DOCUMENT RESUME

ED 118 152 IR 003 063

AUTHOR Diodato, Virgil
TITLE Tactile Media for the Visually Handicapped.
PUB DATE 76
NOTE 18p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage
DESCRIPTORS *Blind; Instructional Aids; *Sensory Aids; State of the Art Reviews; *Tactile Adaptation; Technology; *Visually Handicapped

ABSTRACT

New technological developments allow even the most severely visually handicapped person to read print, sense images, and operate calculators and meters. One of these new developments is the Optacon, which converts printed images to vibrations sensed by finger touch, and may be used to read print, handwriting, and calculator displays. Another device, the Visio- Substitutuion System, converts visual images to vibrations over a 10-inch area of the user's back, enabling him to sense a complete image. The Binary-coded Output Display is designed to allow reading of measuring units such as meters and counters. The technology of tactile illustration is improving, both with commercially available tactile maps and illustrations and with materials (such as aluminum foil, paper and screen, and cellophane) adaptable to individual needs. Other educational aids useful to the visually handicapped include the abacus, the geoboard (with fixed pegs over which rubber bands are stretched to teach number theory and geometry), origami, models, mockups, and realia. Teachers and librarians thus have a variety of devices available to help improve their services to the visually handicapped. (LS)

TACTILE MEDIA FOR THE VISUALLY HANDICAPPED

by

VIRGIL DIODATO, M.L.S.

BALL STATE UNIVERSITY

Do you know that even the most severely visually handicapped person can read this morning's newspaper, operate an electronic calculator, and even sense images emitted by an overhead projector? The creation of media for those who see with their fingers or skin should make the resources in schools and libraries available to more people. Developments range from sophisticated electronic devices that convert ordinary print into vibrations sensed by the fingertip to the realization that heat produced by a projected image can be sensed as readily as the image can be seen. This article briefly describes some of these developments.

I. The Optacon

The word "Optacon" is derived from the phrase, "optical-to-tactile converter." In 1960 John G. Linvill had the idea that such an instrument could aid the visually handicapped, and he and James C. Bliss developed the idea at the Electrical Engineering Department of Stanford University. By 1971 the device was being marketed by Telesensory Systems, Inc., Palo Alto, California. By 1974 it had passed through the prototype and field-testing phases of development, and over a thousand were available for sale. Approximately 500 were sold in 1974.[1]

The device converts printed images to vibrations. Need for such a system is dictated by the existence of much printed matter that is not in Braille. Thus, correspondence, notes, classroom handouts, as well as many books and periodicals are not available in a format usable by Braille-reading persons.

There are two major components of the Optacon: the scanner and the control-tactile unit (see Figure 1). The control-tactile unit weighs approximately four pounds and resembles the size and shape of an audio-cassette tape recorder. The scanner is small enough to be grasped in one hand. The entire device is powered by a battery in the control-tactile unit. The reader moves the scanner across a line of print so that the protruding section of the scanner passes over the letters of the words. In this section of the scanner are 144 phototransistors applied to a 1/2 X 1/4 inch silicon chip. As this window of transistors passes over a letter, the one-eighth square inch area is sampled. The transistors do not observe the entire image, but rather 144 points of the image. Whenever one of the points is dark (that is, when part of a letter has been observed), the appropriate phototransistor is activated, and a corresponding electrical signal is sent to the control-tactile unit, where a conducting reed is stimulated into vibration. This flat reed, one of 144 reeds situated parallel to the surface upon which the Optacon rests, is connected to a steel wire one-hundredth inch in diameter. A vibrating reed causes one of the 144 steel wires to vibrate with its tip extending outside the housing of the unit into a finger groove. In order to sense the vibrations the reader places one finger in the groove. The scanning of a letter produces vibrations in those portions of the finger groove that are analogous to that area of the phototransistor array that has been excited by the dark portions of letters. And so the reader sees the letter by sensing its shape, which is reproduced in tactile form on the fingers.

Linvill's daughter probably has given the Optacon more use than anyone. After some 130 hours over seven months of use this college student attained a reading speed of fifty words per minute. By 1974 she was at the ninety words per minute level, about half as well as a reader can do in Braille.[2] However, other subjects have shown varying amounts of success, none being as adept as Linvill. The problem for many readers might be that not all visually handicapped persons know the shapes of the letters of the alphabet. The Braille system is based on the positions of six points in a rectangular area, not upon letter shapes.

Nothing prevents the Optacon user from reading cursive type (or handwritten notes and the like) once he is familiar with the writer's handwriting and the ink is dark enough to permit sensing by the phototransistors. Successful improvements at present permit a reversal of ground and figure so that the scanner will respond to light, rather than dark areas. In this way displays on electronic calculators become readable by the Optacon. The scanner can be modified by the user to operate at several inches away from the image. Therefore, a typist can use the Optacon to proofread copy without removing the copy from the typewriter.

Future developments will be spurred by a desire to lower the cost of the Optacon and so make it more widely available. Research is being carried out in the area of grey tones in order to find out if the wires can be made to vibrate so as to indicate to the user the color or shading of the type.

II. The Vision Substitution System

This system is being produced at the Smith-Kettlewell Institute of Visual Sciences, Pacific Medical Center, San Francisco, California, by Paul Bach-y-Rita, Carter C. Collins, Frank A. Saunders, Benjamin White, and Lawrence Scadden. The first model was completed in 1969 after about five years work, and it is still in the prototype stage.

The system consists of a television camera, electrical switching equipment, and tactile stimulators that are attached to a chair (see Figure 2). A camera tripod is used because the modified version of a television camera is too heavy to be hand held. Switching equipment converts the video images to electrical impulses that travel to the tactile stimulators. The vibrations are provided by 400 Teflon-coated probes, which pass through small holes in four arrays of 100 probes each. The pattern of vibration is the pattern that has been sensed by the camera.

The entire set of 400 probes is installed in the back of a chair, and the vibrations are felt by the bare back of the user over an area of ten square inches. The back has been used rather than fingertips because it provides a large surface area that receives a relatively small amount of stimulation from outside sources. The hands are left free so that should the device become portable, the user would be able to manipulate things other than the camera. Presently, the user's hands are involved in controlling the camera's aim, zoom, and lens opening.

Although this is a monocular system, three-dimensionality can be suggested to the user if there is notice of such items as size changes in moving objects or the moving of an object between the camera and some other object. Users have been able to recognize within-room objects such as telephones, photographs of faces, and large block-letter words.[3]

III. Binary-coded Output Displays

Another type of device is the tactile reading unit developed by Elm Systems, Inc., Arlington Heights, Illinois. Any measuring instrument (such as a voltmeter or counter) that is or can be converted to outputting binary-coded information may be attached to the tactile unit. The unit consists of seven rows of four pins each. Each row represents a decimal digit. Each pin represents a binary digit. When the operator feels pins one and two in a given row, he knows that $1(2)^0 + 1(2)^1 + 0(2)^2 + 0(2)^3 = 3$ is the decimal digit in this position. The operator feels all seven rows if he wants seven decimal digits of information. The thumb is placed in a position where it can be touched by a raised pin that indicates the sign of the output.

IV. Illustrations

The development of tactual illustrations for and by the visually handicapped has been a slow process. It is true that the American Printing House for the Blind and other concerns manufacture dissected maps that provide information on political and geographical borders and on topological features. Political information is supplied by a map constructed as pieces of a puzzle that can be taken apart and studied. Maps with discernable ridges and depressions that represent mountains and bodies of water show geographical facts, and these maps are more conveniently subsumed under the heading "Illustrations" than are dissections. The finer maps supply much more information than the dissections -- so much information that research is going on trying to decide how tactual maps should be read: With one hand? With two hands? With how many fingers? With vertical or horizontal scanning of the fingers?[4] Perhaps manufacturers should find the answers before they attempt to create the optimum tactual map.

In any case, if a visually handicapped person lacks experience in relating real objects to symbols, a map or any other illustration will not convey all of the information it contains. Thus, educators bear the burden of preparing the students to use well media such as tactual illustrations. The illustrations for the visually handicapped should not be identical tracings of those illustrations used for sighted persons no more than translations of texts from one language to another should or can be perfectly literal. Although a Braille writer might transcribe the printed words of a text into the raised dots of the Braille symbols quite automatically, he might fail to make illustrations understandable. Visually handicapped readers often have problems with the relationships between different symbols in an illustration, between symbols and ground, between identical symbols in different orientations, as well as between symbols and their real-life counterparts.[5]

Much of tactual illustrating is created using different kinds of raised-line techniques that are analogous to the different kinds of type face. But although different raised-line drawings give different information to the reader, not all of them are as easily amenable to reproduction as is printed material.

A. Aluminum Foil

Using aluminum foil to create illustrations has the distinct advantage of allowing reproduction by the Thermoform machine, a duplicating machine that treats the aluminum sheets as masters for making copies with the same tactual qualities as the original. One problem with this procedure is that the master drawing appears on the opposite side of the sheet upon which the artist is working with such tools as a cutting wheel, stylus, and sculpting stick. The stick produces one of this method's more obvious advantages: the ability to create raised lines at different heights. Erasures are easily made by applying proper pressure to the side of the illustration that is felt by the reader.

B. Paper and Screen

Another method of illustrating uses paper that is clamped onto a flat surface such as a wooden cutting board. Between board and paper is placed fine mesh screening. The tools used here are such items as the cutting wheel and stylus. Although the results are not perfect, the screen causes an easily felt texture to be applied to the drawing. Since the medium is paper, erasure of folds, holes, or indentations is virtually impossible, as is mass reproduction of the texture in some form of copying machine.

C. Cellophane

When a stylus with a ball-bearing tip is applied to cellophane raised lines are pulled out from the medium toward the artist. Thus, unlike the previous two methods, the artist works on the same side of the medium that the reader feels. Disadvantages of using cellophane include the impossibility of machine reproduction and the fact that damp hands or tools play havoc with the material. Erasure is possible, but the mere passage of time allows the surface to fall back to its original flat texture, thus destroying the illustration.

A related development is the use of plastic sheets for letter writing. The sheets have embóssed lines that serve as guides to the writer, who need not write in reverse as some artists must do when making raised-line drawings.

V. Educational Aids

Although any of the above-mentioned developments can be applied to classroom situations, there are several areas of research that have been specifically concerned with the education of the visually handicapped.

A. The Abacus

The abacus has long been a useful tool for teaching school mathematics to the visually handicapped. In 1964 Tim V. Cranmer modified it by enlarging its structure in order to make the columns of beads easier to distinguish and by placing a foam backing under the beads to prevent accidental movements from disrupting their status.[6] Although the abacus has been used for both teaching mathematical concepts and performing calculations, better rules might be needed to insure the optimum use of the thumb and index finger. These fingers must not only manipulate the beads for calculating and clearing but they must also read the status of the beads. Future developments might include differently shaped beads to distinguish between columns, some means for preventing slippage of the abacus and its beads, and a still larger frame.

B. The Geoboard

The geoboard is a peg board device that was originally developed by Caleb Gattegno for teaching mathematics; both sighted and unsighted persons can use it. The pegs are as stationary as the points on a graph, and rubber bands are stretched from peg to peg to represent the perimeters of various two-dimensional geometric figures. The pegs are usually arranged in a rectangular array similar to the vibrating wires in the Optacon. The present model is useful in teaching the number theory and analytical geometry concepts, and as long as the pegs are spaced widely apart, visually handicapped students can manipulate the rubber bands and feel the status of the pegs and rubber bands. Innovators might experiment with nonrectangular arrangements and nonflexible substitutes for rubber bands. At present all figures on the geoboard are closed. Even a line segment is represented by an oblong-shaped figure. Perhaps a nonflexible medium, such as wire, might help educators widen the uses for the geoboard.

C. Origami

This traditional Japanese art of folding paper to represent flowers and other objects can help visually handicapped students to understand geometric concepts, but the paper must have sufficient texture and substance to clearly define the intersections of lines. Braille paper is suitable. In a sense, the student is creating a type of raised-line drawing without using artist's tools.

D. Other Educational Aids

Models, mockups, and realia are among the more obvious tools that the teacher of the visually handicapped can use. Yet in some fields, such as sex education, these media are only now becoming accepted.[7] The definition of "model" can be stretched to include the use of such concepts as shadow and silhouette. A visually handicapped person can certainly feel the heat or absence of heat from, say, a projection of light and dark areas by an overhead projector. Profiles of people standing in the line of the projection or silhouettes placed on the overhead can be sensed by the skin, which can distinguish gradations of temperature.

For students and teachers of art there is cognizance of the fact that both the sighted and unsighted can appreciate certain types of art through the sense of touch, but only recently has the world begun to realize that the sightless can also create art and see the results. Traditional sculpture is probably the most obvious area of participation, but it is a viable possibility that the sightless artist might be able to create a whole new world of art out of the pleasurable or traumatic experiences that he has had with the electronic scanning equipment he carries on his back.

VI. Conclusion

Although not all tactile media are available to all the visually handicapped, development of these devices and techniques can only hasten the day when schools, libraries, and other institutions supply equal services to all persons. For now, teachers and librarians for the sighted have an obligation to be aware of media that might evolve into important components of their services.

References

[1] "Eye in the Fingertip," Scientific American, January 1974, 230:51-52.

[2] "The Blind in the Age of Technology: A Public Discussion," New Outlook for the Blind, September 1970, 64:211; James C. Bliss, "A Relatively High-Resolution Reading Aid for the Blind," IEEE Transactions on Man-Machine Systems, March 1969, 10:8; James C. Bliss et al., "Optical-to-Tactile Image Conversion for the Blind," IEEE Transactions on Man-Machine Systems, March 1970, 11:62.

[3] Paul Bach-y-Rita et al., "Vision Substitution by Tactile Image Projection," Nature, March 8, 1969, 221:963-964.

[4] Edward P. Berla and Marvin J. Murr, "Searching Tactual Space," Education of the Visually Handicapped, May 1974, 6:49-50.

[5] Geerat J. Vermey, "Observations on Raised-line Drawings," Education of the Visually Handicapped, May 1969, 1:51-52; Joseph W. Weidel, "Tactual Maps for the Visually Handicapped: Some Developmental Problems," New Outlook for the Blind, March 1969, 63:80-81.

[6] Roger Huff, "Development of an Enlarged Abacus," Education of the Visually Handicapped, October 1972, 4:88; Manan Lewis, "A Year of Change to the Abacus," Education of the Visually Handicapped, March 1969, 1:29.

[7] Frederick E. Bidgood, "A Study of Sex Education Programs for Visually Handicapped Persons," New Outlook for the Blind, December 1971, 65:318-323; Donald D. Moore, "Sex Education for Blind High School Students," Education of the Visually Handicapped, March 1969, 1:22-25.

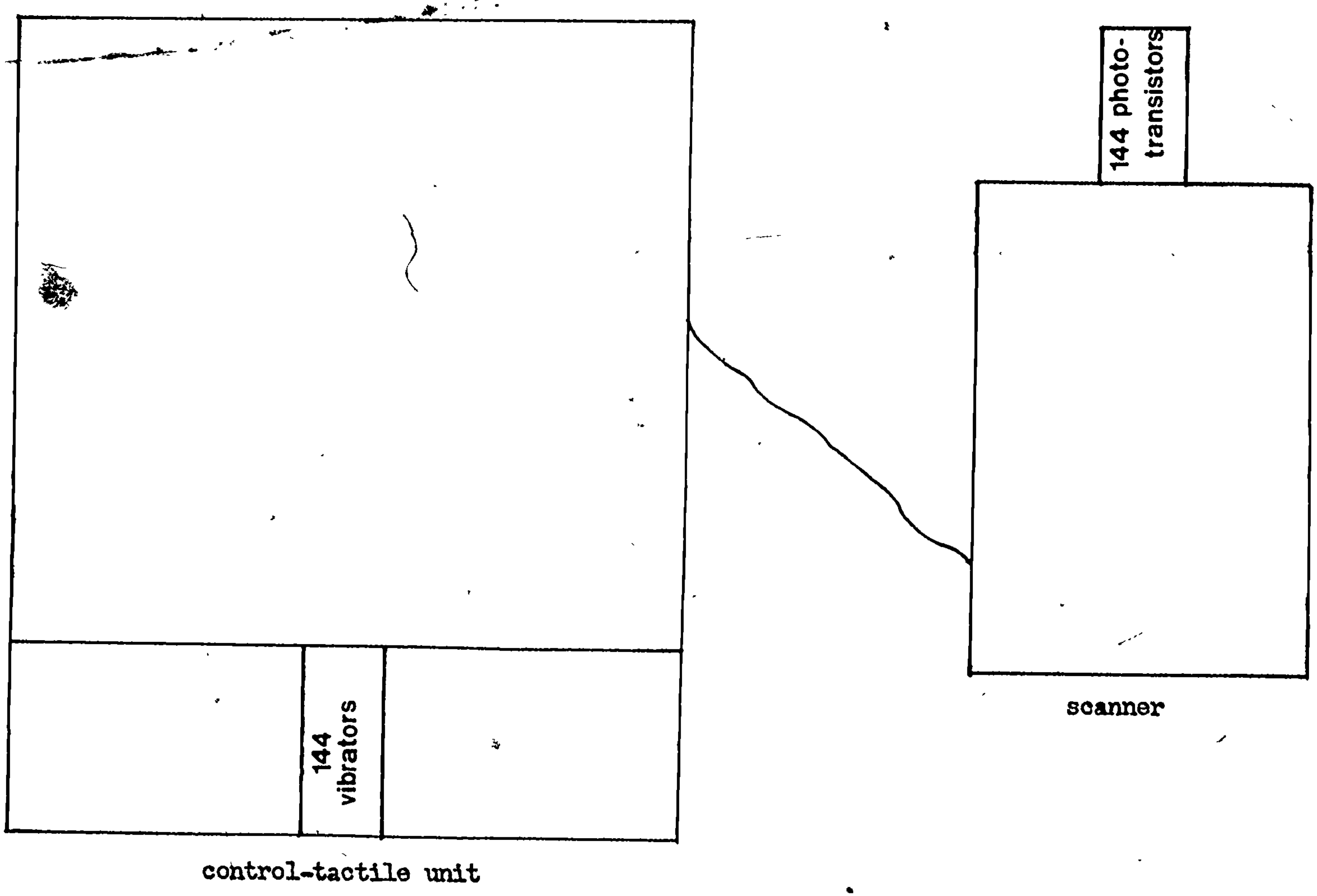

Figure 1. Components of the Optacon (not to scale)

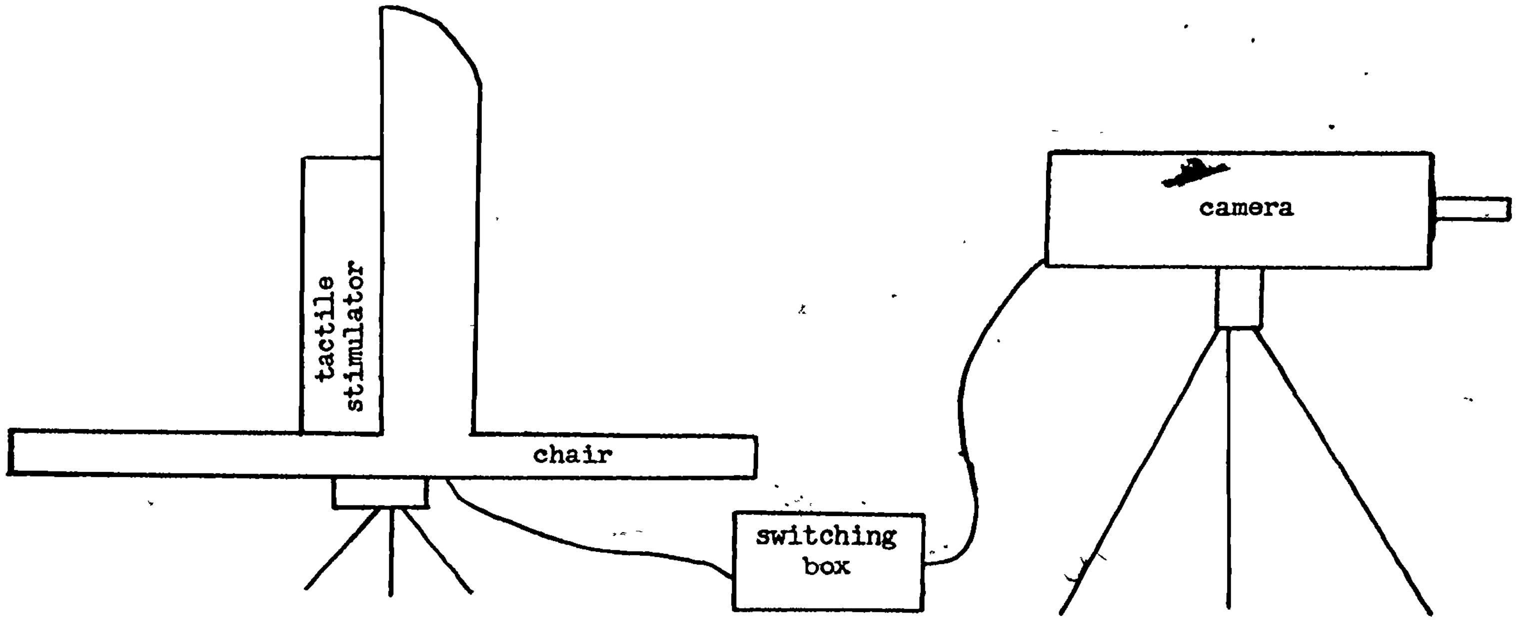

Figure 2. Components of the Visual Substitution System (not to scale)