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## Non-visual Computer Peripherals

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### Introduction

Non-visual computer peripherals have been developed for:

- (i) braille production
- (ii) information retrieval systems
- (iii) outputs for reading machines
- (iv) blind programmers

This survey of devices in production, or under development, is based on replies to a questionnaire circulated in May 1974; the main features of these devices are summarised in Table 1.

A selected bibliography on the use of computers by the visually impaired, but excluding papers on speech synthesis and the employment and training of blind programmers, is at the end of the report.

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Table 1. Summary of the main features of the devices.

Device	Speech-like	Tactual soft copy	Braille paper tape	Braille page	Speed chars/sec
1 ARTS	+				
2 Anderson				+	3.3
3 Boiten			+		
4 Boldt					
5 Boldt					
6 Brown			+		10
7 Charlesworth		+			
8 Gee				+	10
9 Grunwald		+			
10 Haskins	+				
11 Heginbotham				+	60
12 de Jong				+	200
13 Kruger		+			
14 Loeber				+	16
15 Longini	+				
16 MIT				+	16
17 Myers				+	
18 PAL				+	10
19 Rahimi	+				
20 Rubenstein				+	10
21 Schonherr		+			30
22 Spanjersberg				+	7
23 Tagg				+	8
24 Telesensory		+			
25 Thiel			+		12
26 TNO				+	4
27 Trask				+	8192
28 BD-3			+		15
29 LED-120				+	15
30 LED				+	120
31 Wienberger			+		
32 Zawistowski			+		12
33 IBM				+	250

1. Developer American Systems, Inc.  
123 Water Street  
Watertown, Massachusetts, 02172, U.S.A.
- Status Commercially available as part of the ARTS system.
- Description Compiled speech output delivered over telephone lines. ASI speech and teleprocessing system Nucleus 3000 V/L with central processor and 8192 x 16 bit core memory, ASI 16-line multiplexer with receiver data sets or modems and speech storage disc capable of containing up to 500 seconds of speech definable as more than 2000 English spoken words.
- Price \$66,700
- Information Dr. K. R. Ingham, June 1974.
2. Developers G. B. Anderson and D. W. Rogers  
Lawrence Radiation Laboratory  
University of California  
Livermore, California, U.S.A.
- Status Unknown
- Description New print head for Model 33 teletype. Speed one third that of the normal teletype.
- Information Research Bulletin, No. 22, Dec. 1970, pp 111-117.
3. Developer Prof. Ir. R. G. Boiten  
Laboratorium voor Werktuigkundige  
meet-en Regeltechniek Technische Hogeschool  
Stevinweg 1  
Delft, The Netherlands.
- Status Experimental prototype.
- Description Braille printer, powered by electric motor, which prints on Kraft paper tape moving from right to left.
- Information Research Bulletin, No. 26, June 1973, page 219.
4. Developer Professor Dr. Werner Boldt,  
Pädagogische Hochschule Ruhr  
Dept. of Educ. and Rehab. of the Visually Handicapped  
46 Dortmund  
Kreuzstr. 155  
West Germany.

4. Developer Professor Dr. Werner Boldt (continued)
- Status Commercially available.
- Description Electronically-controlled system for programmed learning of the blind. Audio and braille output freely combined. Braille and multiple choice input according to the character of the program. Braille input electrically evaluated as well as multiple choice input. Branched programs - branching controlled by the input modes. All information (audio, braille, memory, coding) stored on magnetic tape (cassette type). During stop periods use as electronic braille-writer, with program cassette or additional material useful for most school subjects.
- Price circa \$2,800
- Information Prof. Dr. W. Boldt, May 1974.
5. Developer Professor Dr. Werner Boldt  
Pedagogische Hochschule Ruhr  
Dept. for Educ. and Rehab. of the Visually Handicapped  
46 Dortmund  
Kreuzstr. 155  
West Germany.
- Status Prototype development
- Description "Braillex" enables the blind user to reach prestored information with relatively short access. Information (verbal or braille) is stored and coded on magnetic tape cassettes. Verbal and braille output (for control) is possible. The information wanted is "called" by braille input and discriminated electronically. Examples: information from dictionaries, storing and use of private archives (telephone numbers, scientific notes, etc.), recalling of special parts in literature (pages, chapters, code words).
- Information Prof. Dr. W. Boldt, May 1974.
6. Developers V. Brown and E. Stuckey  
Teletype Corporation  
Little Rock, Arkansas, U.S.A.  
in collaboration with:  
E. Knoch  
Arkansas Enterprises for the Blind, Inc.  
2811 Fair Park Boulevard  
Little Rock, Arkansas 72204, U.S.A.
- Status One prototype built.

6. Developers V. Brown and E. Stuckey (continued)
- Description The device, which produces braille at 100 words per minute, is in parallel with a standard model 32 or 33 printer so there is keyboard input, print output and braille output simultaneously. The unit consists of a modified punch which punches two rows of three dots each or two rows of four dots each, depending on the need, instead of the 8 bit ASCII.
- Price The original price of duplicating this unit in quantity was estimated to be \$1600.00. However, with the modern LSI circuits available, it is felt that this device could be duplicated for under \$600.00.
- Information E. Knoch, June, 1974.
7. Developer D. V. Charlesworth  
Clarke and Smith Industries, Ltd.  
Melbourne House  
Wallington, Surrey, England
- Status Prototype built, general availability mid 1976.
- Description 12,24, or 72 character 6 point braille display with solenoid operated dots module and computer terminal/information retrieval unit. Fresh lines of information are obtained by pressing button at end of line.
- Price £300 - £1600 depending on application.
- Information D. V. Charlesworth, May 1974.
8. Developer Dr. M. J. Gee  
Scientific Systems Group  
Office of Computing Activities  
University of Dayton  
Dayton, Ohio, 45409, U.S.A.
- Status Prototype
- Description A paper embosser which employs an ASR 33 terminal, and produces a configuration of seven dots arranged in an expanded braille cell, with the addition of a seventh position below position six
- Information Association for Computing Machinery  
Newsletter for Blind Computer Programmers  
4th Issue, Vol, 2, No. 1, page 5.

9. Developer Dr. A. P. Grunwald,  
Engineering and Technology Division,  
Argonne National Laboratory,  
9700 South Cass Avenue,  
Argonne, Illinois, 60439, U.S.A.
- Status Production Prototype.
- Description Device converts symbols recorded on magnetic tape to raised braille dots on a plastic belt. The belt moves conveyor-like at an adjustable speed; the dots are "erased" by depressing them and new ones raised.
- Information Research Bulletin, No. 23, June 1971, page 106.
- 10 Developer Haskins Laboratories Inc.,  
270 Crown Street,  
New Haven, Connecticut 06510, U.S.A.
- Status Prototype.
- Description Full text-to-speech processing system is now working in the laboratories. The synthetic speech is not entirely natural although intelligible. Sufficient progress has been made to justify the construction of a pilot reading service centre which would have a combined research and service function.
- Price \$350,000
- Information P. W. Nye, June 1974.
- 11 Developers Professor W. B. Heginbotham  
D. W. Gatehouse and D. G. Hassel  
University of Nottingham  
University Park  
Nottingham, NG7 2RD, England.
- Status Design study.
- Description A terminal to produce a 36 character wide line of braille print at a speed of 60 characters per second operating on a line printer principle. Also, meant to be adaptable to desk calculating machine. The machine sets up the braille terminals by operating from a bank of 7 electro-magnetic devices.
- Price Estimated £1000.
- Information Prof. W. B. Heginbotham, May 1974.

12. Developers Prof. D de Jong and Ir. A. N. Westland  
Technological University Delft  
Leeghwaterstraat 3  
Delft, The Netherlands,
- Status First prototype ready in July 1974
- Description Braille lineprinter operating with papertape as input or on-line with a computer. Working on normal braille paper (180 gsm), printing 5 lines per second, each one consisting of maximum 40 braille cells.
- Information Ir. A. N. Westland, May 1974.
13. Developer F. Kruger  
National Center for Deaf Blind Youths and Adults  
New Hyde Park  
New York, NY 11040, U.S.A.
- Status Prototype available
- Description A single-cell softcopy braille display which can be connected to a computer via an acoustic coupler.
- Information Electronics, 7th February 1974, page 46.
14. Developer N. Loeber  
IBM Corporation  
P. O. Box 66  
Los Gatos, California 95030, U.S.A.
- Status Experimental unit
- Description Page braille embosser, based on standard IBM terminal. The unit embosses from the rear, with the data appearing on the front side of the paper. A metal die is used to mate with the selected pins to provide positive control in forming the raised dots.
- Information American Federation of Information Processing Societies, vol 39, 1971, pp 79-87 and N. Loeber, June 1974.
15. Developer Professor R. L. Longini  
Medical Systems Engineering Laboratory  
Carnegie-Mellon University  
Pittsburgh, Pennsylvania 15213, U.S.A.
- Status Fourth generation device built.
- Description An alphanumeric audio output where the sounds are voice-like enough so that 100% phonetic output can be learned as a dialect. Forty hours of training (high IQ) permits 150 words per minute of English to be understood.

15. Developer Professor R. L. Longini (continued)  
 Price Circa \$300 if built in quantity.  
 Information Professor R. L. Longini, June 1974.
16. Developer Massachusetts Institute of Technology  
 77 Massachusetts Avenue  
 Cambridge, Massachusetts 02139, U.S.A.  
 Status Commercially available but supply limited.  
 Description The Brailleboss is an automatic braille printer which can operate at speeds up to 16 characters/second.  
 Information Research Bulletin, No. 24, March 1972, page 161.
17. Developer F. H. Myers  
 Bell Telephone Laboratories, Inc.  
 6200 East Broad Street  
 Columbus, Ohio 43213, U.S.A.  
 Status Laboratory prototype  
 Description A braillewriter was modified for electronic control. Seven solenoids and seven contacts were added.  
 Information Research Bulletin, No. 24, March 1972, page 164.
18. Developer Perceptual Alternatives Laboratory  
 358 Life Sciences Building  
 University of Louisville  
 Louisville, Kentucky 40208, U.S.A.  
 in collaboration with Electronic Systems Development Corporation.  
 Status Second prototype built.  
 Description Braille page embosser that will operate at teletype speeds.  
 Price Under \$1000.  
 Information Annual report of Perceptual Alternatives Laboratory, July 1974.
19. Developers Professors M. A. Rahimi and J. B. Eulenberg  
 Department of Computer Science  
 Michigan State University  
 East Lansing, Michigan 48824, U.S.A.



19. Developers Professors M. A. Rahimi and J. B. Eulenberg (continued)
- Status Limited production.
- Description The system uses the speech synthesis hardware/software package implemented on Michigan State University's main computers. The buffered output is normally operated at 300 Baud. The phonetic images of words and sentences are built up by concatenation of 8 bit symbols representing the phones of English in the buffer memory. The 8 bit code consists of 6 bits representing the phone and 2 bits representing one of four levels of intonation.
- Price \$4000 - \$5000 per unit.
- Information Professor M. A. Rahami, July 1974.
20. Developer R. Rubenstein  
University of California  
Irvine, California, 92664, U.S.A.
- Status One - off working model.
- Description A teletype terminal was adapted to produce braille printout.
- Information Research Bulletin, No. 24, March 1972, page 161.
21. Developer Dipl.-Ing. K.-P. Schonherr  
Arbeitsgemeinschaft fur Rehabilitationstechnik an der Universitat  
Stuttgart e.V.  
D-7000 Stuttgart 1  
Schlob Solitude, Haus 3  
Germany.
- Status Prototype.
- Description The device is an electromechanical modular display, the module being a six dot braille cell such that braille lines of any desired length can be made. Writing speed is 30 characters per second.
- Information Dipl.-Ing. K.-P. Schonherr, June 1974.
22. Developer A. A. Spanjersberg  
Dr. Neher Laboratory  
St. Paulusstraat 4  
Leidschendam, The Netherlands.
- Status Six printers have been built.
- Description The 7 bits of a braille code have to be presented in parallel to the input. The braille characters are embossed on the paper which is transported in the printing mechanism by pin feed. The speed is about 7 braille characters per second.

22. Developer A. A. Spanjersberg (continued)  
 Price D.Fls.15,000  
 Information A. A. Spanjersberg, May 1974.
23. Developer Dr. W. Tagg  
 Hatfield Polytechnic  
 Hatfield, Herts, England.  
 in conjunction with the Royal National Institute for the  
 Blind and Business Data Products Ltd.  
 Status Prototype built and in daily use.  
 Description For Output - IBM Model D braille typewriter plus sighted  
 typewriter. For input - specially designed keyboard. These  
 three components are linked electronically to each other and  
 to a standard Datel data transmission unit.  
 Information M. Jenkins, Hatfield Polytechnic, May 1974.
24. Developer Telesensory Systems, Inc.  
 1889 Page Mill Road  
 Palo Alto, California 94304, U.S.A.  
 Status Prototype being evaluated  
 Description Hewlett-Packard (Santa Clara) have developed an ASCII to Optacon  
 interface bypassing the Optacon's camera to feed the signals  
 directly into the circuitry.  
 Information Measure (Hewlett-Packard), May 1974.
25. Developer Ing-Buro Thiel  
 6105 Ober-Ramstadt  
 Grafengasse 2, West Germany  
 Status Commercially available from stock.  
 Description Braille tape input-output attachment to enable blind person  
 to operate telex-teletypewriter machines. Output speed is 12  
 braille characters per second.  
 Information International Catalog of Aids and Appliances for Blind and  
 Visually Impaired Persons, 1973.
26. Developer T.N.O.  
 Delft, The Netherlands.

26. Developer T.N.O. (Continued)
- Status One-off working model.
- Description Input is from eight hole punched paper tape which is fed to a modified Perkins brailier and automatic cutting apparatus. A code-translator has a maximum capacity of one braille plate embossing and six braille printing machines. The speed of production is 4 characters per second.
- Information Research Bulletin, No. 25, Jan 1973, page 266.
27. Developer Trask Datasystem AB  
Stockholmsu, 34  
182 74 Stocksund, Sweden.
- Status Prototype being built.
- Description The Zoltan Braille Embosser is a fully automatic system which can provide single copy documents at the rate of 10 seconds per sheet embossed on both sides (interpoint). A second sheet with the same text takes 1 second and all additional copies  $\frac{1}{4}$  second each. The quality will be equivalent to that obtained from rotary press using zinc plates. All the functions of the machine are controlled by an electronic digital controller. Text input is made with paper or magnetic tape or alternate as desired. For this reason the aquisition and storage costs of a text library are minimal.
- The machine contains two embosser drums which print both sides of a sheet simultaneously. Each drum contains 6720 movable pins. The input text determines the position of each pin, which in turn embosses the paper to provide the corresponding braille text.
- Price circa Skr. 200,000
- Information Trask Datasystem AB, May 1974.
28. Developer Triformation Systems, Inc.  
P. O. Box 127  
Wall Street Station  
New York, NY 10005, U.S.A.
- Status Commercially available, delivery 90 to 120 days.
- Description The BD-3 is a portable unit which produces braille on paper tape, when used in conjunction with a keyboard, digital equipment, a computer, almost anything that uses coded information. Weight - 15 pounds. Speed - up to 15 cps. Operating modes - EIA interface, TTY interface (other interfaces optional). Input code - ASCII, EBCD, BCD, Correspondence, Baudot, any code with eleven bits per character or less.

28. Developer      Triformation Systems, Inc. (continued)
- Price              \$1850
- Information       Triformation Systems, Inc., June 1974.
- 
29. Developer      Triformation Systems, Inc.  
P. O. Box 127  
Wall Street Station  
New York, NY 10005, U.S.A.
- Status             Under development.
- Description       The LED-1 is a stand-alone braille device which produces braille device which produces braille from a keyboard, from a computer, from almost any coded information on a page of paper. Speed-up to 15 cps. Operating modes - EIA interface, TTY interface (other interfaces optional). Input code - ASCII, EBCD, BCD, Correspondence Baudot, any code with eleven bits per character or less.
- Information       Triformation Systems, Inc., June 1974.
- 
30. Developer      Triformation Systems, Inc.  
P. O. Box 127  
Wall Street Station  
New York, NY 10005, U.S.A.
- Status             Commercially available, delivery 90 to 120 days.
- Description       The LED-120 is a high speed braille printer which can produce braille from a keyboard, from a computer, from magnetic cassettes or from almost any source of coded information. Speed up to 120 cps. Operating modes - EIA interface, TTY interface (other interfaces optional). Input code - ASCII, EBCD, BCD, Correspondence, Baudot, any code with eleven bits per character or less.
- Price              \$9000
- Information       Triformation Systems, Inc., June 1974.
- 
31. Developer      Z. Weinberger  
National Physical Laboratory of Israel  
Hebrew University Campus  
Jerusalem, Israel.
- Status             Unknown

31. Developer Z. Weinberger (continued)
- Description A braille tape embosser produces braille cells on half-inch machine paper tape. By suitable interfacing, the braille can accept input from computers, card readers, Telex tape and Monotype tape.
- Information Research Bulletin, No. 21, August 1970. page 118.
32. Developer W. A. Zawistowski  
Computation Centre  
Polish Academy of Sciences  
P. O. Box 22-00901 Pkin,  
Warsaw, Poland.
- Status Prototype.
- Description The tape reader-writer unit (type WAZA) reads 8 hole punched paper tape and outputs braille embossed on paper tape. Writing speed is 12 characters per second.
- Price Circa \$100
- Information World Council for the Welfare of the Blind,  
Sao Paulo, August 1974.
33. Developer IBM Corporation  
Armonk, New York 10504, U.S.A.
- Status Commercially available
- Description The printing mechanism on an IBM 1403 line printer has been modified to produce braille at about 250 characters per second.
- Price Dkr. 550,000
- Information J. Vinding, September 1974.

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VOL 11, JUNE 1968, PP 417,418,440.
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MITRE MATRIX, VOL 5, NO. 2, 1972, PP 22-31.
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MITRE CORPORATION, 1971, 139 PP.
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PROCEEDINGS OF THE BRAILLE RESEARCH AND DEVELOPMENT CONFERENCE, MIT,  
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THE MUNSTER WORKSHOP, MARCH 1973.
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