THE SIXTH TECHNICAL CONFERENCE ON READING MACHINES FOR THE BLIND

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INTRODUCTION

On a number of occasions over the past dozen years, the Prosthetic and Sensory Aids Service of the Veterans Administration has brought together individuals with an interest from varying viewpoints, in the formidable problems involved in developing reading machines for the blind. A number of such meetings were rather informal though highly productive conversations. During the period 1954–58 five more formal technical conferences were held, each resulting in a host of new ideas and techniques. For a variety of reasons it was not feasible—nor really necessary—to organize a sixth conference until this year. It is the sincere hope of the writer that he has adequately summarized the proceedings of this meeting, which included display of several varieties of operating equipment.

Even though much of the nation was bogged down with heavy snowstorms, 61 persons attended the Sixth Technical Conference on Reading Machines for the Blind held January 27–28, 1966 at the Veterans Administration Central Office, Washington, D.C. It is estimated the attendance was down about 30 percent as a result of the storms. Tabulating the current affiliations of the participants shows that 17 were from the educational fields, 15 from industry, 14 from agencies for the blind, 13 from Federal government (Veterans Administration—7, National Institutes of Health—2, Vocational Rehabilitation Administration—1, Library of Congress—1, United States Navy—1, National Bureau of Standards—1), one from the National Academy of Sciences-National Research Council, and one a private practicing ophthalmologist. Professor Thomas A. Benham of the Department of Engineering at Haverford College, Haverford, Pennsylvania, served as chairman as he has done so many times before at earlier conferences in the series. A list of the six Veterans Administration-arranged conferences appears below:

Conference No.	Date(s)	Location	Number of participants
1	Aug. 20, 1954	Commodore Perry Hotel, Toledo, Ohio	11
2	Apr. 25, 1955	Franklin Institute, Philadelphia, Pa.	24
3	Aug. 3, 1955	Rockefeller Institute, New York, N.Y.	38
4	Aug. 23–24, 1956	Veterans Administration, Washington, D.C.	50
5	Sept. 17, 1958	National Academy of Sciences, Washington, D.C.	68
6	Jan. 27–28, 1966	Veterans Administration, Washington, D.C.	61

Although there is a gap of over seven years between the fifth and sixth conferences, certain other meetings arranged under different auspices were held in that period and have served some of the same information-exchange purposes. Among these were the Human Factors Society Sensory Extensions Symposium, Cambridge, Massachusetts, Sept. 12, 1960; the Office of Naval Research-National Bureau of Standards Symposium on Optical Character Recognition, Washington, D.C., Jan. 15–17, 1962 (1); the International Congress on Technology and Blindness, New York, June 18–22, 1962 (2); and the Office of Naval Research-American Optical Company Symposium on Optical Processing of Information, Washington, D.C., Oct. 23–24, 1962 (3).

CONFERENCE AGENDA

The major substantive subdivisions of the agenda for the Sixth Conference were as follows:

- Single-Channel Devices
- Direct Translation Machines
- Intermediate Machines
- Recognition Machines
- Output/Display Systems
- Other Systems of Reading for the Blind
- Use of Telephone Network
- Visual Effects Through Stimulation of Remaining Parts of the Visual System

In the remainder of this paper the highlights of the meeting presentations in these areas will be covered. A more detailed record of the proceedings (4) should interest those desiring to "dig deeper."

SINGLE-CHANNEL DEVICES

Mr. Leo M. Levens, chief engineer of the Engineering and Manufacturing Division, American Foundation for the Blind, New York, discussed the current status and recent history of optical probes with audible outputs. He commenced his presentation by quoting a remark made by Mr. A. Wexler (5) of Melbourne, Australia, a teacher of science to blind students: "By means of photoelectric cells coupled electrically to sound emitting apparatus or to vibrators, a great variety of phenomena normally observed by sight can be made perceptually accessible to the blind, or if need be, to the deaf-blind." Mr. Levens indicated that there is nothing new about the obviously logical combination of a set of elements to transduce information from the optical world of vision to the sound modality so useful to blind people. Dr. Edward J. Waterhouse, now director of Perkins School for the Blind, Watertown, Massachusetts, as early as 1938 used a photoelectric cell and buzzer arrangement in an apparatus used by blind students in determining the altitude of the sun.

Associated with the *input* end of an optical probe one usually finds, singly or in various combinations, lenses; light-conducting rods, tubes or fibers; illuminators; color or polarizing filters; light choppers; orifices; or irises. Light *sensors* in use include light-sensitive resistors, diodes, transistors, and photovoltaic cells. The electrical *detection* or conversion to sound is often accomplished with variable frequency oscillators or tone generators, with multivibrators, or with amplitude controlled oscillators. The power supply is usually a battery, but some permanent equipment installations may use the powerlines. The output end may involve an earpiece, a loudspeaker, or a "Sonalert" oscillator and sound-reproducing means. It should be noted that optical probes may be hand-held, or may be attached to a fixed mount, sensing materials passing by, or may be on scanning mountings designed to allow traversing any particular track.

Optical probes may be used by blind typists to orient letterheads and deal with margins. Switchboard operators use them to locate lighted lamps. Colors can be matched through use of filters. Urinalysis is possible and is important to blind diabetics. Various laboratory scientific experiments can be done by blind persons if aided with an optical probe. The blind radio repair technician also finds uses for a probe as does the blind person interested in using a telescope for astronomy.

Mr. Levens alluded briefly to the early work of Dr. C. M. Witcher (6) at AFB and MIT, which culminated in the production for AFB in 1957 of 45 "Audivis" probes (Fig. 1), by Dunn Engineering Associates, Cambridge, Massachusetts, at a reported cost of $35 each. He also referred to the devices of Messrs. A. Wexler (5), R. S. Muratov (7), and S. L. Bellinger and Dr. I. Browning (8).

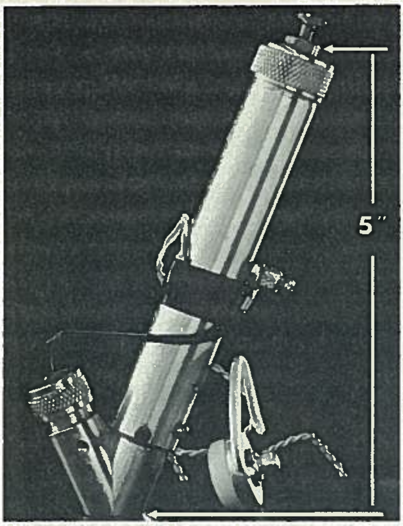

FIGURE 1. "Audivis" optical probe for the blind produces an audible output in the earpiece dependent on the amount of light incident on the input photocell.

Mr. Levens demonstrated several optical probes including one fitted to a hand-held boy scout's compass. Professor Benham, the chairman, also showed a 3 by 3 by ½ in. optical probe built by "Science for the Blind." Professor Mann mentioned related MIT students' theses (9, 10), but indicated these developments had never been carried through a thorough user-trial phase.

In addition to the optical probe devices with tactile output mentioned by Professor Mann, the writer of this paper briefly described suggestions in this area attributed to Drs. Heinz E. Kallmann and Robert J. Moon. The Kallmann idea involved a photoelectrically controlled tactile stimulator at the end of a vibrating reed, this reed itself mounted orthogonally on a second vibrating reed. As the unit passed over black on a page the two reeds would be driven electrically to vibrate, causing the stimulator tip to describe a small rectangle. Sensed with the fingertip this vibration would be the indication of black on the page below.

The Moon idea comprised a photosensitive element carried at the fingertip by a glove or cuff arrangement, and a tactile "pincher" or stimulator on the same fingertip. The power and electronics could be on the hand or elsewhere, connected by fine wires. If the finger, so equipped, were scanned over a page, a tactile signal would be received at the scanning finger whenever it passed over black.

Professor Benham mentioned a probe he had built with electrical stimulation as output. He demonstrated this and then passed it among those present for personal trials.

DIRECT TRANSLATION MACHINES

Miss Mary Jameson of London, England, a pioneer having 48 years of experience with the optophone, spoke to the group via a tape recording on "The Optophone: Its Beginning and Development." Her remarks are included in this issue of the Bulletin as a separate paper immediately following this article.

The writer, a Veterans Administration staff electronics engineer, related experiences using the Battelle 200-hour optophone training course with a blind social worker who has volunteered to take the lessons in spare moments. Despite the severe pedagogical shortcomings of such an informal arrangement, the subject has reached the 80th lesson with performance about the same as the average at Battelle Memorial Institute during their more intensive controlled learning study.

Dr. Leo H. Riley, director of the American Center for Research in Blindness and Rehabilitation (ACRIBAR), Newton, Massachusetts, told of optophone evaluation work conducted at his activity. ACRIBAR chose volunteer subjects of above average intelligence who expressed a desire to read ink-print. They were examined for physical fitness, IQ, hearing loss, psychological adjustment, and with the Battelle subject-selection test and the Seashore discrimination tests. Six persons were selected, three men and three women, with ages from 29 to 49 years, and IQ in the 110 to 141 range. The first formal lessons commenced in January 1965. Attrition in the slate of six subjects because of obtaining employment in conflict with lesson times, moving out of town, and extended illness, brought the tests to a halt. One subject reached a 7.1 wpm reading rate after 85 lessons, another 4.5 wpm after 66 lessons. The project operations are currently being revised to allow for training in the evenings and on week ends.

A staff braille instructor from the Veterans Administration Hospital at Hines, Illinois, Mr. Harvey Lauer, presented a talk on "The Potential Uses of the Optophone." Mr. Lauer's talk also appears in full following this paper. In addition, Mr. Lauer gave a demonstration of reading with both the Battelle optophone (Fig. 2) and the Mauch Laboratories "Visotoner."

Messrs. Hans A. Mauch and Glendon C. Smith were present to discuss the Mauch Laboratories "Visotoner," a miniaturized version of an optophone-style reading machine for the blind (11). The "hardware" aspects of the "Visotoner" were first considered in April 1964, and the first prototype was completed about six months later. The nine tones are the same as those used in the optophone developed at Battelle Memorial Institute. Letters within a 5:1 size range are accommodated by an automatic focus mechanism controlled by a braille-dot-marked clock-position adjustment knob. Maximum type height is 0.440 in. The unit is held by the hand and runs on long rollers coated with a high surface friction material. Once

FIGURE 2. Using the VA-Battelle optophone reading aid for the blind. Photocells in the probe which is in the user's right hand convert images of the print on the page to electrical signals which control tones fed through the earpiece. The probe is being guided along the line of print with the aid of a manual tracking device.

on a line these parallel rollers help keep the probe in the correct reading position. Hum-free operation is assured by use of power from a rechargeable nickel-cadmium battery weighing 12 oz. The "Visotoner" and hearing-aid-type earphone weigh only 10 oz. This includes circuitry comprising 38 silicon transistors, 63 resistors, 18 capacitors, and 12 diodes. Mr. Smith voiced the hope that the small size and light weight would contribute much towards the unit's acceptance by blind users.

Mr. Loyal E. Apple, chief of the Central Section for Rehabilitation of Visually Impaired and Blinded Veterans, Veterans Administration Hospital, Hines, Illinois, addressed the group on "Factors Affecting Reading Machine Instruction in Rehabilitation Centers." His complete paper is given following this article.

In the general discussion which followed the presentations relating to optophones, Dr. Selfridge inquired about the evidential basis for the use of tones as the optophone's display. Professor Mann queried the choice of the particular tones used, and the fact that the same ones are so often used. Reference was made to the late World War II Committee on Sensory

Devices work wherein tones emerged as a reasonable output, and to the brief exploratory work at Battelle. Drs. Cooper and Murphy and Messrs. Mauch and Freiberger tried to answer the questions in part. The author said he felt a definitive study as to the best audible output for a direct translation machine was yet to be made. Dr. White entered a plea that tests on such outputs could be done through simulation without building actual devices. He also reiterated a point he made several years before, that reading speed in words per minute is not a good measure of performance with a reading machine. He feels a measure of the time taken to read a telephone number in a telephone book, or to get information from a label, would be a much more appropriate rating means.

Dr. Murphy spoke briefly of the need to make graphic materials like charts and maps available to the blind. Sighted persons often make raised line drawings for the blind, but the Naumburg Visagraph and the later "Faximile" Visagraph were attempts to mechanize this process. These devices optically scanned the ink-print original which was mounted on a rotating drum, and with a solenoid-operated embossing point produced embossed replicas in tin or aluminum foil. Professor Mann mentioned a Gestetner process for making a stencil from an ordinary ink-print original, using a special ink in the Gestetner stencil duplicating process, then briefly baking this ink to produce a hard, raised, tangible image. Professor Benham added the point that with automatic embossed copymaking, the editing function of a human embosser is lost, i.e., confusing non-essentials are embossed along with the necessary material of the drawing.

Professor Geldard reviewed his work on the "Optotact" [a] idea at Princeton University. After mentioning the lack of success of just presenting signals, in whatever form they happened to be, to the skin, he emphasized the importance of determining just what kinds of discriminations the skin can best make. Passing quickly over discrimination in the intensity and frequency dimensions, he said the skin is superb as a temporal discriminator. Space or locus discrimination is most difficult for the skin, and many proposed information transfer means employing the skin are conceptually at great odds with what is known of communications via the skin. Professor Geldard is using a ten-channel system with ten small vibrators mounted on the body away from the head and shoulders and rib cage to prevent cochlear assist. Two vibrators are mounted on each arm, but not in symmetric positions, two on the abdomen, and two asymmetrically on each leg. Signals of 200 milliseconds duration and 2-second spacing were used in paired discrimination tests. The "signals" were derived through use of an IBM typewriter to type symbols, then scanning at controlled speed past a Battelle optophone probe whose outputs were amplified to control the body-mounted vibrators. As with the optophone, a thin long vertical bar would excite all circuits, and

[a] Now called "Optohapt."

all vibrators would operate. With a horizontal line only one vibrator ideally would operate. Other shapes, including letters, would give spatial-temporal patterns of vibrator activity. Ranking the patterns used in decreasing order of discriminability Professor Geldard found the period, quotes, a solid black square, hyphen, equal-sign, arrow to right, plus sign, letter "I," square shape in outline, Greek letter π, slash, diamond shape in outline, and letter "L." Note that the easiest letter, the "I," is in ninth place, the next, the "L," in 15th, and "A" is in 40th. Direct translation of letter shape for skin sensing by these means does not seem a fruitful procedure. Professor Geldard said one of the main lessons learned here is that the skin does not like Euclid.

Professor Linvill spoke briefly of his work (12) on tactile devices in collaboration with Dr. Bliss at Stanford Research Institute. An old idea enhanced with new technology is how he assesses the reading device using a 96-point 12 by 8 array of piezoelectric bimorph stimulators. Letter information, computer simulated so far, is used to produce a "Times Square" presentation of tangible letter shapes moving across the perforated plate supporting the sensing finger(s). Piezoelectric reeds are simple and efficient "motors" for the purpose. A vibration of only one micron amplitude can be felt, and one of 10 microns is easily sensed. With a stylized type font based on an 8 by 5 matrix, all three subjects could read at 20 wpm after 10 hours of training. Changing type style slowed "readers," but in time they learned the new style and were able to read a variety of fonts. Even though harder to read by eye, showing only 3/5 of a letter at a time did not seem to slow tactile reading. Showing lesser fractions did interfere with performance. An enormous amount of improvement is realizable through training, and Professor Linvill is convinced 35 wpm is achievable with this system. Making use of silicon monolithic circuits fabricated in Stanford laboratories, he hopes to construct a small unit capable of reading from ordinary print.

The reading machine of central importance in the Veterans Administration program at Mauch Laboratories (11) is a medium cost, personal, recognition-type device. To locate lines of type for this machine, and to resolve printed symbols beyond its capabilities, a set of raised pin stimulators giving somewhat the impression of tangible embossing was incorporated as part of the input probe. Considering this device as possibly useful by itself, it was constructed as the "Visotactor B" without the photocells used in the recognition machine. The "Visotactor B" (Fig. 3), portable reading machine for the blind developed at Mauch Laboratories, was described by Mr. Smith. Eight vibrators, in four pairs, are used two to each of four fingers which are inserted into four finger-rests of the unit. A blind subject has been trained at Mauch Laboratories on the "Vistotactor B," using the Battelle 200-hour course. At the time of this writing, the subject was reading from an adult's book of mystery stories, for 20 minute test periods, averaging about seven wpm. Four more "Visotactors" are to be constructed in the near future.

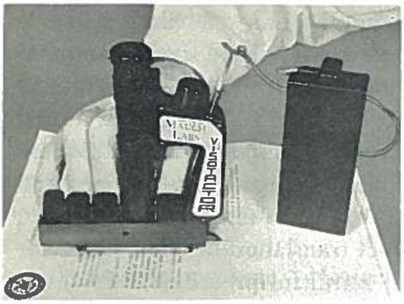

FIGURE 3. The "Visotactor" reading machine for the blind. Vibrating stimulators feed tactile information to the four finger-tips according to the printed letter shapes on the page over which the device is rolled.

INTERMEDIATE MACHINES

Dr. Nye, who had worked at Britain's National Physical Laboratory but who is currently at California Institute of Technology, recalled some of the work done at NPL (13) with so-called intermediate machines. These reading machines are "intermediate" on a scale having direct translation devices at one end and recognition machines at the other. Some measure of recognition and information processing takes place in these machines above and beyond the rudimentary operations of a direct translator, but short of the rather complex operations in a true recognition machine. The aim is to combine as well as possible the simplicity and low cost of the direct translation type with the improved performance of a recognition type.

In one set of experiments at NPL, a lower case alphabet was scanned by successive vertical scans and the following six letter-features were determined for each letter:

- ascender
- descender
- ribbon height vertical
- upward curving line
- downward curving line
- horizontal line

This feature information was stored in a token matrix, and after a smoothing conversion to an analog form, the information was used to control production of an audible output. One of a number of possible arrangements involved control of six parameters in an "artificial larynx" (hiss generator, three formants, larynx frequency, larynx amplitude) by the processed information from the letter shapes scanned.

Comparative tests of several NPL developed outputs led to a general conclusion that the richer the audible display the better in terms of probable reading speed and comprehension. Dr. Nye indicated that while natural speech is an ideal output form for a reading machine, we need not wait until mechanized speech production is perfect and fully understood. Outputs embodying known psychoacoustic data relating to displays may well be studied now to produce non-speechlike outputs superior to the optophone types now being tried.

RECOGNITION MACHINES

Messrs. H. A. Mauch and G. C. Smith gave some details of the work on a recognition machine at Mauch Laboratories, Inc., Dayton, Ohio (11, 15). Mr. Mauch made clear the differences between his inexpensive, fairly slow, and relatively portable device for use by the blind, and the large, expensive, high-speed devices used in industry. Because the blind user shares much of the burden of its operation, the machine for the blind can be commensurately simpler than its fully automatic counterpart used in industry. The blind user may have to find the text on the page, align the page in the device, change lines when the end of a line is reached, track along the line, and make size-of-type adjustments.

The Mauch unit is designed to recognize upper- and lower-case letters and ligatures in about nine common fonts. A tactile output is also provided, when necessary, by the "Visotactor A," the optical probe part of the system. Numerals and graphic indicia which the device fails to recognize may be "read" tactually by operating in the Visotactor mode, at slower speed.

Mr. Smith cautioned that only a laboratory prototype of the recognition reading machine has been tested to date. This device does, however, recognize typed or printed letters, and then produces an audible output in word-like groups of the spelled-speech sounds developed at Metfessel Laboratories. With the aid of a series of slides Mr. Smith briefed the audience on the technical aspects of the recognition reading machine. He referred to the "multiple snapshot" principle and the electro-optical directional effect realized in the slabs of polycrystalline photoconductive material (15) depending on the current source and sink edges versus neutral edges. The photocell development and fabrication work of the Laboratories was also summarized. Trials of the completed device show it can accommodate for some misalignment of printed material relative to the scanner, but plans are already made for an improved version which will be more tolerant of misalignments.

In planning the conference it was hoped that representatives of the character-recognition industry would indicate how their work and achievements could be used to enhance the reading machine program for the blind. Apparently unable to attend because of the severe weather, most expected representatives of industry could not be heard. Mr. David H. Shepard, president of Cognitronics Corporation and a pioneer in character recognition work (16), provided a summary. He mentioned equipments of Philco Corporation, Recognition Equipment Company, Intelligent Machines Research (now Farrington Electronics, Inc.), IBM, Burroughs, NCR, RCA, and Control Data Corporation (Rabinow Division). Mr. Shepard feels problems of format, pictorial material, advertisement layout, overlapping typed characters, and imperfections in paper and printing may pose the greatest difficulties in automatic reading for the blind.

OUTPUT/DISPLAY SYSTEMS

Professor Milton Metfessel plans to complete a final report on his project in mid-1966 which will contain detailed information concerning the generation of spelled-speech alphabets. It should be noted that spelled-speech is an audible output or communication system based on pronunciation of the series of letters comprising a text. The distinguishing aspect of the Metfessel system is that the pronunciation for each letter is carefully tailored so that one stored version may be used in any context while maintaining a high level of comprehension and coalescence of the letters into smooth-flowing word-like groupings.

Because of the expected thorough report, Professor Metfessel avoided great detail in his talk. Use of the system presupposes a knowledge of spelling. The communication rate for spelled-speech is very flexible, ranging from 1 wpm to 120 wpm. At slow rates, up to about 15 wpm, most people understand almost any kind of spelled-speech with little or no training. Problems really begin at speeds of about 70 wpm. Professor Metfessel feels he has solved the problem in that he is able to put together any text from his set of reference letter-pronunciations with a fairly smooth spelled-speech output at speeds up to 120 wpm.

At this meeting, several samples of spelled-speech were presented as well as recordings illustrating how the letter pronunciations are achieved. Compatible spelled-speech involves use of the same voice recording on the same tape at the same sitting with all adjustments held constant. The recording speaker speaks a sentence which ends with a group of letters to be pronounced. From these the desired letter is singled out to become one of the reference set.

Lack of a good standard means for measuring word-per-minute rates was mentioned along with some technical details of spelled-speech production. Professor Metfessel mentioned equal interval presentation, the "framing" of the letter sound in the interval, cutting out terminal and/or initial parts of letter sounds, use of rhyme in alphabet production, and the span of attention capabilities of a person receiving spelled-speech.

Dr. Franklin S. Cooper and Miss Jane Gaitenby of Haskins Laboratories, New York, reported on their work on audible outputs for reading machines for the blind. Aiming at a high performance unit, they have assumed that the machine has to "talk English." Hoping to use the results of the many others working on optical character recognition, the Veterans Administration has retained Haskins Laboratories to study the complementary or output part of the reading machine. Two principal approaches have been followed, one involving outright synthesis of speech, the phoneme being the unit element of consideration, and the second involving compiled speech, the word being the unit. Both avenues have been pursued to a point where outputs have been demonstrated. During the course of these studies, important advances in both equipment technology and understanding of machine production of speech have occurred. On the basis of this new knowledge (17) a most promising form of speech output for a reading machine has been proposed. Dr. Cooper calls this "re-formed speech." One possibility for its production involves a speaker first recording a vocabulary of words, perhaps 7000 or so as was done for compiled speech. These words are then stored in digital form in digital stores which are becoming more commonplace as digital computer technology advances. To use the words in an output system one must take them from the store in accordance with the letter and word knowledge from the character recognizer. The novel possibility here is that instead of coming up with a single output pronunciation as with compiled speech, the digitized word information can be further processed through a "digital spectrum manipulator." This extra step allows for variation of pitch and amplitude contours of the words. Such variational control, based on contextual data, should provide for a more natural and hence more acceptable speech-like output of a reading machine.

Miss Gaitenby played some recordings of compiled speech run at about 98 wpm drawing on a 7100-word recorded vocabulary. Selections where all words were available were demonstrated, and others requiring spell-out of the words not in the vocabulary were played. Miss Gaitenby touched on her extensive studies aimed at the selection of the most appropriate pronunciations of the words to be entered into compiled speech vocabularies, and also her experiences with spelling of words not in the system. These spelled words are often the unusual words, or proper names, and are generally *not* easy to comprehend if spelled at a fair rate in admixture with the pronounced words. Trials are yet to be made of spelled words in context using Metfessel's spelled-speech rather than just citation spelling-bee pronunciations.

Dr. Cooper summarized by mentioning the several types of reading machine output systems he has considered. He cited synthetic speech, compiled speech, and phrase-reading devices of several kinds and complexity levels. Some economic forecasts were made. He pointed out that some systems will probably be more expensive than a human reader; however, a word reading machine with some intonation could possibly compete economically. He felt that in the not too distant future, information dissemination problems for blind people will be largely in the administrative and organizational areas rather than in the technical.

The "Speechmaker" automatic speech generation equipment developed at Cognitronics Corporation (18) was described by the company's president, Mr. David H. Shepard. The heart of this device is a 3-in. photographic film audio memory drum with up to 32 tracks, one track for each of 31 utterances, words, or phrases, and one for a timing pulse. A light source and aperture provide a narrow light beam that is directed through the rotating drum. This light beam is modulated by the prerecorded audio signal on each track, and is in turn detected by silicon photosensitive cells located behind each track within the drum. The output of the photocells is then amplified to a level compatible with the particular employment of the unit. Switching for selection of the sounds to be heard can be done on a basis of either 31 individual switch closures, or by a binary decoding matrix performing the selection function from a standard 5-bit binary code. Mr. Shepard mentioned that the capacity of these units can be increased beyond the 31 tracks mentioned above, and that the prices vary from under one thousand to several thousands of dollars. The Cognitronics work has been chiefly device oriented in contradistinction to work at the Metfessel and Haskins Laboratories where the utterance has been studied. Mr. Shepard suggested that a merging of these approaches through sharing specialized knowledge could be very fruitful.

OTHER SYSTEMS OF "READING" FOR THE BLIND

The managing director of the MIT Sensory Aids Evaluation and Development Center (SAE&DC) (14), Mr. J. K. Dupress, spoke about some modern trends in braille translation and production. A computer is generally considered the appropriate means whereby material in one form or another can be encoded into braille. A key punch operator not knowing braille, or a perforated tape such as "Teletypesetter" or "Monotype" can be employed to feed text to the computer. The IBM 709 used at the American Printing House for the Blind has been employed in this translation service and has transcribed over 100 books to Grade II Braille so far. Several persons have written programs for braille translation using smaller computers, but the output from these has never been perfect Grade II Braille.

Several student theses at MIT have involved braille and the mechanized production of braille (19, 20, 21, 22, 23, 24). Staff members at SAE&DC are working to carry some of these student efforts closer to completion.

Mr. Dupress also referred to means for the production of small numbers of copies of braille documents, to mechanical braille displays such as the IBM belt reader and the Blanco device, and to recent attempts at small powered-braillers. He also touched on the recent special application work with high speed line printers of the kinds used in the computer industry. With braille-cell-embossing type bars and properly resilient backing platens, these printers have produced good braille at high speeds.

Mr. Dupress concluded with the thought that computers owned or operated by school systems may very well be used to generate braille in the future.

Mr. Alfred Korb, from the Division for the Blind of the Library of Congress, spoke about Talking Book, rapid speech, and recent efforts to increase speed of recorded speech without altering the pitch. He mentioned that some fast speaking radio personalities talk at 200 wpm, American Printing House for the Blind and American Foundation for the Blind usually record at 150–175 wpm, and that some recordings are at 80–120 wpm. By way of contrast he estimated a sighted twelfth grade student reads silently at about 250 wpm and a good braille reader at 90 wpm. The Library of Congress is looking for applications of compressed materials by selected surveying of some of the 80,000 people registered in the Library of Congress program. To date, some have complained of difficulty in understanding the speeded speech.

Mr. Alan Beaumont of the Solocast Company, Stamford, Connecticut, briefly described and demonstrated the Solocaster, a high fidelity, portable, record player. The unit is battery powered, light in weight, transistorized, and can be played in any position, even swinging through the air, thus offering "in-motion" performance.

USE OF TELEPHONE NETWORK

Another class of alternative solutions to some of the reading problems of the blind, mentioned at these meetings since the Second Conference held in April 1955, generally involves use of the telephone lines to transmit a facsimile of a printed page from the blind user's location to a central office. The graphic matter is sensed or read by machine or operators at the central location, and the information is then conveyed back over the phone to the user. Messrs. David H. Shepard and Joseph H. Kroeger of Cognitronics Corporation demonstrated publicly for the first time two variants of such a system. In the first, typed numeric data were scanned on a rotating drum facsimile-type apparatus at the Conference in Washington. The video information from this scanning was sent by the telephone lines to the plant at Briarcliff Manor, N.Y., where automatic character recognition was accomplished. The numerals were then "spoken" back over the telephone in human-voice recorded numerals by the "Speechmaker," the automatic speech-generation machine developed at Cognitronics and referred to above. In the second, alpha-numeric material scanned in Washington was read back over the telephone by a sighted reader from a CRT display at Briarcliff Manor.

The scanning system used in the Cognitronics demonstrations had an adaptive feature in that the pickup head traversed blank areas of the paper at a higher rate than it did for print-bearing portions. Scanning efficiency was thus increased. Pulse code modulation and integrated circuitry contributed to the success of the operation. Initial prices of these scanners are expected to range between $2500 and $7000 depending on the model. Telephone charges and costs of the central office operation will also be involved. There was a brief discussion of the economics of such a service, but in the time available and with the data on hand a clear resolution of the economic aspects was not possible.

VISUAL EFFECTS THROUGH STIMULATION OF REMAINING PARTS OF THE VISUAL SYSTEM

The use of ophthalmic spectacles is commonplace in the solution of the reading problem of many persons. Conceptually it is but a short step to consideration of prostheses analogous to eyeglasses for use when the visual dysfunction is other than just a refractive error. While simple enough in concept, in practice direct replacement for defective or missing parts of the visual system has, to date, proved most difficult. The subject has received attention for a long time as one may learn if the 25-item reference list on page 549 of the book *Blindness* (25) is noted along with the seven newer citations on pages 588–589 of the reprint edition of the same book.

Professor Theodor D. Sterling, chairman of the Committee on Professional Activities of the Blind, Association for Computing Machinery, spoke briefly on the subject of "artificial vision." He pointed out the naturalness of the thought process which, on recognizing a biologically defective element causing the blindness, then quickly proceeds to the areas of direct visual prosthesis and stimulation of the visual centers as a replacement for the lost sense. As technology gallops forward more serious researchers are beginning to explore the practical possibilities of such visual prostheses. Because of the great human values involved in blindness and proposals for its amelioration, discussions of artificial vision have been generally quite tactfully conducted within the scientific community. Currently, physiologists and psychologists are grappling with problems of how to preprocess optical information from the environment so as to recode it to appropriate electrical signals which may eventually find their way to the brain. Additional evidence of the current interest in visual prostheses traceable to recent technological advances may be found in Dean George A. Mallinson's paper (26).

ADJOURNMENT

Prior to adjournment the group considered project areas for continuing or future work. Included were comments on time compression and expansion of speech, graphics and images via telephone lines, time sharing of centralized expensive equipments with telephone terminals in the users' homes, improved means to prepare embossed drawings, instructors and instructional techniques for optophone, Visotoner, and Visotactor. The chairman thanked the participants and the Veterans Administration and then closed the sessions.

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