with coordination and technical assistance from a small staff at Washington.

SENSORY AIDS

Research on aids for the blind and the hard-of-hearing is part of the program of the Research and Development Division, Prosthetic and Sensory Aids Service, Veterans Administration. The following notes on the progress of this work include the title and location of the research activity as well as the names of the principal researchers. In most instances more complete reports on each of the projects mentioned are available. These may be studied at the Prosthetics Reference Collection at the offices of the Research and Development Division. Some reports are available in limited quantities for free distribution, others are published in scientific books and journals, and a few may be obtained from the Office of Technical Services (OTS) or the Defense Documentation Center (DDC) (qualified requestors only).

Fabrication of Obstacle Detectors for the Blind
Bionic Instruments, Inc., Bala Cynwyd, Pa.
J. Malvern Benjamin

Some maintenance work and bench testing on the Model G–5 obstacle detectors built in previous years was accomplished at the plant of the designer-manufacturer, Bionic Instruments, Inc. The instruments were in use during 1963–4 in the testing and evaluation program conducted at Tracor, Inc. Personnel at Bionic Instruments continued their study of the problem of electronic guidance aids, noting new component developments. In fiscal year 1964 the group renewed activity in the curb-detection area and commenced studies of new sources (such as gallium arsenide) and detectors of the radiant energy used in the unit.

Evaluation of the Haverford-Bionic Instruments Obstacle Detector
Tracor, Inc., Austin, Tex.
Bruce H. Deatherage, Ph. D., Philip Worchel, Ph. D.

The Model G–5 obstacle detector developed at Haverford College and Bionic Instruments, Inc., underwent systematic evaluation under controlled conditions at Tracor. Blind subjects from the Travis Association for the Blind, Austin, Tex. (equivalent of a "Lighthouse"), local schools for the blind, and the Kerrville Lions Camp (a rehabilitation center for blinded adults) were tested with their conventional travel mode, given relatively brief instruction in the use of the obstacle detector, and then tested on their ability to traverse a specially designed route containing a number of selected obstacles, re-

located and rearranged for each trial. In discussions between representatives of Bionic Instrument, Inc., Haverford College, Tracor, The University of Texas, and the Veterans Administration, it was decided that more extensive training in use of the device should be given the subjects, that more emphasis should be placed on speed, and that greater stress should be given to performance in a realistic street situation in contrast to the controlled but difficult obstacle course. Some information was also obtained on the use of an obstacle detector integrated with a simulated cane to provide a more complete guidance aid. Attention was also given to the development of psychological and other selection tests to help in developing prescription criteria. On the basis of the recent series of studies on the effectiveness of the obstacle detector with a select group of totally blind subjects following a particular training schedule, these conclusions and recommendations were offered:

1. There were wide individual differences in pretraining performance on a standard obstacle course. The highest number of errors and the longest time occurred with those subjects who normally walked unassisted. The most effective were those blind subjects who used a dog. In between the two groups were the cane-users.

2. Using the obstacle detector on the standard obstacle course, each subject in the original series took about three times as long to walk as with his customary aid. Errors with and without the obstacle detector were about the same. Analysis of errors and time according to mobility aid showed that subjects who walked unassisted made many fewer errors with the detector than without it. For those subjects using a cane or a dog, the device was of little help and probably was even a hindrance.

3. After much more training in the use of the obstacle detector, the blind subjects significantly reduced the time to walk the obstacle course when instructed to proceed as rapidly as possible, yet errors remained about the same.

4. In the field tests, the blind group, on the average, made fewer errors but took somewhat longer with the customary mode of travel than with the obstacle detector. Again, however, the subjects who normally walked unassisted did much better with the obstacle detector in the field trials.

5. An analysis of the collisions on the standard obstacle course showed that the subjects, in general, had most difficulty in avoiding narrow openings and low obstacles.

6. During the training sessions, the subjects had great difficulty in detecting the flat black wall. Often it could be detected only when the subject was within a few inches of it.

7. The effectiveness of the obstacle detector varied with the degree to which it was charged. A freshly charged detector, for example, would pick up a signal at 10 ft., but the same instrument, when considerably discharged, would pick up the same object at a maximum of 5 ft.

8. Cane users and "unassisted" blind subjects were about equally effective in the first part of the training sessions, but toward the end of the sessions, the cane users made fewer errors and took less time. This difference might have been due to better motivation, previous use of a travel aid (cane), or better acceptance of "blindness" and need for aid.

9. Most of the subjects complained about the location of the far-range button. It was inconvenient to use.

10. About one half of the subjects indicated a desire to own the obstacle detector. Those who used guide dogs were the most positive, those who traveled unassisted were the most negative; in between the two groups were the cane-users.

11. Several personality variables were found to be significantly related to evaluation, learning, and performance. With cross-validation data, it should be possible to predict response to the obstacle detector with greater-than-chance accuracy on the basis of psychometric information.

Guidance Device for the Blind
Haverford College, Haverford, Pa.
Professor Thomas A. Benham

This project aims at the development of an electronic device to aid in the independent mobility of blind persons. Although Professor Benham serves chiefly in a consultative capacity, he is currently recruiting among blind people for five prospective trial users of the Model G–5 obstacle detector.

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

During the last two years there were three major accomplishments in spelled-speech research:

1. An estimated 40 percent reduction of the staccato effect in spelled-speech. Working with two persons, Professor Metfessel produced and refined the "Pfeiffer" (female voice) and "Starks" (male voice) alphabets of spelled-speech sounds.

2. Development of a new method of programing spelled-speech training. The new method resulted in faster learning of spelled-speech than was achieved during the 1962 training series. Thirteen

subjects were trained for 5 hours, at one hour per week. It has been concluded that some people can learn to understand spelled-speech at a rate of 80 to 90 words per minute with very little training. Many other persons will need much more training, and for them the task will be more difficult. How to program the training to keep these slower learners interested and encouraged so that they will continue to the point of fast and efficient performance is a question of great importance. There are two methods that appear promising. The first method combines vocabulary building with contextual material by allowing trainees to hear key words of connected materials shortly before the whole sentence or paragraph is presented. In the second method, double presentation, there is one playing for listening only and a second for responding. The first method tends to maintain interest, whereas the second decreases the stress in the response situation.

3. Construction of a pilot model of a teaching machine, designed for use in home-training sessions. The machine includes a "play" unit for the cartridge-type tape recordings, provisions for recording the trainee's responses for later analysis, rerun capabilities, and a device for running the tape for specified intervals, which gradually increase as skill increases. The machine is usable by a blind person without assistance.

Further activities on the project will involve minor refinements to the alphabet sounds to improve transients between letters even further, construction of additional teaching machines, preparation of new training materials, home training of blind persons, and analysis and publication of the results of the spelled-speech programs.

Research on Audible Outputs of Reading Machines for the Blind

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

This is a research study on methods for the production of speech (or speechlike sounds) by synthetic methods, by recombinations of recorded words and syllables, or by a combination of methods. The aim is to produce an audible output that a blind person could assimilate rapidly and without excessive training.

Following fundamental studies and development of special rules for intonation and stress, approximately 7,200 individual word recordings, each especially recorded for making compiled speech with the interim word-reading machine, have been prepared. These word recordings are on strips of magnetic tape, each mounted on a card. Each recording has been carefully edited, and the exact instants at which it begins and ends are indicated by punchmarks in the card. These punchmarks

serve to start and stop the recording of a continuous, cumulative text. A number of short tapes of connected speech have been prepared from the cards, primarily to test the suitability of specific recordings of frequently occurring words and to vary phonetic, syntactic, and semantic combinations.

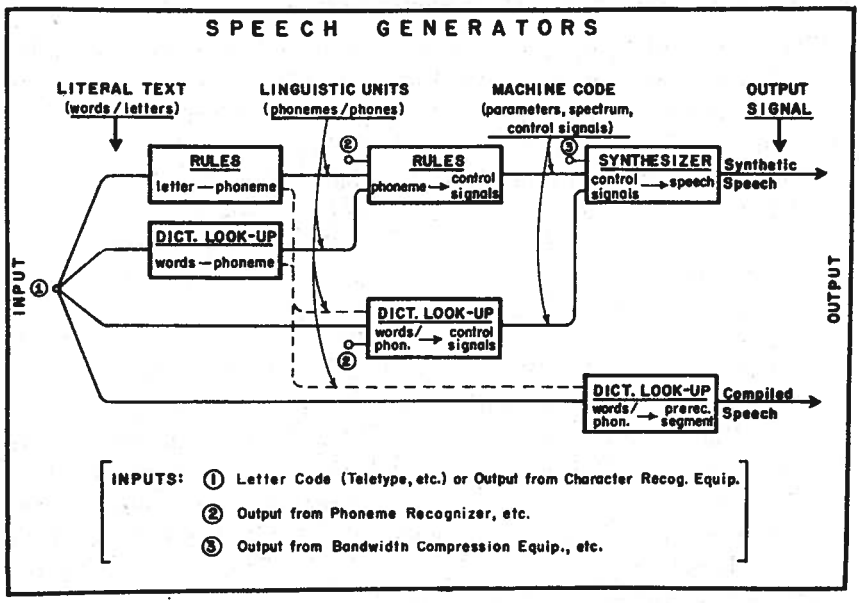

FIGURE 1. *Means of providing audible speechlike outputs.* (*Block diagram prepared by Haskins Laboratories.*)

Although study of synthesis of speech directly from rules has proceeded, it has had less priority than the preparation of word recordings. Work on programing stress and intonation contours from phonetic transcriptions will continue. It now seems likely, according to Dr. Cooper, that further work on synthesis should be on these suprasegmental phenomena rather than on generating speech spectra from sequences of phonemes. This part of the speech-synthesis problem may, in fact, be more simply handled by the storage of control signals in a random-access memory. As a result of study during the past year some modifications in emphasis have emerged. The best method of generating speech appears likely to be one that will store electronic "instructions" for synthesizing words rather than the system of stored voice recordings. This hybrid method, partly compilation and partly synthesis, has the advantages of smoother and more natural stress and intonation contours and less obtrusive spelling of words that are not in the main storage. Various possible approaches

to the problem of providing an audible speechlike output for a reading machine are indicated in the block diagram prepared by Haskins Laboratories (Fig. 1).

Output Characteristics and Construction of an Interim Word Reading Machine

Haskins Laboratories, Inc., New York, N.Y.
Franklin S. Cooper, Ph. D., Eugene Peterson, Ph. D.

The word-reading machine has been designed and constructed under a fixed-price contract with the Veterans Administration. At this writing it is very nearly completed. Much of the electronic circuitry has been rebuilt this year and has been installed and tested. The machine will take byproduct punched paper tape ("teletypesetter" code) from a magazine, sense the tape for the words punched therein, search its 7,200-word storage for each word, and then transfer a prerecorded utterance of the word, if available, to an auxiliary accumulator tape that can later be played back to give the words at essentially a normal rate for reading aloud. Words for which no pronunciation has been stored will be spelled out aloud by using alphabet sounds such as those developed at Metfessel Laboratories for spelled-speech. Plans for the future, as a part of the fundamental studies described above, include a program of testing the acceptance by blind people of recordings prepared by the machine. Simultaneously, varying fractions of spelling (to cover words not stored in the machine) may be checked while providing a current events news service for blind people cooperating in the tests.

The Development and Evaluation of Optophone Devices for the Blind

Battelle Memorial Institute, Columbus, Ohio
John L. Coffey, Ray R. McFarland, William D. Hitt, Ph. D.

By June 30, 1963, the work on the optophone device at Battelle Memorial Institute was essentially completed. Commencing April 15, 1957, engineers and psychologists on the Battelle staff, with the cooperation of a number of blind persons, developed and evaluated the Battelle device. They also conducted several training classes in the use of the device and produced a series of instructional courses, culminating in 200 lesson plans covering a 200-hour training course. Teaching aids included 43 5-inch reels of magnetic tape recordings. Six annual reports to the Veterans Administration document the work of the project in detail. The last one, "The Evaluation and Standardization of Selection and Training Procedures for the Battelle Aural Reading Device," dated June 30, 1963, may be obtained from the chief, Research and Development Division, Prosthetic and Sensory Aids

Service, Veterans Administration, 252 Seventh Avenue, New York, N.Y. 10001.

During fiscal year 1963, 10 Model D units (fig. 2), 5 spare probes, and 2 sets of replacement printed-circuit boards were constructed for Battelle by the manufacturing vendor, Aeronca Manufacturing Corp., and most of the these have been delivered. These units are production-engineered prototype models built to a set of specifications developed at Battelle.

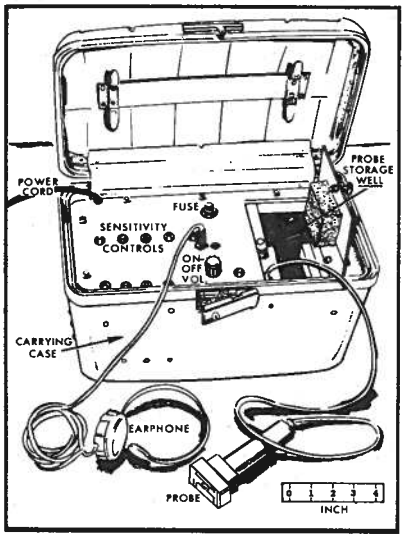

Figure 2. *Battelle Optophone, Model D.*

A one-week teacher-training seminar was held at Battelle May 13–17, 1963, for the purpose of training a group from outside the Battelle community in the instructional techniques used with the training classes. This group forms a potential nucleus of instructors who could teach others how to use the device. On August 9, 1963, during the annual convention of the Blinded Veterans Association at Columbus, Ohio, Dr. Eugene F. Murphy, Mr. John L. Coffey, and two blind users presented a demonstration of the Battelle optophone to interested members and guests.

The need for further data on learnability, practical utility, acceptability by blind persons, potential for rehabilitation, prescription and selection criteria for users, general design, and techniques for training and use seem necessary from clinical application studies. Emphasis will be on utility for immediate personal interpretation of correspondence and personal documents, direct proofreading of touch typing, identification of paper money, and similar tasks. The psychological implications of independent deciphering of typed or printed material

as well as the impact on education and rehabilitation accruing from access to material used by sighted persons may be studied with the Battelle device.

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

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

On August 2, 1957, work on a reading machine for the blind was started at the H. A. Mauch Research and Development Laboratory (since renamed "Mauch Laboratories). The overall plan at that time was for this contractor to concentrate on an "intermediate" device. The machine was to be intermediate in size, weight, cost, complexity, and estimated time to completion of development, i.e., more complex than the "direct translation" optophone unit being studied at Battelle and much simpler than the highly complex "recognition" types being developed independently by industry. To supplement the work of industry, special attention had to be given to outputs suitable for the blind. This was done by the VA contracts with Haskins Laboratoies and Metfessel Laboratories. Although Mr. Mauch has changed many of the details of his original concepts, he is still working to produce a device not only functionally superior to the simpler Battelle optophone, but a device that will also be more economically feasible than the sophisticated and expensive print recognizers only slowly being introduced into the world of commerce.

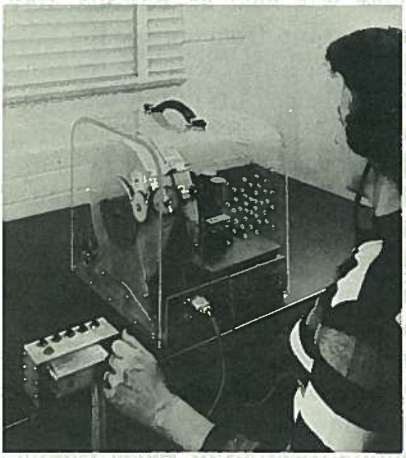

FIGURE 3. *Mauch Word Synthesizer.*

FIGURE 4. *Model B Visotactor.*

During fiscal year 1963 much of the work at Mauch Laboratories involved the Visotactor scanning probe and the Colineator mechanical tracking aid. The existing Word Synthesizer (Fig. 3), designed and constructed at Mauch Laboratories, accommodates the sound of the 26 letters in Metfessel spelled-speech and can include up to 31 different sounds (based on operation by a five-unit code). Mauch Laboratories plan to recognize and pronounce the 26 letters and common ligatures like "fi" or "fl." For economy of size and cost, however, numerous symbols such as numerals, punctuation marks, and Greek letters are undistinguishable by the Mauch recognition unit and are not provided in the word synthesizer. An alternative plan was necessary to identify these relatively rare characters and to assist in locating printed areas on a page and in aligning the scanning action of the probe to the line of print. It was conceived that the Visotactor could be used as a tactile read-out adjunct to the system. This hand-operated input optical probe, which in Model A form primarily provides information from the printed page to the recognition array, is designed to include a tactile read-out section as well. Eight mechanical stimulators (two for each of the four fingers), fitted in finger rests on the device, will create an effect similar to the impression a person receives when he draws his four fingers, ranged in a vertical line, over embossed letters. The thumb will be used in moving from line to line. Such a probe, with battery power supply, could also be detached and used as an independent portable unit for relatively slow direct translation of print to tactile stimulation. To study this idea Mauch Laboratories concentrated on the simpler Model B Visotactor (Fig. 4), a unit capable *only* of the linear tactile operation mentioned above and not including the recognition array and controlling means for the Word Synthesizer.

To aid in tracking along the lines of print, whether using audible and/or tactile output modes, Mauch Laboratories designed and built the Colineator, a precision guiding aid constructed on a 8½ x 15-inch plate of ⅛-inch laminated safety glass (Fig. 4). This may support thin material or press flat a page in a book. A ⅜-inch diameter ground steel rod is mounted along the upper edge of this plate, at adjustable heights, to accommodate a range of thicknesses from single sheets to magazines or books. A crosspiece supported by miniature ball-bearing rollers runs on this rod. A second ⅜-inch rod, sliding vertically through the crosspiece, carries the Visotactor at its lower end. Vertical motion of the second rod is resisted by adjustable friction applied by a Rulon "A" pad located inside the crosspiece.

Effects of Electroacoustic Characteristics of Hearing Aids upon the Ability of the User to Understand Speech

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

To improve its hearing aid program the Veterans Administration has retained this contractor to conduct investigations on the relationships between user judgment, clinical performance, and physical characteristics of such aids. The search for a measure of speech intelligibility adequate to reflect true differences among hearing aids continues. The investigators have recently concluded that neither the conventional phonetically balanced monosyllabic word lists nor the multiple-choice sentence intelligibility tests, such as Karlin's "Auditory Test No. 8," hold much promise as tools for establishing the behavioral correlates of the electroacoustic characteristics of hearing aids. Present plans call for use of an entirely new set of sentence materials and tests which will emphasize learning and understanding of content rather than rote repetition of verbal material.

Development of Test Procedures for Evaluation of Binaural Hearing Aids

Northwestern University Auditory Research Laboratory, Evanston, Ill.
Raymond Carhart, Ph. D.

Work is progressing to refine the methods and data resulting from several years' activity in comparison studies of binaural versus monaural hearing aids. By means of a questionnaire survey, a large amount of subjective data has been gathered on both types of aids. Results so far suggest that neither monaural nor binaural hearing aids restore a listening efficiency in daily life equal to normal hearing. Detailed studies of the "head shadow effect" have been conducted by comparing monaural direct hearing with monaural indirect hearing, using the specially developed competing-message techniques of testing. Several papers based on the research conducted under this project have been prepared for publication in various acoustic and audiological journals.