

Various makes of wheelchairs are being investigated in order to produce a uniform armrest to be used to aid the patient in self-elevation. The armrest modifications are designed to be completely self-contained and telescoping. The armrest elevates in height so that a patient can use it as a rudimentary parallel bar to assist in rising from the wheelchair to standing in the PACO.

SENSORY AIDS

Edited by

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Laser Cane Blind Mobility Aid
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A concluding report on this contract will appear in the next issue of the Bulletin.

Research on Audible Outputs of Reading Machines for the Blind
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Introduction

The central objective of Haskins Laboratories' research on audible outputs is the production of clear intelligible English Speech by an

entirely automatic process. Work carried out during the past 6 months has been focused on three aspects of the primary goal: on improving the method and performance of speech synthesis-by-rule programs, on the measurement of research progress through listener evaluation studies, and on upgrading existing programs in order to achieve greater naturalness in the prosodic output.

Development of New Synthesis Methods

Changes of various types are routinely made in the synthesis-by-rule programs during the course of this research, usually in parts of the program which are designed to be easily replaced or altered. However, as with many programs which operate in a research environment, unanticipated requirements eventually emerge which are difficult to satisfy without an almost total revision of the program structure. When this occurs, some serious consideration has to be given to whether the sought-for-modification is likely to yield sufficient improvement to justify the time and effort required to rewrite the program. The decision is usually not an easy one to make and frequently a collection of desirable changes accumulates before a radical redesign of the programs is undertaken.

Over the past 2 years it has been learned that the present form in which the rules for synthesis must be stated is extremely restrictive and that, to most users, the computation of the parameter values is unnecessarily obscure. Accordingly, plans have been laid. The programming of an algorithm has begun which will allow the researcher to define his own phonetic units, features, and symbols according to his own theoretical bias; to formulate his phonological and phonetic rules in a convenient notation; and to see clearly how the synthesizer parameter values for an utterance derive from his definitions and rules. In this new research-version of a synthesis-by-rule program it is intended to take special care to limit all aspects of the program which are beyond the user's reach and to make the function of these inaccessible components conceptually quite straightforward.

It is now conceived that the new program will have routines for transmitting parameter values to the synthesizer and for editing, displaying, and storing transcripts, rules, and parameter values. It will also have a basic algorithm that will compute parameter values for phonetic units from certain arguments, more powerful facilities for the statement of rules, and a more versatile routine to convert the input transcription and rule statements to a suitable internal representation. Finally, the program will have provisions for rule-debugging.

Work on coding this program for the Laboratories' new PDP 11/45 computer has begun and the components required to interface

the OVE III synthesizer to the computer have been purchased. In addition, a software synthesizer (an alternative to the OVE III) has been programed on the PDP 11/45 to generate speech by a process of computation which frees the speech output from some of the constraints of hardware synthesis. Although much slower than the OVE III, it is expected that the synthesizer routine will be particularly useful in future research.

Listener Comprehension on Easy versus Difficult Texts

Following the procedures described in previous issues of the BPR, some further studies of the comprehensibility of synthetic speech have been made. For the new tests two pairs of text passages were selected from a reading test for college students. The first pair consisted of the same passages used in the earlier study; both were equally difficult and contained narrative material of general interest. The new passages, which were selected for their greater difficulty, covered technical subject matter from the fields of anthropology and geology. They were also of roughly equal difficulty. Recordings were made of each text spoken either in synthetic speech or by a human speaker at the same rate of delivery. The text duration ranged from 12-14 min. After a period of practice on about 10 min of continuous synthetic speech, 18 naive listeners heard, in randomized order, one member of the easy and difficult pairs of passages in synthetic speech and the other member of each pair in natural speech. A multiple-choice 14-item questionnaire was administered to each listener on each passage and the period of time required to provide as many answers as the listener could recall was measured. The listeners were then asked to replay all, or parts, of the texts as many times as was necessary to allow them to fully complete the questionnaire. This additional time was also recorded.

Preliminary data from these experiments show that the differences in the aggregate time taken to answer all the questions (which includes the time taken to rewind the tape recorder and rescan the text) averaged 7.5 min for the human speech and 11.7 min for the synthetic speech. On the narrative texts, the mean difference between the time required to answer questions on human versus synthetic speed was 3.6 min rising to 5.0 min for the more difficult technical prose. Average differences in the time required to respond to technical versus narrative material were 2.9 min for natural speech and 4.3 min for synthetic speech. Broadly these results confirm the fact that listeners perform less well on complex reading matter, and also indicate that their performance decreases somewhat more rapidly on synthetic speech as the technical content increases. However, the rate of this decrease is not as large as one might be led to expect

from a casual appraisal of synthetic speech. Moreover, the data show that the speed at which the listeners absorbed the synthetic speech materials was roughly 8-10 times faster than the reading speeds achieved with direct translation reading devices.

Improving Current Synthetic Speech Programs

During the final months of this reporting period, Dr. Ingemann returned to the Laboratories for a brief visit and converted her rules for speech synthesis into a form which could be used by the most recently revised program. Since the new program provides greater flexibility and dynamic control over several parameters not previously available, an attempt was made to take advantage of this flexibility and to find appropriate values for the additional parameters. Plans are being made to run tests on this new set of rules to determine what effects the changes have on intelligibility.

Work is also in progress on the construction of a new version of the program module which converts the string of phonological symbols into a string of parameter frames to drive the hardware synthesizer. The intent is to make the program more responsive to prosodic information which is either already present in the phonological string or which will be introduced via additional symbols. In order to achieve this an algorithm will be designed which begins by hierarchically organizing the vowels and consonants into clusters which are in turn organized into syllables; then into phonological words (around their stresses); and finally into phonological phrases (or breath-groups). Just as the acoustic realization of vowels and consonants differs according to the immediate string context (i.e., of other vowels and consonants), so the new algorithm will allow for variant versions of the hierarchical units in their string contexts. For example, the syllable *stead* has two kinds of length depending upon whether it is followed by another full syllable as in *steadfast* or a weak syllable as in *steady*. In the case of *steadfast*, the first syllable retains its normal length but in the word *steady* it attempts to "incorporate" the weak second syllable and, in so doing, is considerably shortened. This particular contextual effect of syllable upon syllable is an important part of the general effect of "stress-timing" in American English.

Studies aimed at improving the naturalness of synthetic speech have also been conducted during recent months. Some of the factors which contribute to speech naturalness are voice-quality, coarticulation with and across syllables, rate, and phrasing. The last topic is of particular interest.

Phrasing, when performed by human readers, is closely linked to the intended semantic interpretation—a facility only indirectly

available to a reading machine at present. However, as described in previous reports, it has been developed and demonstrated that primary phrasing effects can be produced by means of a fairly primitive semantic/syntactic stress-rule program. (The rules depend on the essentially binary stress distinction between content and function words, and on probable grammatical sequences and their relationships to stress-intonational contours.) It is believed that further improvements in the assignment and implementation of stress in synthesis output will be partly dependent on gaining a better understanding of the stress patterns of natural speech and partly on the approach which is taken to parsing before stress assignment.

To aid making observations of natural speech, an acoustic stress-analysis technique has been developed and operated on a pilot basis. Perceptual tests designed to verify the procedure are still underway with naive listeners. If the results are favorable, it is planned to try the analysis scheme on a new variety of lexical and grammatical structures in order to learn more about prosodic contours.

Turning from the stress rule implementation problem and work on phonetic segments, parsing studies have progressed to the point where some results are expected which may significantly be an assist in demarcating phrases. The approach requires that each word of the stored dictionary contain a grammatical denotation (a number from 0 to 9) that signifies the most probable role played by the given word. Certain numerical sequences are equivalent to common grammatical units, some of which may be punctuated by a pause, or by pseudo-pause, some of which may be identified as subjects, prepositional phrases, predicates, infinitive constructions, etc. This procedure, and the consequent phrasing of text material may permit some degree of variable tempo (or other prosodic feature) assignment—which could modulate the rather stable prosodic patterns that now occur, especially in long synthetic sentences.

In recent months, attention has focused on the problem of converting words not found in the dictionary (i.e., capitalized words, proper names, etc.) from letters to sounded syllables. Attacking these words chiefly from the right end to the left, and picking off syllables at grapho-phonologically appropriate intervals, has shown that most relatively uncommon “English” words, like the general vocabulary, reveal numerous spelling-to-sound regularities, particularly in their rightmost chunks. Preliminary tests of name pronouncing by rule indicate that the great majority of individual surnames can be converted to sound correctly by fairly simple rules. These rules, however, are based on an analysis of American stress and pronunciation, and some “foreign” names are consequently sounded

out with American stress patterns, with the result that the pronouncing may be somewhat unsophisticated (e.g., Rousselat is heard as [r'ɔsələt]). Nevertheless, it is anticipated that native American listeners can adjust to such sporadic mispronunciations.

Conclusion

To sum up, the research carried out during the current reporting period has been focused primarily on the improvement of synthetic speech quality. Work has begun on the development of better rules for the conversion of orthography to phonetics and tests indicate that the gap between listener performances with synthetic speech and natural speech is closing. Further studies of natural speech promise to yield improvements in the prosodics of synthetic speech and efforts are continuing toward the development of new analysis techniques.

Research and Development in the Field of Reading Machines for the Blind

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This report describes progress through June 30, 1975, on Mauch Laboratories' development of personal reading machines for the blind.

The most advanced reading machine being built at Mauch Laboratories is the Cognodictor, an optical character reader designed with the special needs of the blind in mind to identify the letters of the most common type styles as they are scanned by a hand-held probe. Its usual output consists of short, spoken letters (spelled speech) which correspond to upper or lower case letters or ligatures. Alternate outputs such as braille or synthesized speech may very well be available in the future. In addition, the Cognodictor produces tactile or acoustic tone patterns corresponding to the print scanned so that the user can adjust the probe for letter size, tracking, and italic slant. He also uses these patterns to identify numerals (which usually lack context clues) and letters incorrectly read by the machine if the correct letter is not apparent from context.

The Cognodictor breadboard has a Recognition Matrix consisting of electronic templates stored in programmable read-only memory circuits. Each template is compared with the Cognodictor's Second Register which contains a skeletonized version of the letter just scanned by the probe. The skeletonizing is done by Mauch Laboratories' Two-Dimensional Multiple Snapshot Process (U.S. Patent

#3,827,025) which is less expensive to implement and better suited for the Cognodictor in other ways than any of the processes in use in commercial optical character readers. A remote time-shared computer and several special programs were utilized in the development of templates which accept and identify upper and lower case letters, ligatures, and punctuation marks from a wide variety of type styles extending beyond the design set of 13 styles.

A new Word Storage Unit which can store up to 64 characters in a First-In-First-Out (FIFO) or silo buffer storage circuit was designed and built on the breadboard. Later, a printed circuit board which will be used in the Cognodictor prototypes was designed to contain the circuits of this new Word Storage Unit.

Several other additions were made to the breadboard, such as a circuit which measures the probe's speed relative to the letter images, a circuit which uses this speed signal to detect word spaces, and a circuit which inserts a variable number of silent codes, depending on the speed, into the Word Storage Unit when a word space is detected to group the letters into words upon playback. A reverse switch also was added to the Stereotoner probe temporarily used with the Cognodictor breadboard.

Mauch Laboratories' Stereotoner is a new aural direct translation reading aid which is noteworthy for a stereophonic output code, a ten to one zooming range, a switch which permits normal operation on reversed (light on dark) letters, a very small optical probe, and a compact, lightweight control box which rests on the user's chest held by an adjustable neckstrap. Sixty-five Stereotoners are being used in an evaluation study sponsored by the Veterans Administration and the National Academy of Sciences and conducted by American Institutes for Research. Mauch Laboratories provided repair service and other technical assistance as required.

Not counting batteries, which are replaced locally, 16 Stereotoners (out of the above 65) were involved in 20 repairs during the 12-month period ending June 30, 1975. The most frequent repair was cable replacement. Consequently, a new cable which appears to be longer lasting and easier to store properly was designed. It is being used in current repairs. The battery contact was also improved and wider bases which improve stability were installed on three Stereotoner probes for testing.

Experiments made at the Stereotoner schools with provisional pacing devices tended to support the idea that a Pacer which holds the probe and moves it smoothly along the line of print at a speed from 6 to 60 words per minute selected by moving a knob or lever would be useful in learning and in building speed (Fig. 16). Although such a Pacer was scheduled for development in late 1975, it proved

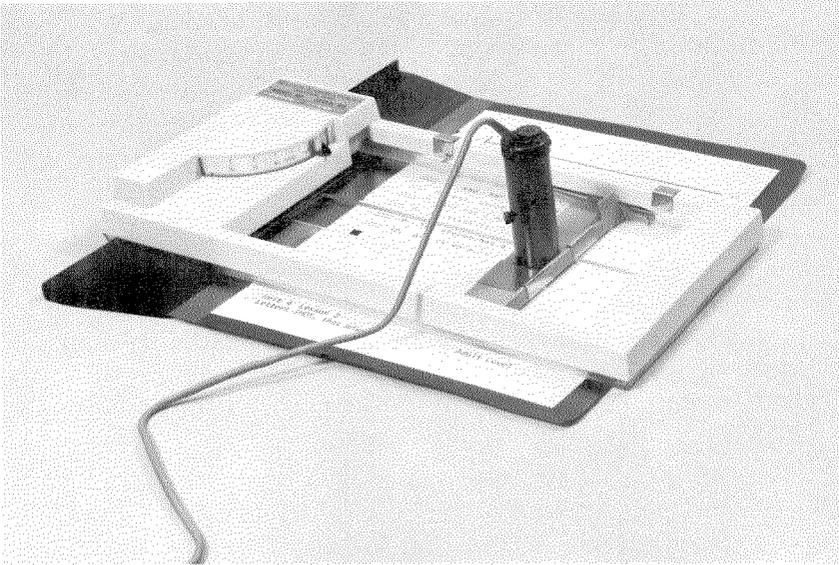


FIGURE 16.—Mauch Laboratories' Pacer moves the Stereotoner probe smoothly along the line of print at a speed from 6 to 60 words per minute which the user can select by moving a lever.



FIGURE 17.—Mauch Laboratories' Colineator is shown set up for use in reading in a book. The sheet being read is firmly held between the 9 × 12 in. magnetic pad and the steel base plate of the Colineator.

possible to assemble a first prototype somewhat earlier.

A prototype of a new design Colineator which assists the user of the Stereotoner or Cognodictor to track lines of print accurately and to change lines quickly when reading books, magazines, newspapers, or single sheets was assembled in May 1975 (Fig. 17). It is much more compact and much less expensive than earlier Colineators.

Future work includes completion of the Cognodictor breadboard, design of an optical probe for the Cognodictor, and construction of three Cognodictor prototypes. Other work to be undertaken, if time and resources permit, includes building improved prototypes of the Pacer and the new Colineator and designing a microprocessor-based interface between the Cognodictor and Votrax speech synthesizer. Mauch Laboratories will also continue to provide technical support to the VA hospitals using the Stereotoner.

Clinical Application Study of Reading and Mobility Aids for the Blind Central Rehabilitation Section for Visually Impaired and Blinded Veterans

VA Hospital, Hines, Illinois 60141

John D. Malamazian, Harvey Lauer, and James J. Whitehead

During the period January to June 1975, work has continued on research and the field evaluation of three major electronic devices, namely, the Laser Cane, the Sonicguide, and the Pathsounder. Additional time has been spent in establishing an electronic mobility aids course of training for blinded veterans at Hines VAH. Of the existing thirty beds, two are now set aside each month for candidates.

The development of an electronic mobility aids program is based on the promising preliminary evaluation results plus the availability of serial production models and qualified Orientation and Mobility teachers.

Evaluation and training with the electronic devices ranges from 2 to 6 weeks, depending upon the aid selected and the veteran's ability. All candidates for this program have previously completed a recognized O&M (long cane or dog guide) training course and are selected on the basis of established criteria. Each potential student is familiarized and evaluated with each of the three devices. If it is determined that the veteran can benefit from the use of any of the aids, a subsequent training program is initiated. Present performance level, travel needs, and personal preference are factors which affect the joint decisions of prospective trainees and O&M Specialists in the selection of a mobility device.

By January 1975, nine blinded veterans had participated in the program, of which six were long cane travelers and three were dog

guide users. Six have successfully completed the training with five selecting the Sonicguide and one the Laser Cane.

In preparing for a more active role in teaching blinded veterans available electronic mobility devices, the CBRC is sending its mobility staff members to Western Michigan University for a course in teacher preparation. By June 1975, eleven staff members had completed the course while four were scheduled for subsequent months.

During the week of May 12-16, 1975, a meeting was held with Palo Alto VAH personnel and the staff of American Institutes for Research, Palo Alto, under Dr. Robert Weisgerber. The purpose of the conference was to work on creating a compendium which would be a topical outline with hierarchical relationships of mobility tasks. The ultimate goal of the VA-sponsored project is to develop a standard evaluation protocol for environmental sensors and mobility aids.

Leicester W. Farmer presented a paper "Travel With Electronic Devices in Adverse Weather" at an AFB-sponsored conference in Minneapolis, Minn., February 23-25, 1975.

**Clinical Trials of Reading Machines for the Blind
Central Rehabilitation Section for Visually Impaired and Blinded
Veterans
VA Hospital, Hines, Illinois 60141
John D. Malamazian and Harvey Lauer**

This project entails the clinical evaluation and application of ink print reading aids for the blind. At present, these include the Stereotoner, which has an audible output, and the Optacon, which has a tactile output. There were five major activities during the period from January to June 1975:

1. Mr. Lauer gave 3 to 4 weeks of basic training to two veterans and one civilian instructor in the use of reading aids. Two instructors from Northern Illinois University were given teacher training with the Stereotoner which spanned a 9-day period. Six veterans were tested and familiarized with both reading aids.

2. Mr. Lauer continued to gather data for the Stereotoner project sponsored by the VA and conducted by the American Institutes for Research. He continued to assist AIR staff members in the revision of the Stereotoner instructional course.

3. Mr. Lauer attended and participated in the Annual Convention of the National Federation of the Blind held in Chicago in late June. He lectured and demonstrated reading aids to students and professionals who were on detail at Hines or who visited during the reporting period.

4. During this reporting period the responsibility of teaching veterans to use the new speech-compressing tape recorders was turned over to staff members in the communications department. Mr. Lauer worked with those instructors to that end, but he continued to gather and disseminate data about new developments in this field and to demonstrate and lecture about speech compressors to visitors.

5. During the previous reporting period, it was noted that several developers presented electronic hardware and designs for hardware to serve blind people. This activity has doubled during the present reporting period, which has prompted Mr. Lauer's observation that we are currently experiencing a "technological baby boom" in work for the blind. Currently the spotlight seems to be on electronic calculators and optical character recognition reading machines. The study of such devices and designs and the dissemination of reports and information about them have used an increasing amount of Mr. Lauer's time during this reporting period.

Instruction In, and Evaluation of, Reading Machine Techniques The Hadley School for the Blind

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The final section of the non-veteran part of the Stereotoner Research and Evaluation Project was reached with the last three students admitted for training. One was taught in January, one in February, and the last one in late March. All three students successfully completed the training program. Followup communications have confirmed that all three are using the Stereotoner for mail reading, short personal-type readings, and personal letters. Two of the students are doing secretarial work and find the Stereotoner helpful towards independence.

Other students have been sending in the criterion exercises for the Home-Study units. These exercises were evaluated and reports on student progress sent to American Institutes for Research.

Three potential students were given the Stereotoner Auditory Selection Test as well as the Optacon Screening Test.

The main thrust of activity has been to followup with completed students who have not submitted any criterion exercises. Letters and telephone communication were used. It is hoped that an increase in student feedback will result.

Student reluctance to do the Home-Study units has prompted a study of these units. Impressions and conclusions will be sent to American Institutes for Research. Evaluation of these units has also

been solicited from students actively working on them. These reflections will also be forwarded to American Institutes for Research.

**Clinical Application Study of Reading and Mobility Aids for the Blind
Western Blind Rehabilitation Center**

VA Hospital

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**Kenneth Wiley, Greg Goodrich, Ph. D., Nancy Darling, and Richard
Bennett**

Electronic Mobility Aids

Since January 1975, Nancy Darling and William Ekstrom have trained two veterans with the C-5 Laser Cane and three veterans with the S2A Sonicguide. In addition, five orientation and mobility staff members have attended the 6-week training program on electronic mobility aids at Western Michigan University.

Eccentric Fixation Research

This project, being conducted by G.L. Goodrich, Ph. D., is an examination of two techniques for training eccentric fixation in low-vision veterans with central field losses. The emphasis on both techniques is to develop effective training procedures which are efficient, easily applied, and which do not require long training periods. Currently, seven veterans at the Western Blind Rehabilitation Center have received eccentric fixation training from Judy Holcomb, O.D. The preliminary results from this project indicate the feasibility of eccentric fixation training. Currently additional data are being collected on this project by Dr. Goodrich.

Optacon Activity

Three blinded veterans received Optacon instruction from the Western Blind Rehabilitation Center. One of these veterans received 43 hours of training and terminated training. The other two veterans completed Optacon training and were issued Optacons for use at home.

Stereotoner Activity

Activity continued to center around the VA-American Institutes for Research Stereotoner Evaluation Project. Mr. Richard Bennett provided Stereotoner instruction for two project trainees. Both received sufficient training for independent reading.

Mr. Bennett read for several hours with Stereotoner No. 003, one of several Stereotoners incorporating an improved cable and a slightly longer carriage and roller. He found the changes increased probe stability and aided freehand tracking. He felt that slight additions in length of carriage and roller, along with a change to a rubber-covered roller, would add significantly to the improvements noted.

Dr. Robert Weisgerber of AIR and project personnel developed material designed to provide some Stereotoner and code orientation for potential trainees for use prior to Center instruction. These materials, designated as the Stereotoner Pre-Training Series, were recorded at the WBRC in preliminary form by Miss Claudette Smith of AIR and Mr. Bennett.

C.C.T.V. Followup Evaluation

The CCTV evaluation is designed to examine the patterns of use of CCTV systems by veterans trained through the Blind Rehabilitation Program. The current project, under the direction of Gregory L. Goodrich, Ph. D., assisted by Nancy C. Darling, Rex A. Ward, and Edwin B. Mehr, O.D., yielded data on 42 veterans from both the Eastern and Western Blind Rehabilitation Centers. The total population for this study is expected to approach 200 veterans.

Development of Test Procedures for Evaluation of Binaural Hearing Aids

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We are studying the interaction that occurs when a signal plus background competition is filtered and when the result is then subjected to peak clipping. A series of test materials has been prepared for this purpose. These materials cover the range from no clipping to 30 dB of clipping. The filtering being used is the inverse of the long-term spectrum of speech, with the result that speech passed through it becomes "white" and competing sound is changed correspondingly. This form of filtering plus compression proved to retain intelligibility excellently when speech alone was passed through it. The question now at issue is the degree to which intelligibility can be retained when competition is also present. Data are being gathered on normal hearing subjects and will eventually also be obtained from hearing-impaired ones. The experimental conditions which are being employed mimic circumstances of hearing-aid use. They vary from the situation where weak competing signals are being reproduced just

audibly and without clipping to circumstances where stronger competing signals are being reproduced at only a moderately higher level because clipping is serving as a limiter. Conceivably, a hearing aid which "whitens" speech signals substantially and holds to a narrow dynamic range through peak clipping could be useful to some hearing-impaired persons. Our current research is directed toward examining this hypothesis.

Development of Improved Techniques for the Analysis of Hearing-Aid Performance

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No progress report was submitted by this contractor for this report period.

The Reading of Printed Materials by the Blind Behavioral Science and Technology Program

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During the period January-June 1975, progress was made in several research and development areas related to the evaluation of the Stereotoner.

Materials Development

During the 6-month period, a set of tapes was developed for pretraining purposes. It is anticipated that these tapes will be duplicated and made available to all candidates accepted for training. It is expected that this procedure will save a considerable amount of time at the outset of formal training, since many of the orientation and familiarization tasks should have been achieved at home in advance.

Also during the period, work was begun on the revision of the basic course materials. Revisions are based on feedback from the instructors and a decision to place the student and teacher materials in closer proximity.

Auditory Selection Test

Following analysis of the Auditory Selection Test data from 128 blind testees, it was decided that the test could be shortened con-

siderably without appreciable sacrifice of predictive power. This shortening has been accomplished and a draft version of an Examiner's Handbook has been prepared. When it is typed, duplicated, and released, this handbook will allow rapid scoring and interpretation of results in the field by test administrators.

Data Collection

Eight trainees were visited at home during the period, with AIR staff administering Criterion Test B and conducting informal interviews. It should be borne in mind that these trainees had all completed formal training some months before. Thus, there was interest in determining whether they were progressing, losing skill, or staying about the same as when they exited formal training. A wide variation existed among the individuals visited. For most of those tested, the reading of narrative materials was generally acceptable in both accuracy and rate. However, it was also true that most trainees had considerable difficulty with print materials presented in unusual formats, type sizes, or type styles.

Among those given a second criterion test was a young 7th grade student. He was administered a special age-appropriate test similar to that used for Optacon students in a previous AIR study. Nine more persons will be visited at home by the end of August, completing testing with Criterion Test B.

Other data collected during the period included: 1. telephone interview data obtained on each trainee 1-month after the completion of formal training, 2. instructor training data obtained for those trainees still being formally trained, and 3. Auditory Selection Test data on potential applicants for training, as received from various agencies and VA stations across the country.

Final Report

Looking ahead to the next 6 months, AIR staff will complete the analysis of all data and prepare and submit a final report to the Veterans Administration and the National Research Council. This report will detail our case-by-case findings as well as summary conclusions on group data to the extent that these are warranted by the limited number of cases involved.

The Final Report should be completed by January, 1976.

**Clinical Application Study of Reading and Mobility Aids for the
Blind**

Veterans Administration Hospital

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Chester Lewis**

Additional subjects have been tested in the speech compression task described in previous reports in (BPR 10-21 and 10-22). The sample size is now 111 blinded veterans with a substantial number of test-training-retest data points. The previously noted relationship between ability to comprehend speech at high compression levels and the individual's personal adjustment as measured by California Psychological Inventory (CPI) and Minnesota Multiphasic Personality Inventory (MMPI) has been further validated. The proportion of veterans successfully meeting criterion levels of comprehension at presentation rates of approximately 485 words per minute has increased to over 70 percent of the total sample. This increase is believed to be related to the staff decision to test only those veterans with either vocational, training, or avocational needs to process large quantities of taped speech. Data from this expanded sample were reported to a conference on devices and systems for the disabled in Philadelphia (1,6).

Information being gathered from the responses to questionnaire on use by partially sighted veterans of their low-vision aids, is being compiled and analyzed. Supplemental questions on patients using prism optics are also being sent out. The subject sample is being increased in the ongoing evaluation of prism use by veterans with visual field restrictions. Initial reports of evaluatory results and training methods have been included in an article published in a mobility newsletter (7) and in a presentation to mobility instructors (2).

General information pertaining to clients of the Eastern Blind Rehabilitation Center for the period from 1969 to 1973 has been coded and analyzed in several ways. Descriptive statistics (mean, standard deviation, and confidence limits) and histograms were generated by computer for variables such as response to a patient satisfaction followup questionnaire, the scores on various psychometric tests, and miscellaneous demographic information. The validity of questionnaire responses was determined by selected on-site visits, phone conversations with the clients and VIS Team representatives, and selected recall of veterans for refresher training. These normative data are being prepared for publication.

Further analysis was undertaken to examine the possible relationships between these variables. A large correlation matrix was generated and the results are being examined. The population is also being divided into subgroups for the purpose of finding differences in regards to satisfaction with training and devices, which may indicate inadequate delivery of rehabilitation services.

Because of the importance of leisure time pursuits in the lives of many blinded veterans, several optical and electronic sensory aids are being evaluated for possible use in strictly avocational areas. Lens systems like the Luxo Lamp are being used for model building and household maintenance. Closed circuit television magnification systems are being examined for possible use in small engine repair. The Locotone, a device designed to be used as an auditory landmark, has been used with some success as an indicator of the position of the hole for blind golfers. Monocular telescopes are also being evaluated for use in golfing, bowling, and other sports activities.

The study of acoustic parameters of mobility performance in the blind has moved forward in response to the excellent input gained from the multi-disciplinary meeting held on this subject in West Haven in November 1974. Additional effort has been focused on the creation of an auditory task with predictive capabilities in this area. This work has been advanced considerably through a master's thesis which looked at one such task, that of spectral shape difference detection. It was found that when a client's ability to detect the presence of a "notch" filtered in a broad background of noise is measured, the results correlate well with his performance in the corridor task, described in previous reports in this journal (5,10). Serendipitously, the task not only predicts performance in a "real-world" environment, but also seems to provide a very significant learning effect (8,9).

Studies are underway to examine the effects of hearing-aid use on various auditory tasks required of the visually impaired. This experimentation is being conducted in the hope of providing impetus for special design considerations in hearing aids used by the blind and to develop methods of training the blind using available hearing aids. Efforts are being made to disseminate to mobility instructors information on physical-acoustic characteristics of various environments and psychoacoustic characteristics of the human auditory system (2,7).

The study of velocity and veer in straight line travel is continuing in the same direction as previously reported (5,10) with additional subjects being tested and trained. The strong relationship between personal adjustment, as measured by the CPI and MMPI, and velocity and veer continues to dominate this study (3,4). Pilot studies are

being run to test the efficacy of monitoring performance in these tasks as an indication of the state of the personal adjustment of the client during his stay at the center and during the course of his training in the use of prosthetic devices.

The plethora of optical low-vision aids, mobility aids, communicative aids, etc., constantly being evaluated and issued to veterans, are not mentioned because of their diversity and number. All of these devices are regarded as important and the research staff is constantly striving to keep abreast of the latest technological innovations in sensory aids for the blind. The "major" devices and the extent of their deployment from the Eastern Blind Rehabilitation Center are presented in Table 1.

TABLE 1

Device	Number of Veterans screened	Number of Veterans trained	Number of devices issued
Sonicguide	25	6	4
Laser Cane	6	0	0
Pathsounder	10	5	2
Stereotoner	30	7	1
Optacon	23	9	7
CCTV	350	126	106
Speech compressor	111	53	49

Papers and Publications

Papers presented or published in the period January 1, to July 31, 1975:

1. De l'Aune, William, Walter Needham, Chester Lewis, and James Nelson: Speech Compression and Blinded Veterans. Devices and Systems for the Disabled, Conference, Philadelphia, Pennsylvania, April 1975.

2. De l'Aune, William: Acoustics and Mobility in the Blind. Invited Seminar, Western Michigan University, Kalamazoo, May 1975.

3. De l'Aune, William, Walter Needham, and Gregory Kevorkian: Relationship Between Indices of Mobility and Personality Factors in the Blind: 1. Minnesota Multiphasic Personality Inventory. J. Int. Res. Commun. Syst., 3:30, 1975.

4. Needham, Walter, William De l'Aune, and Gregory Kevorkian: Relationship Between Indices of Mobility and Personality Factors

in the Blind: II. California Psychological Inventory. *J. Int. Res. Commun. Syst.*, 3:81, 1975.

5. Gillispie, George, William De l'Aune, Patricia Gadbow, and Chester Lewis: Research at the Eastern Blind Rehabilitation Center. *Bull. Prosthetics Res.*, BPR 10-21:170, 1974.

6. De l'Aune, William, Walter Needham, Chester Lewis, and James Nelson: Speech Compression and Blinded Veterans. *Proceedings of the Conference on Devices and Systems for the Disabled*, Temple University, 69, 1975.

7. De l'Aune, William and Walter Needham: Mobility Research at the Eastern Blind Rehabilitation Center. *Long Cane News*, 8(1):8, 1975.

8. De l'Aune, William and Stephanie Bauer: Audiometer Predictor of Acoustic Environmental Assessment Performance in Blinded Veterans. I. Methodology and Instrumentation. *J. Int. Res. Commun. Syst.*, 3:406, 1975.

9. Bauer, Stephanie and William De l'Aune: Audiometric Predictor of Acoustic Environmental Assessment Performance in Blinded Veterans: II. Results and Discussion. *J. Int. Res. Commun. Syst.*, 3:407, 1975.

10. Gillispie, George and William De l'Aune: Research at the Eastern Blind Rehabilitation Center. *Bull. Prosthetics Res.*, BPR 10-22:463, 1974.

Development of a Hearing-Aid System with Independently Adjustable Subranges of Its Spectrum Using Microprocessor Hardware

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During the first half of 1975, work was primarily concerned with the analysis of various digital sequential filters and with their comparison with standard digital filters that are widely used in other applications, such as Chebychev filters. As our design requires filters in which interactions between various bands of the spectrum are minimal, the performance of standard filters was found unsatisfactory for our purpose. Consequently, a filter based on Fast Fourier

transforms and the inverse of such transforms was derived (using modified Hanning and Parzen windows) to yield, via off-line time-series identification, a spectral performance far superior to that of standard filters when band-pass and cut-off properties are concerned. Subsequently, an off-line program was designed for adjusting the parameters of this filter so that it could match the spectral characteristics of a standard hearing aid to those required by the audiologist for a particular hearing-aid user. The print-out of this program, in terms of parameters of an autoregressive-moving-average (ARMA) filter model, was then employed to design the filter hardware to be interfaced with a conventional hearing aid. Hardware design embodying a microprocessor and a recursive filter using discrete-tapped-analog delay lines (TAD's) has been performed, and a realization which is essentially a hybrid analog/digital system has been constructed.

Finally, the testing of the above hardware has been started, and alternative designs, combining TAD's with hardware multipliers has been investigated regarding computational speed, noise effects, and extendability to 20 bands.