem sufficiently motivated to do well with the optophones. We are satisfied so far that allowing the subject to use the optophones at home is a better approach than having the subjects come to the Research Center to use the optophones as was originally planned.

Evaluation of Ultrasonic Aid for the Blind

American Center for Research in Blindness and Rehabilitation, Newton, Massachusetts 02158

Leo H. Riley, M.D., and Mrs. Ruth Morris

The results of the recently completed field tests are being summarized for possible publication.

The Center is awaiting receipt of some instructional text and tape-recorded materials, which are being used at Hines and at Palo Alto. It is planned to make use of these materials with selected subjects.

Reading and Mobility Aids for the Blind, Centrally Directed Clinical Application Program

Central Rehabilitation Section for Visually Impaired and Blinded Veterans, VA Hospital, Hines, Illinois 60141

John D. Malamazian and Harvey L. Lauer

Working with the Mauch Visotoners (optophones) and the Mauch Visotactors B (tactile optophones), it is endeavored to bring this equipment from the laboratory into use in the following four ways:

Testing

The Mauch viscous damping pacing aid was added to several reading machines and found to be valuable for reading, both with and without the Colineator (tracking board), and for making recordings of the Visotoner output. It reduces pace variations and results in higher legibility.

Earphones were tested and equipment calibrated for use with fitted earmolds. The results will be a more uniform ear coupling for students. An accessory for making tape recordings of improved quality was tested and also an accessory was used which facilitates note-taking while reading.

Developing Instructional Aids and Teaching Skills

A series of instructional Visotoner tape recordings was made and is now being evaluated. These include letter, word, and sentence studies. Several days were used in working with Miss Margaret Butow of the Hadley School for the Blind. This work included testing equipment, help in beginning work with a deaf-blind student, and assistance in developing the Hadley School home study course for screening Visotoner candidates.

A teaching manual was drafted for users and instructors of the Visotactor B. An instructor's monitor for the Visotactor was devised by Mr. Lauer which is proving very helpful in demonstrating and in working with beginners. Tactile aids were developed and duplicated, which illustrate letter shapes and the stimulus patterns of the Visotactor.

Direct Teaching of Students

The Visotoner—Seven students were given instruction during the period just prior to this writing, four of whom were selected for continued training. Of these, two have reached Lesson 150 (three-fourths of the Battelle Course). These two students are reading typewritten material in addition to the course material. (The reading speeds of all students vary between two and ten words per minute.) New personal uses for the Visotoner continue to be found.

The Visotactor B—A veteran who began working with this instrument in November has reached Lesson 70. Mr. Lauer is currently developing his own skill with the Visotactor.

Public Information

An article, "The Visotoner: A Personal Reading Machine for the Blind," by Harvey Lauer which appears elsewhere in this issue of the Bulletin is also slated for publication in three other periodicals: The New Outlook for the Blind, The New Beacon, and The Home Teacher. Tape recorded demonstrations have been published in small "taped" periodicals with small circulations. Correspondence is carried on with agency personnel and equipment is demonstrated for interested persons. A presentation was made by Mr. Lauer at the Midwest Conference of Home Teachers in Columbus, Ohio, in September 1967, and the occasion was used to make a helpful and interesting trip to Mauch Laboratories in Dayton, Ohio.

Development of Correspondence Courses for Personal Reading Aids for the Blind

The Hadley School for the Blind, Winnetka, Illinois 60093

Donald W. Hathaway and Margaret Butow

A master recording is soon to be made of the 25-lesson taped correspondence course designed to screen economically candidates for more extensive personalized training in optophone-style reading machines such as the VA-Mauch Visotoner. Current activities center around perfecting the specialized techniques necessary for recording and duplicating the training tapes.

New letters of the alphabet will be introduced at the rate of between two and five letters per lesson. Eight to ten words will also be introduced in each lesson, and there will also be one to three sentences. Tests employing words produced in the "code" of the machine will be included in each lesson. Part of each test will allow for immediate check and reinforcement as some answers will be provided in the tape. Other test selections and oral questions will have to be answered and forwarded to the course instructor at Hadley School for the Blind for grading and comment. In the more advanced lessons of this preliminary screening course there will be examples of materials from the Battelle Memorial Institute 200-hour training course and demonstrations of the effects of alignment of the probe to the line-of-type and of the size-of-type adjustment. The effects of illuminating-lamp brightness setting will also be touched on. In the 25th and final lesson of the course there will be a five-part final examination.

Development of Test Procedures for Evaluation of Binaural Hearing Aids

Northwestern University, Evanston, Illinois 60201

Raymond Carhart, Ph. D., and Wayne O. Olsen, Ph. D.

A part of the current work on this project involves the development of test materials in which monosyllabic words are presented against modulated white noise competition. The use of modulated white noise is currently being studied since other work in the laboratory has indicated that white

noise, modulated by a 10 dB step every 125 msec., produces masking very much like the interference provided by the second talker of the competing message test. Tests of speech discrimination employing noise competition are more easily replicated than competing message tests.

Work is also underway with a system in which the output of a hearing-aid microphone in a conventional behind-the-ear hearing-aid shell is led to different hearing-aid receivers through an adjustable clipping unit. The use of different hearing-aid receivers primarily affects the bandwidth of the system, while adjustments on the clipping unit determine the amount of harmonic and intermodulation distortion. This system allows systematic study of the influence of bandwidth and distortion on speech intelligibility achieved by hearing-impaired persons for speech amplified and distorted by this system.

Two matched systems such as described above have been built in order to study further monaural and binaural hearing-aid use. In this work on monaural and binaural hearing relatively low-level low-frequency noise such as present in most environments is utilized in addition to the other competing signals described above, in order to create conditions which more closely reflect everyday listening situations.

Electroacoustic Characteristics of Hearing Aids
Houston Speech and Hearing Center, Houston, Texas 77025
James Jerger, Ph. D.

A full report on the selected 21 commercially available hearing aids which were on the VA contract list for Fiscal Year 1966 will be published in the next issue of the Bulletin. It will appear under the title "Effects of Electroacoustic Characteristics of Hearing Aids on Speech Understanding." The article will be broadly concerned with the relationship between the electroacoustic characteristics of hearing aids and their successful use by the hearing impaired.

The Effects of Distortion on Hearing-Aid Performance
Auditory Research Laboratory, VA Hospital, Washington, D.C. 20422
George Simon, Ph. D.

In the Auditory Research Laboratory, VAH, Washington, work continues on analyses of earmold design, receiver substitution, and CROS hearing-aid performance. This coming year, even though Dr. George Simon will be leaving for Memphis State University, Memphis, Tennessee, an intensive study will be made of the performance of in-the-ear hearing aids. In addition to the articles appearing in this issue, there is at least one paper on hearing-aid investigation to be presented at the November 1968 ASHA Convention in Denver, Colorado.

Results of the work in progress in this laboratory indicate promise for the contribution of new analysis equipment in the measurement of hearing-aid

performance. Further, development of a semantic differential of quality will materially assist investigators in relating subjective performance with hearing aids to electroacoustic characteristics.

Influence of Input and Gain Values upon Electroacoustic Properties of Hearing Aids

BioCommunications Laboratory, University of Maryland, College Park, Maryland 20742

G. Donald Causey, Ph. D.

The first year of contractual arrangements with the University of Maryland has resulted in the completion of a new BioCommunications Laboratory engaged solely in psychoacoustic research to further understanding of hearing-aid characteristics, evaluation, and use. A thorough survey of all past investigations in the area of speech intelligibility materials has been conducted. This knowledge is being utilized in efforts to develop a new set of materials which, it is hoped, will replace present materials in use by the VA to help in setting compensation levels and for hearing-aid evaluation purposes. Once available, these materials and others will be utilized to correlate speech intelligibility with physical measures of hearing-aid performance.