

Acknowledgements

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Tactile Graphics Kit

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Introduction

Tactile Graphics Kit

To the extent that it is possible, blind students should have access to the same information as sighted students. Concern for this principle has been traditionally reflected in efforts to convert print materials into braille or recordings. While tactile and auditory verbal materials have justifiably been the major focus of attention in reducing the information barrier for blind students, another useful means of communication, graphic displays, has been largely ignored. Graphic materials in the form of maps, graphs, diagrams, and charts are, however, considered to be an indispensable form of communication in the world of the sighted and, consequently, have proliferated to an extent unparalleled in history. Quite simply, graphic materials have been recognized as having the capability of conveying certain

types of information that cannot be easily or efficiently presented in verbal form. Any person, regardless of visual status, is at a disadvantage if he or she cannot extract the wealth of information that is available in graphic displays.

The mass production of tactile graphic displays (sometimes referred to as raised line drawings) cannot be solely relied upon to meet the needs of blind students. Situations often arise both inside and outside of the classroom which make it desirable for students to have a tactile display that is not available as a commercial product. To satisfy these special needs, volunteer transcribers, materials centers, mobility instructors, and individual teachers have taken it upon themselves to construct the displays. Typically, this involves the construction of a display

from scratch, using whatever materials are readily available. Frequently this results in the use of symbols that cannot be easily discriminated from one another tactually, and a good deal of time and effort is then wasted because the display is not very readable.

The primary reason for developing the Tactile Graphics Kit was to provide all of the necessary ingredients for constructing readable, tactile graphic displays of all types: maps, graphs, diagrams, and charts. Basically, three different types of symbols are needed to design a graphic display. They are point, linear, and areal symbols. Point symbols are used for representing specific locations, landmarks, or objects on a display, such as a city on a geographical map or a desk in a map of a classroom. Linear symbols are needed to represent

boundaries or lines to be followed. Examples of linear symbols are rivers on a map, the outline of an amoeba in a biological diagram, or the curves on a graph. Areal symbols represent regions of extent, such as a body of water on a geographical map or a parking lot on a mobility map. Several of these three types of symbols are usually required and several of each are provided in the kit. All of the symbols of each type in this kit have been tested with blind students to ensure their discriminability. This is extremely important. If tactile symbols are confused with one another, the user will not be able to meaningfully interpret the display and will likely become frustrated. Only those symbols which were found to be tactually discriminable by at least 95% of the blind students participating in their evaluation are included in the kit. To get a better idea of how linear, point, and areal

symbols can be used to construct a graphic display, examine the kit-produced sample in Figure 1 on pages 14-15.

To assist you in taking maximal advantage of the Tactile Graphics Kit, several areas of potential interest are covered in the sections of this Guidebook. Section I describes the tools and materials contained in the kit and explains how to use the components of the kit in constructing tactile graphic displays. Section II presents information obtained from research studies and practitioners in the field on how to design more readable displays. The characteristics intrinsic to good displays are elaborated in this section. In Section III are research findings that should prove useful in training blind persons to read and interpret tactile displays more effectively. Finally, a bibliography of studies and articles in the area of tactile

graphics is given on pages 103-106. Anyone interested in furthering his or her knowledge on this topic will find numerous readings from which to choose.

It is strongly recommended that you read Sections I and II and thoroughly familiarize yourself with their content before actually constructing your first graphic display. Then choose some simple displays and practice making them before attempting more complex ones. While the tools in the kit were chosen and designed for ease of use, it should be realized that optimal results will only be attained with practice. The kit is versatile and allows the development of some degree of skill which, in the long run, will make your work in designing and constructing graphic displays more enjoyable and satisfying. Take your time. Skill will come with patience and practice.

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Section I

Using the Tactile Graphics
Kit Effectively

Tactile Graphics Kit

Overview

With the tools and materials contained in the kit, you can construct a “master” graphic display, which can then be used to produce as many copies of the display as you want. Basically, the idea is to create a master display by embossing heavy gauge aluminum foil with the point, linear, and areal symbols provided in the kit. Lines are

embossed in the foil with the front (or shiny side) face down, while point and areal patterns are embossed in the foil face up. The result is a raised image on the shiny surface of the foil. This master image can then be reproduced in the desired number of copies by using a conventional thermoform machine. The final product will thus be a Brailon® plastic braille paper copy of the foil master.

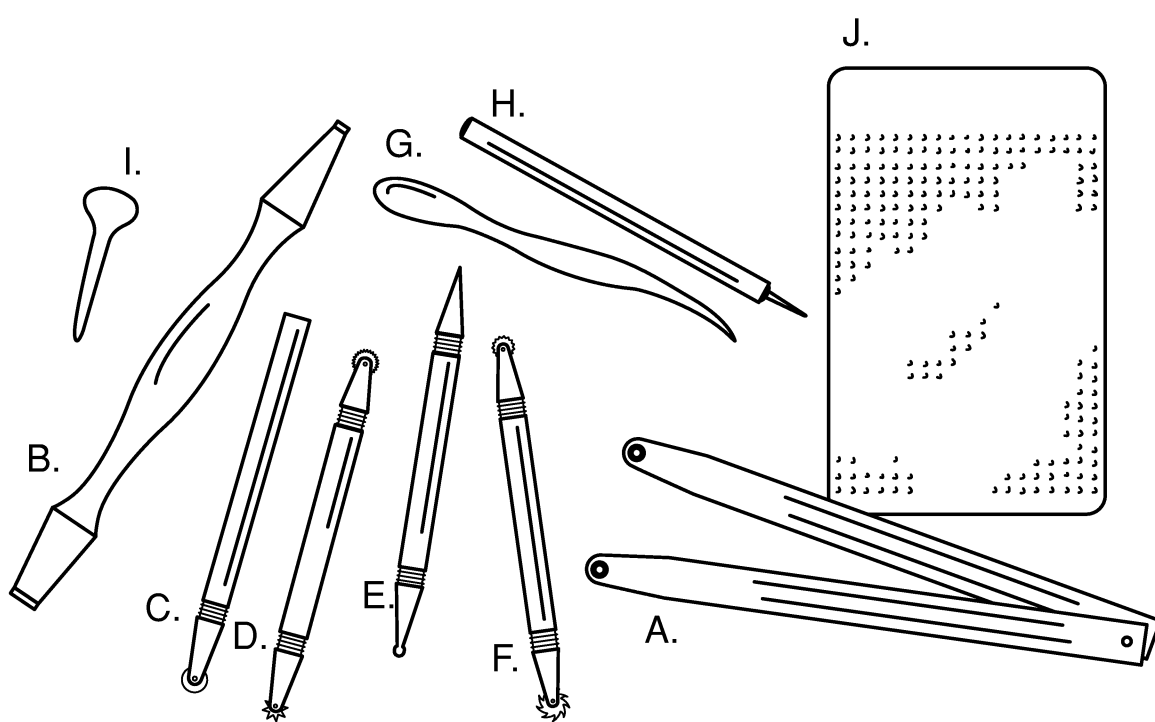


Figure 2: Kit Components

- A. Tongs (point symbols)
- B. Hammer
- C. Roller Tool
- D. Line Tool (Lines 1 & 2)
- E. Line Tool (Lines 3, 4, & 5)
- F. Line Tool (Lines 6 & 7)
- G. Line Sharpening Tool
- H. Vent Tool
- I. Wooden Eraser
- J. Plate (areal pattern)

Kit Items not shown:

- 1. Slate & Stylus
- 2. Ruler
- 3. Rubber Pad
- 4. Aluminum Foil Squares
- 5. Tool Pouch

Before proceeding, examine Figure 2 on page 19 closely and familiarize yourself with the tools contained in the Tactile Graphics Kit. This figure will help you identify the kit's components as they are discussed in the following sections.

Transferring the Image to the Foil

The first step in constructing your master display is to transfer the desired image (map, graph, etc.) to the back or white surface of the foil. This task can be accomplished in one of two ways. The first involves drawing the image freehand directly on the white backing of the foil. When this is done, it must be remembered that whatever is drawn on the back of the foil will appear *in reverse*, or as a mirror image on the

front of the foil. Consequently, direct freehand drawing is best undertaken when the image is simple (and thus easily reversed when drawing), when the image is symmetrical (for example, a circle), or when the orientation of the image is not important (for example, the outline of an insect). The second method of image preparation involves a two-step process:

Step 1: Construct the image you wish to reproduce by

- A. Drawing it freehand on a sheet of paper,
- B. Placing a sheet of tracing paper over the image and tracing it with a pencil, or
- C. Photocopying it.

Step 2: Transfer the image to the foil backing. If the size of the display you have constructed is the size you want (remember

that it has to fit on the back of the 11 x 11 inch (28 x 28 cm) foil square), then you are ready to transfer it to the foil by the following methods:

A. Place a sheet of carbon/graphite paper on a hard surface with the inked side face up. Then lay a sheet of foil on top of the carbon/graphite paper so that the shiny side is face up. Now put the image you wish to emboss on top of the foil and tape it down at the corners to prevent slippage. Trace the image with a pencil, applying medium pressure. The reversed image will appear on the back of the foil, ready for embossing by the line tools. The nonreversed image will be evident on the front of the foil, making it easy to emboss the point symbols and areal patterns.

B. Trace or draw an image on paper with a soft lead pencil. [Note: Remember to simplify an existing drawing by tracing only the essential features needed for the tactile graphic.] Tape the penciled side of the paper against the painted side of the foil and place on a hard tabletop. Using the clay modeling tool, rub the entire surface of the paper to transfer the penciled image to the painted side of the foil. Before detaching the paper from the foil, check to see if the image is completely transferred by carefully lifting small portions of the paper. Once the image is completely transferred, detach the paper from the foil; a full “mirrored” image will appear.

If the size of the display you wish to reproduce must be either enlarged or reduced, you have two possibilities:

1. Draw the image freehand in a larger or smaller form directly on the foil backing, or
2. Use a photocopier to resize your drawing

Braille Labeling

It is suggested that you label your display by embossing braille cells *directly* into the foil with the slate and stylus provided in the kit. This can be done before or after the embossed image is completed. If done afterwards, care must be taken to prevent smashing embossed areas sandwiched between the arms of the slate. This is especially true for labels placed *within* a display (for example, the name of a city in a geographical map). By holding the slate in place *without pressing down* on it, braille cells can be embossed with no damage to the raised graphic.

You may find it easier, however, to emboss the labels *first*, before any embossing of point, linear, or areal symbols is undertaken, eliminating this potential problem. This procedure should not present undue difficulties since the complete design of the display should already be plotted and drawn on the back of the foil. Labeling decisions should in fact be made when designing the display. Another alternative is to emboss the braille on *strips* of foil or braille paper and then *glue* these strips onto the shiny surface of the foil in the desired locations. Rubber cement or a glue stick work well for this purpose. This procedure is useful for the labeling of a display *after* all of the other embossing work is completed.

To emboss braille cells, simply slide the foil, white side up, between the arms of the slate and use the stylus to punch

dots in the foil. Remember that cells must be brailled in reverse, as is always the case when using a slate and stylus.

Embossing Point Symbols in the Foil Master

There are seven point symbols contained in the Tactile Graphics Kit. Each one can be distinguished from every other one, so if necessary, you can use all seven in the same display to represent seven different things. To emboss a point symbol in the foil, place the foil on a hard surface with the shiny side up. Then position the tong so that the foil is sandwiched between its two prongs, as illustrated in Figure 3. The raised image of the point symbol on the head of the tong should be facing up. Now grasp the wooden hammer as shown in

Figure 3 and strike the head of the tong with the large end of the hammer. One or two strikes of sufficient force will do. If you would prefer to emboss the point symbols in the foil with the white side up (so that you can see more clearly

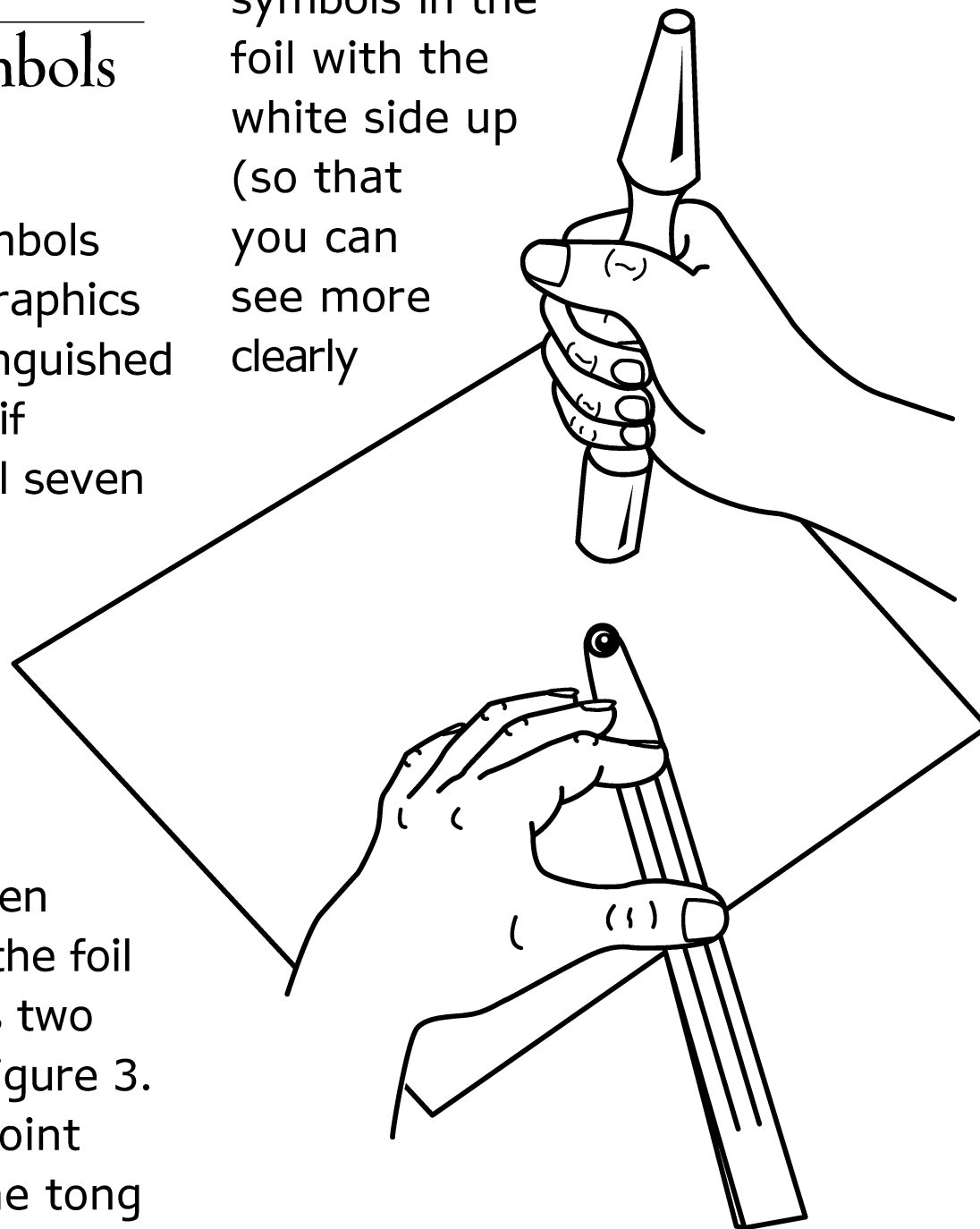


Figure 3: Proper use of tong and hammer for embossing point symbols.

where the point symbols were sketched in), simply turn the tong upside down and strike the bottom end of the tong's head. This will also result in a raised image on the front of the foil. For examples of the seven point symbols, refer to Figure 4 on page 25.

There is one special purpose point symbol in the set, and it is produced by tong "G." This symbol is meant to represent a staircase, an important feature in most mobility maps. It consists of two "steps," one elevated above the other. By properly positioning this symbol on a map, you can indicate the orientation of a stairway.

Embossing Lines in the Foil Master

The major part of embossing involves the tooling of lines in

the foil. With the tools provided in the kit, you have the capability of producing seven different types of lines (as shown in Figure 4 on page 27), all of which have been tested to ensure that they can be distinguished from one another tactually. Five of these are general purpose lines and two are special purpose lines. Both will be discussed.

General Purpose Lines. Notice that *Line 1 (single-dotted line)* and *Line 2 (double-dotted line)* are produced by the two ends of the same tool. A different wheel is attached to each end. To emboss these lines in the foil, place the black rubber pad on a *flat, hard surface* and lay the foil on top of it, *shiny side down*. The rubber pad must always be used when embossing lines in the foil. Cradle the line tool in your hand in much the same way as you would a pen when writing (see Figure 5 on page 27). Now roll

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the wheel over one of the lines you want to emboss. For Line 1 and Line 2 apply enough pressure to *perforate* the foil with the teeth of the wheels. This will produce more distinct lines when thermoformed. You may find it easier to control the movement of this wheeled tool by *pulling* it rather than pushing it across the surface of the foil. If you want to emboss a straight line, you can do it freehand or you can use a ruler. In the latter case, simply place the wheel against the edge of the ruler and roll the wheel over the foil.

Line 3 (thin solid line) and *Line 4 (wide solid line)* are produced by the two ends of the same tool (see Figure 4). To use the line-drawing tool, position it in your hand in the same way as you did the wheeled tool. It is important to slant it at approximately a *45° angle*. Again, you will find it easier to obtain a good result if you pull the tool *towards your body* when embossing the foil. If, for example, you are embossing a

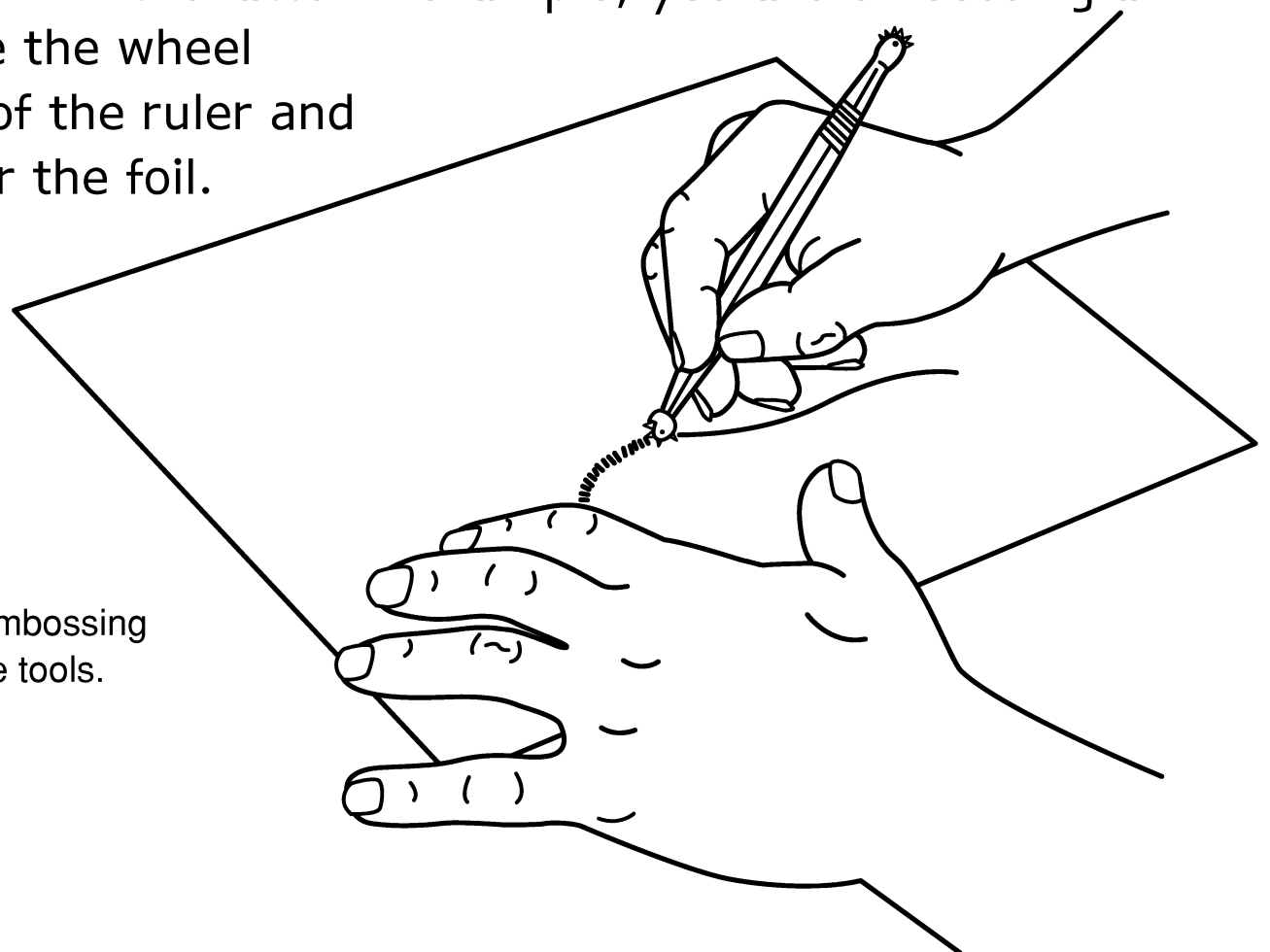


Figure 5:
Proper hand position for embossing
linear symbols with the line tools.

large “T” in the foil, rotate the foil so that you can emboss the top bar of the “T” by pulling the tool towards you. This is easier than trying to pull the tool horizontally across your body, which is what would have to be done if the foil were not rotated. When using either end of this tool, apply as much downward pressure as you can *without perforating* the foil and move the tip across the surface in a smooth, continuous motion. Apply pressure consistently. Then, for best results, place the foil on a *smooth, hard surface* and *retrace* the line with the embossing tool. This will eliminate irregularities in the line caused by uneven pressures applied during embossing. Practice is the only way you will be able to determine the amount of pressure that is needed to get maximum depth without tearing the foil.

Line 5 (see Figure 4) is made with the *same end* of the tool which makes *Line 3*. *Line 5* is a *thin dashed* line. To emboss it in the foil, simply make *1/4 inch (6 mm) long dashes* separated by *1/8 inch (3 mm) blank spaces*. Do not perforate the foil. *NOTE:* The single dotted line (*Line 1*) and the thin solid line (*Line 3*) are the easiest ones to emboss in graphic situations requiring tight turns in the line.

Special Purpose Lines. *Line 6* and *Line 7* are produced with the same line-drawing tool (see Figure 4) and are intended for special purposes only. *Line 6* is a *fine dotted* line of lower elevation than *Lines 1* through *5*. It is primarily intended to be used

- A. As a *guide line or lead line* for connecting specific features of a display with their braille labels, and

B. As the vertical and horizontal *grid lines* in graphs.

To produce this line, roll the wheel over the surface of the foil, applying fairly *light* pressure. Do not perforate the foil.

Line 7 (directional line) has the unique quality of being able to convey direction of movement. When scanned with the fingertips in one direction it feels smooth, while in the opposite direction it feels rough. Because of this characteristic, it can be used in place of the traditional arrowhead symbol. It is superior to the arrowhead in that the direction of the line can be felt at every point along its length and thus is less likely to cause confusion. Direction of movement is indicated by the *smooth* feeling. To use this tool, pull the wheel across the foil while applying *heavy* pressure so that the teeth bite into the

metal. Notice that the line feels smooth when scanned in the same direction that you moved the wheel. If, for example, you want to indicate movement (smooth feeling) from the top of the display to the bottom, roll the wheel over the foil from the top to the bottom.

Fine Tuning the Embossed Lines.

After you have finished embossing the lines, *remove the rubber pad* from beneath the foil and place the foil *shiny side up* on a *smooth, hard surface*.

Grasp the *wooden line sharpening tool* so that the flat side faces upward (see Figure 6) and rub

Figure 6:
Line sharpening.

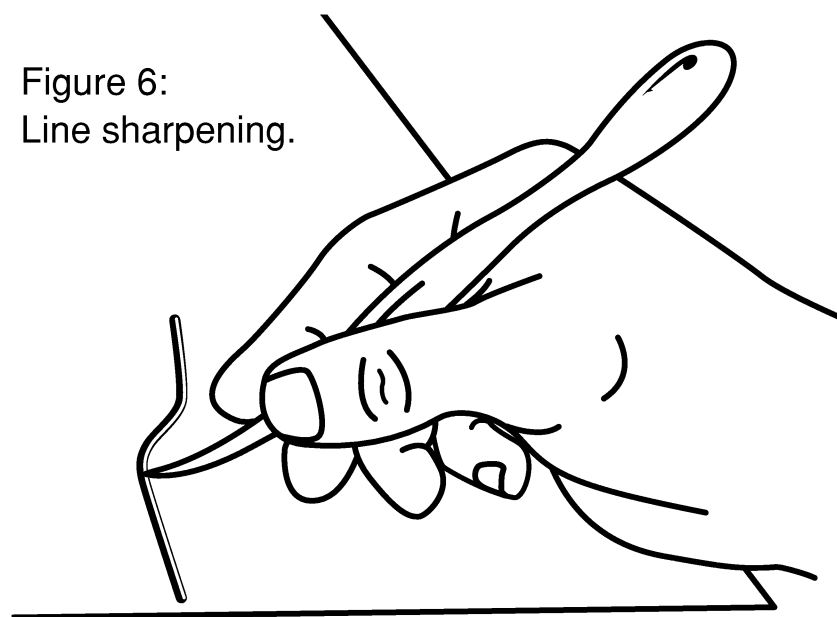




Figure 7: Cross section of embossed line (before and after line sharpening).

the point of the tool back and forth along both sides of all of the raised lines so that they are more distinct to the touch. Do not be afraid to work the metal with this tool. The foil is malleable and can be easily shaped. *Line sharpening* is an important task, *especially for the solid lines* and the *dashed line*. Making the sides of the solid lines nearly *vertical* (see the cross section in Figure 7) will greatly increase their structural strength. Vertical sides produce a more *rigid* thermoformed solid line than do slanted sides. A little extra work will greatly improve your tactile display. **NOTE:** Because of the greater amount of line sharpening required by the solid lines, it is advisable to

emboss the solid lines *before* proceeding to the dotted lines.

A Final Check. If you have embossed Lines 1 through 7 properly, they should look and feel very similar to the thermoformed examples shown in Figure 4. Compare your work with these examples and note any differences. The most frequent problems are caused by

- A. Insufficient sharpening of the lines,
- B. Applying too little pressure, or
- C. Applying too much pressure.

Practice embossing the lines properly before beginning your first tactile display. Only through trial and error will you learn to use the line tools effectively.

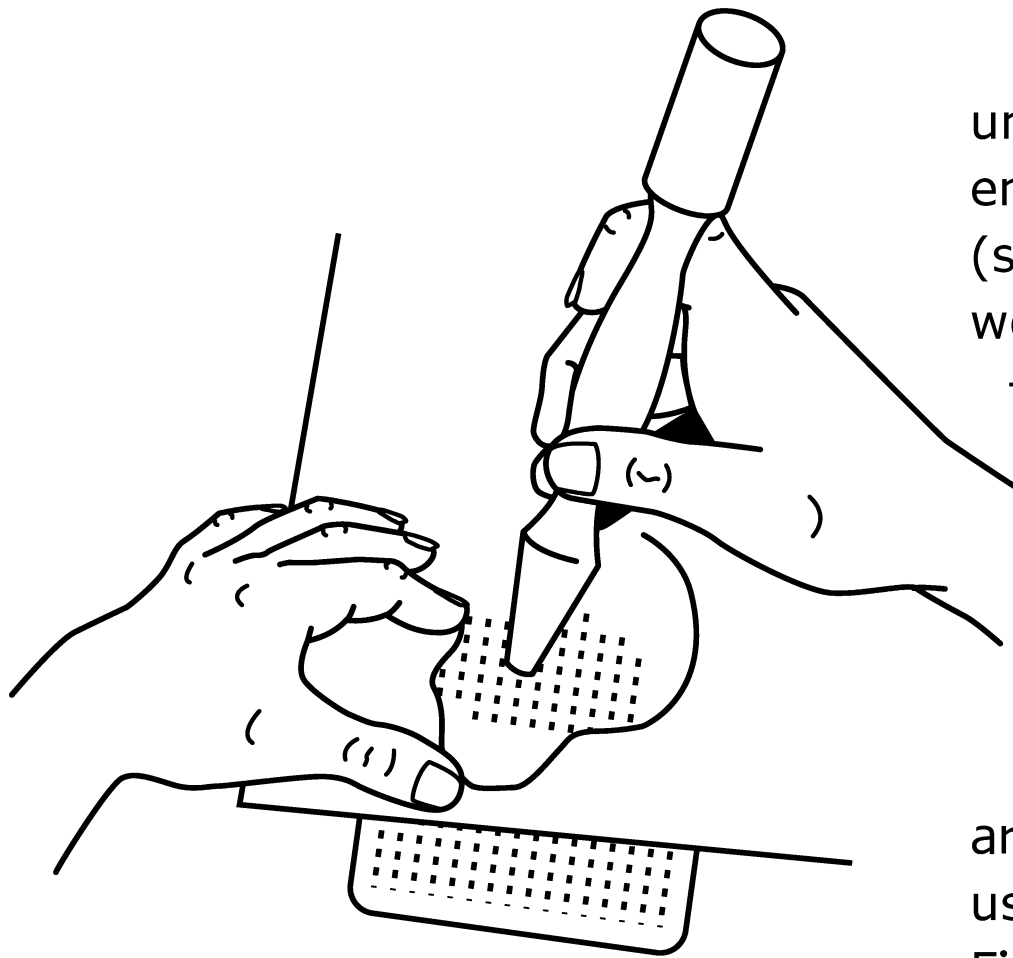


Figure 8: Proper use of plate and hammer for embossing areal patterns.

Embossing Areal Patterns in the Foil Master

Four plates for producing four distinct areal patterns in the foil are contained in the kit (see Figure 4 for the thermoformed versions of these patterns). Place one of the plates beneath the foil (shiny side up), directly

under the area you want to emboss with an areal pattern (see Figure 8). Grasp the wooden hammer and *strike* the foil repeatedly within the outlined area. Use the large end of the hammer for large areas and the small end for small areas.

Another way of raising an areal pattern in the foil is by using the roller tool shown in Figure 2. To do this, simply roll the wheel back and forth over the outlined area on the foil (see Figure 9 on page 32). This tool is especially useful for

- A. Embossing small areas, and
- B. Embossing the exact contours (outer edges) of outlined areas.

Generally, the two ends of the hammer should be used for the major part of the work and the roller for the finish work.

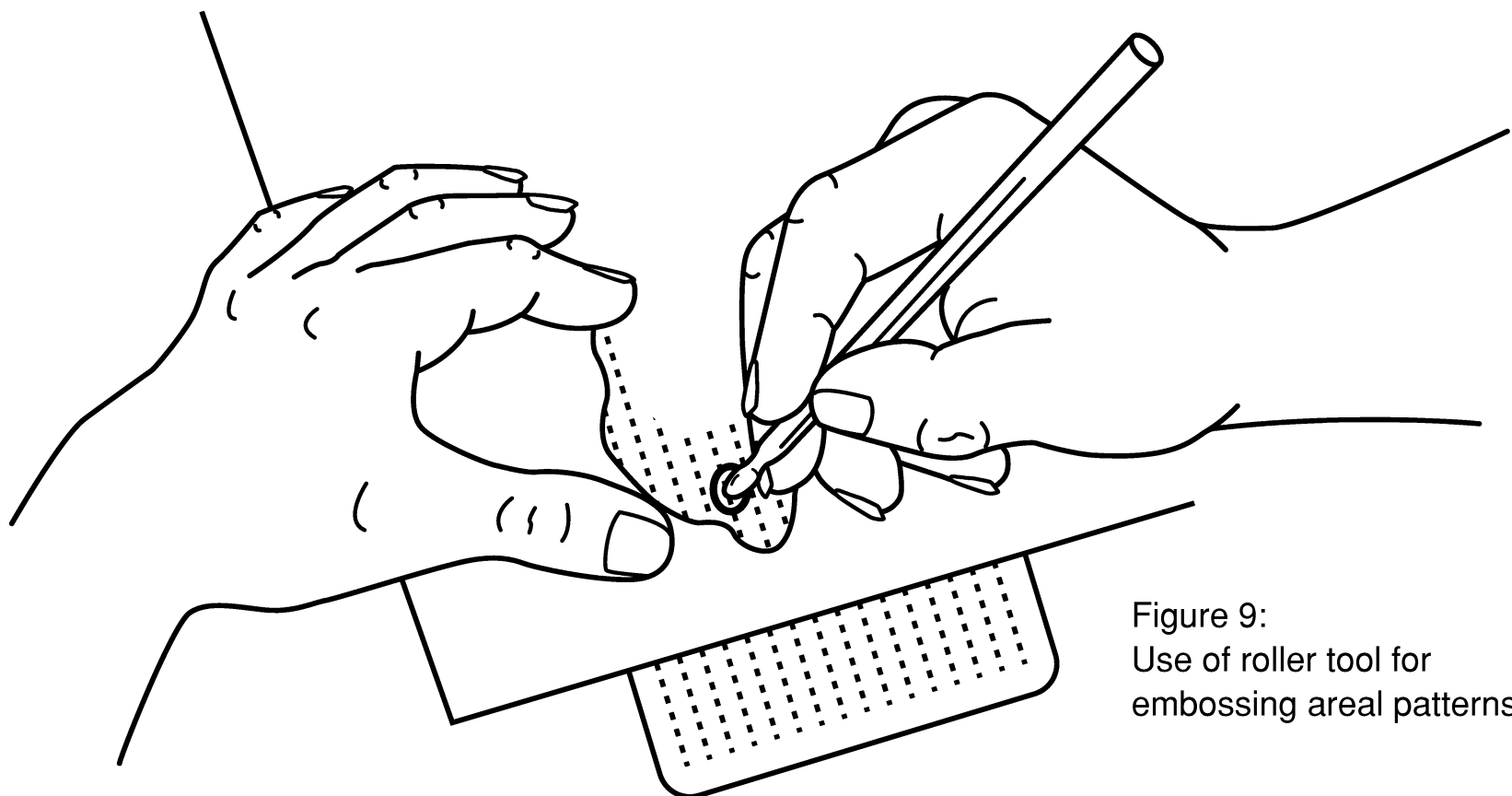


Figure 9:
Use of roller tool for
embossing areal patterns.

NOTE: Do not allow the plate to move around beneath the foil while embossing, as this will distort the desired areal pattern. Placing the plate on the rubber pad will help prevent such slippage.

Completing the Display

Erasing. One of the advantages of embossing displays in foil is

that errors can be erased. If a large area, such as an areal pattern, needs to be changed, use the large end of the *wooden eraser* provided in the kit. Simply lay the foil shiny side up on a *smooth, hard* surface and scrub the area vigorously with the eraser until it is flat and smooth. New patterns can then be embossed in that same area. If you need to do more precise erasing, such as correcting a

small part of a linear or areal pattern, use the wooden line sharpening tool. Use either or both of these tools to erase any extraneous marks in the foil that are not part of the graphic. If there are any bulges in the foil (sometimes resulting from the embossing work), gently press them flat with your fingertips, or use the wooden eraser.

Readying the Foil for

Thermoforming. The thermoform machine works by means of a heat/vacuum process. To get good copies, the pump must be able to suck the Brailon sheet down onto the foil master. Since aluminum foil is nonporous, it must be punctured with tiny holes to allow a good flow of air through it. To do this, place the foil master *shiny side up* on a thick piece of cloth. Take the *vent tool* (pin with long wood handle) provided in the kit and prick holes about two inches

apart around the outside margin of the foil sheet, about 1/2 inch from the edge. Prick holes at about one-inch intervals along *both* sides of the solid lines and the dashed line. Prick a hole or two next to (or within) each point symbol and braille label. Prick holes in the areal patterns at the rate of about one per square inch. Prick additional holes in tight spots, such as the corners formed by two intersecting lines.

Thermoforming the Foil Master.

Place the foil, shiny side up, on the metal grid of the thermoform machine. Lay a sheet of Brailon on top of the foil and fix the clamp tightly in place. Set the heat dial on "high" and the timer on "3" or "4." Slightly higher than normal settings are usually required for graphic displays. Give the machine 5 to 10 minutes to warm up. Now slide the lid

forward. At the sound of the buzzer, push the lid back slowly and then press the button that turns off the vacuum pump. If the Brailon copy of the master is blurred, you may need to either prick more vent holes in the foil or readjust the setting of the time control. If all goes well, a distinct image of the master display should be formed in the plastic sheet. Make as many copies as are needed and then store the foil master in a vertical position for later use.

Summary

1. Transfer the graphic display to the white surface of the foil and indicate labels that are needed.
2. Emboss braille labels in the foil with the slate and stylus.
3. Emboss the point symbols in the foil with the set of tongs.
4. Place the foil on the rubber pad and emboss the lines in the foil with the line tools.
5. Place the foil shiny side up on a hard, smooth surface and sharpen the lines with the wooden line sharpening tool.
6. Emboss the areal patterns in the foil using the patterned plates.
7. Prick air holes in the foil with the vent tool.
8. Thermoform Brailon copies of the foil master.

Section II

Designing Legible Tactile Displays

Tactile Graphics Kit

Tactual, or more generally, haptic perception is a useful system for acquiring information about the environment, especially when the more dominant visual system is malfunctioning or completely shut down. It should not be assumed, however, that tactual perception operates in a manner similar, although inferior, to visual perception. Not only is the tactual system limited to picking up less detailed information, but it also processes the information it gathers in a different way than does the visual system. Vision allows a simultaneous differentiation of the features composing an image and an immediate grasping of their spatial relationships. Touch only permits the acquisition of information in a piecemeal fashion with each feature being fed into the system in sequential order. Integration of the

composite image is achieved only gradually and with some effort. The implication of this process for graphic design is that the successful tactile graphic will hardly ever be one that is a mere transliteration of the visual image. Graphic displays for the blind must be designed specifically for reading by the fingertips. A graphic that is easily interpreted visually will not necessarily be tactually meaningful.

The fundamental differences between the visual and tactual systems of perception are nowhere more evident than in the illustration of three dimensionality. The perceptual cues used to convey depth in a two-dimensional drawing are visual in nature and have no equivalents in the tactual realm. Cues such as interposition (the occlusion of parts of one object

by another), relative size (objects appearing smaller as distance increases), and linear perspective (the gradual converging of lines at the horizon, such as the rails of a railroad track) are visual properties of three dimensionality that are learned from constant exposure to and experience with a structured environment viewed at a distance. These same properties can be successfully transferred to a pictorial representation, in a sense “tricking” the eye to perceive the scene in three dimensions. This gestalt or total experience, however, cannot be represented for the fingertips which, by their very nature, cannot process the kind of information inherent in distal stimulation. Even though it is possible that some especially gifted blind individuals may be able to make sense out of three-dimensional illustrations through

a laborious process of analysis and integration, it is extremely doubtful that even these individuals will perceive depth in any way that corresponds to the visual experience. Generally, a tactile illustration of a three dimensional object or scene will feel like an incomprehensible jumble of lines and textures to the blind student and should be avoided.

This section of the Guidebook attempts to describe some of the factors that will help you to design more meaningful tactile images for the blind reader. There are few hard and fast rules to go by, however, given the current level of knowledge in the field. Consequently, the following information represents general guidelines rather than established principles.

A Common Myth

The greatest fallacy to commit when designing a tactile display is to assume that blind persons have an extraordinary sense of touch. The blind do not possess an uncanny ability to “see” with their fingertips. On the contrary, research studies and field observations have indicated that most blind students at all grade levels have rather poorly developed tactual skills. While this is not meant to imply that the situation is hopeless (several studies have shown that vast improvements can be made with even limited training), it does emphasize the fact that careful planning must be made when converting a visual image to a tactile one. It simply cannot be assumed that a graphic will be made meaningful to the blind by merely raising it above the surface point for point. Blind or not, a person cannot be

expected to gain the same degree or scope of information with touch as is possible with vision. Tactile materials are an alternative to, but not a complete substitute for, visual materials. When designing a display for the blind, *think tactile!* Examine the display yourself. If it’s confusing to your fingertips, the chances are good that it will be confusing to the probing fingertips of the blind.

Simplicity

In constructing a tactile display, the single most important principle is simplicity. Consider the purpose behind each display you are constructing and present only the information that is necessary to convey it. For example, exercises in counting frequently portray pictures of animals or objects as the units to be counted. Such

figures are difficult to perceive tactually. The same information can be represented in the graphic by using simple geometric shapes, which are more easily recognized tactually.

Eliminate nonessential or confusing details. If, however, the detail is important to the purpose of the graphic and cannot be eliminated, present it as clearly as possible. You can often accomplish this by either enlarging specific areas or by breaking the graphic up into several parts. In the latter case, each section is presented in detail on a separate display in enlarged form. It is then recombined with the other sections in a skeletal diagram which gives the overview while omitting the finer detail that is represented in the enlarged sections. In this way, a complex graphic involving a good amount of detail can be made intelligible to the blind user without over-

whelming him. Whenever possible, however, present all of the information in a single display, as the mental recombining of several displays into a single one is a difficult task in itself. This is especially true for younger students. Always consider the population for whom the graphic is being constructed and remember that students in the upper grade levels generally are able to handle more detail than students in the lower grade levels.

Make every effort to construct a simple graphic free of irrelevant or confusing details. It is better to present too little rather than too much information in a single display, as additional information can often be gained verbally. In fact, tactile graphics should be regarded as supplementary materials, to be used in conjunction with verbal text or

verbal commentary. The combination of these two forms of communication often proves more beneficial to the blind student than either used alone.

Clutter

A cluttered diagram results when too many tactile symbols are used in a display, when too many are packed into a limited area, or when similar or noncontrasting symbols are placed adjacent to one another. All of these cases will result in a diminution of *contrast*, a design feature which provides easiest discrimination and recognition for the tactual reader. The greater the contrast between the elements making up a display, the less clutter and confusion will be generated, and the more readily understandable it will be.

The ease of discriminating and identifying a particular feature on a display will depend upon the context in which it is found, that is, upon the physical characteristics of other features with which it is surrounded. With this in mind, sets of point, linear, and areal symbols were chosen for inclusion in the kit based on their mutual discriminability. Within each set, only those symbols which could be successfully distinguished from one another by at least 95% of a sample of 60 braille reading students were deemed useful for the kit. In other words, *within* each set the symbols *feel* different. To aid in the tactual discrimination or contrast *between* the three sets of symbols, a height factor has also been added. Tactual perception is highly sensitive to differences in elevation. Consequently, the areal patterns, when embossed in the foil, are lowest in elevation, the

point symbols are the highest, and the lines are generally in between. A good deal of contrast among the kit's sets of symbols is thus already incorporated in the design of the symbols themselves. This does not, however, totally eliminate the problem of clutter. For instance, even symbols which have been found to be tactually discriminable from one another may be confused if placed too closely together on a display. This is especially true of the linear symbols. Not only is it difficult to distinguish two lines that are closely spaced, but it is also difficult to trace them with the fingers. Always examine the lines yourself. If it is difficult for you to stay on a line and follow it with your fingertips, then you can be assured that the graphic will be confusing to the blind user.

Problems of clutter can also arise when symbols from the

different sets are placed too close to one another. A point symbol which is too close to a line may be harder to identify and in fact may also make it more difficult to follow the line. A point symbol embedded in an areal pattern will be harder to locate. As a rule of thumb, always maintain a spacing of approximately 1/8 inch (3 mm) between adjoining tactile symbols to reduce clutter. Trying to pack more symbols into the same area will usually not result in an increase in information but rather, from a functional point of view, a decrease. In fact, when it is feasible, separate the symbols by more than the minimum distance of 1/8 inch (3 mm). You often can accomplish this by enlarging the graphic and using the *entire* display area. That is, the 10 1/2 x 10 1/2 inch (27 cm) center area of the foil. However, a margin of 1/2 inch (13 mm) must be left on all sides to allow for proper thermoforming.

As a final caution concerning clutter, it should be noted that labels placed in a display should also be spaced no closer than 1/8 inch (3 mm) next to any symbol; and remember that the more labels you include in a display, the more cluttered it will become. Unless the graphic is simple, it is better to use a key. Also avoid the use of lead lines connecting labels with the elements to which they refer. These often will be confused with the lines making up the diagram. If lead lines are used, use a less prominent line such as Line 6. More will be said of labeling later in this section.

Lines

Although all seven of the lines produced by the tools contained in the kit can be used in a single diagram, this should be avoided when possible to reduce the

diagram's complexity. When only using a few lines in a display, choose ones which feel maximally different. For example, if only two lines are needed, use a solid (Line 3 or 4) and a discontinuous line (Line 1 or 2). Also try to use these two general types when lines must be placed close to one another, or when they intersect. A solid line located near (or intersecting with) another solid line will not provide as much contrast as would a solid line placed next to a dotted line.

When planning your display, determine which features of the display are most important and represent them with the most attention getting lines.

Generally, it is agreed that dotted lines stand out the most, so use Line 1 or 2 as the primary or major line. Taking both attentional prominence and contrast into consideration, a

reasonable order for choosing the lines to use in your display is:

1. Line 1
2. Line 3
3. Line 2 or Line 4
4. Line 4 or Line 2
5. Line 5
6. Line 6
7. Line 7

Line 6 is a less prominent line and generally should be used only for lines of secondary importance, such as lead lines in labeling or the background grid in a graph. Line 7 is a special purpose line, and although it can be used in any graphic situation requiring a seventh line, it is primarily intended to be used in place of the conventional visual arrow. When the wheel on the tool used to make this line is rolled over the foil, it leaves a sawtooth impression. When stroked by the fingertip in one

direction, the tactual impression is smoother than that felt in the opposite direction. This cue has been found to be useful in indicating direction of motion. In fact, as the complexity of a diagram increases, it has been found that the directional line led to shorter response times and fewer errors than the visual arrow. Use of this line permits light rays, vectors, and paths of moving bodies to be represented in a way that is tactually meaningful. The direction of the line can be felt at every point along its length. Because many students are not aware of the existence of this symbol, it is desirable to include a short explanation of the line in a key, such as "This line is used in place of an arrow. Follow it in the direction that it feels smoothest." If a visual arrow is used, always construct it in the following way:

- A. Place the wings of the arrow at 45° angles with respect to the line that bisects them;
- B. Make the wings 1/4 inch (6 mm) in length, and
- C. Make the bisecting line at least 1/2 inch (13 mm) in length. Only one type of line, either solid or dotted, should be used for the entire arrow.

A few additional pointers on lines:

- When lines intersect, break one of the lines just enough to allow the other line to pass through.
- When a line appears in an areal pattern, maintain a 1/8 inch (3 mm) spacing between the line and the pattern.
- Never make a line of less than 1/2 inch (13 mm) in length. Line 7 should be no shorter than one inch (25 mm).

- Maintain a spacing of 1/8 inch (3 mm) between lines placed adjacent to one another.
- A broad raised line (such as Line 4) has been found to facilitate the task of locating and tracing shapes. This is especially true when several different shapes are interconnected, such as the states in a political map of the United States.

Point Symbols

Point symbols are used to represent specific objects or locations on a display, such as a desk in a map of a classroom or a city on a political map. Except for symbol “G,” all of the point symbols in the kit are abstract in design, so that any symbol can be used to represent whatever you choose. The meaning of the symbol must, therefore, always

be explained in a key or, in a simple diagram, labeled. All seven symbols can be used in the same display if necessary. Once again, maintain a 1/8 inch (3 mm) spacing when placing a point symbol next to a line or when embedding it in an areal pattern.

Symbol “G” is a special symbol that is particularly useful in mobility maps. It represents a stairway. Blind students can feel the two levels of the steps composing the symbol and, consequently, the orientation of a stairway can easily be recognized. Because only symbol “G” has been tested in various orientations in the discriminability study, all other point symbols should be oriented as they appear in the Brailon sample in Section I.

Areal Patterns

The textures included in the kit can be used to represent regions of extent, such as a body of water in a geographical map or the cell body in a biological diagram. Textures should be used sparingly, however, as their presence tends to clutter a map and increases the difficulty of locating point symbols and following lines. A braille label can often be used in place of an areal pattern to eliminate these problems.

As a general rule, do not texture an area smaller than 1/2 inch (13 mm) square, as this seems to be the minimum size conducive to dependable recognition. Because of its finer texture, Pattern I should be used for smaller areas. If only two patterns are needed, use a dotted one (Pattern I or II) and a

solid one (Pattern IV) for maximum contrast. If a line is embedded in an areal pattern, use a pattern that is different from the texture of the line (for example, a solid pattern with a dotted line or a dotted pattern with a solid line). When several patterns are placed next to one another, a line limiting the borders of the different textured areas will help in defining those areas for the searching fingertip. *NOTE:* Patterns III and IV should only be oriented as they appear in the Brailon sample in Section I.

Labeling

If a display does not involve many point, linear, or areal symbols, labels can be placed in the display itself, next to the elements to which they refer. When possible, do this without the use of lead lines to connect the labels with their referents,

as lead lines may be confused with the lines composing the graphic itself. When lead lines are used, Line 6 should be employed and be no shorter than 1/2 inch (13 mm) in length. It should begin no closer than 1/8 inch (3 mm) from the element to which it refers and end at the first or last cell of the braille word or words used as a label. If a lead line crosses a line used in the graphic, break the *lead line* to allow the more important display line to pass through.

To reiterate, do not crowd a diagram with lots of braille, but at the same time, remember that *complete* labeling is important because the student needs to know exactly what is being inspected. When these two principles clash, the solution is a *key*, a kind of coding system which assigns meanings to labels or symbols used in the display. A key is set up as a list, with labels

or symbols presented in the left-hand column and their meanings (descriptive or explanatory material) presented in the right-hand column. Whenever possible, a sample of the tactile symbol itself (a particular point, line, or areal pattern) should be presented in the key, as this will eliminate the need for including a label in the display, thereby reducing clutter. Do not place the symbols in boxes. The lines of the box may be interpreted as part of the symbol itself. Place the word *key:* at the top of the key. Finally, to reduce confusion, group the symbols in the key by symbol type (for example, points at the top, lines in the middle, and areal patterns at the bottom).

If labels are used in the display itself,

A. Use individual letters, placed in alphabetical sequence, from left to right and down

the page, so that the labeling can be easily followed through the diagram, or

B. Use the first letter or first two letters of the item referred to. The braille letters are then presented in the left-hand column of the key and explained in the right-hand column.

If room allows, place the key at the *bottom* of the page, below the graphic. If not, use an additional page, and if bound in a booklet, put this key on the facing page so that it can be referred to quickly and conveniently. Finally, place an appropriate title at the *top* of the page, directly above the tactile display. Keep it brief. Use as few words as possible to describe the nature of the information represented by the graphic. This will give the student a conceptual framework for interpreting the tactile display.

Additional Notes

Braille Labeling:

- Orient braille cells, words, or sentences horizontally so that they can be scanned from left to right. Vertical or diagonal orientations may confuse the reader.
- Avoid embedding braille labels in textured areas, especially dotted textures. This makes them harder to locate and more difficult to read.

Maps (Mobility or Geographical):

Instead of using an arrow to indicate the north edge of a map, emboss a line or areal pattern (one which is not being used in the map itself) across the entire northern margin of the display, and explain its purpose in the

key. This convention has been found to facilitate map orientation.

Graphs:

- Omit grid lines from line graphs whenever possible, since their presence makes it more difficult to follow the data curves. If the purpose of the diagram is merely to show the shape of a curve or curves, grid lines are not needed. However, if extraction of quantitative information concerning points on the curve(s) [or bar(s) in the case of bar graphs] is important, grid lines must be included and should be represented by Line 6. If a *specific* place on a data curve is indicated, use a point symbol to identify that spot exactly.
- Use Line 4 for the graph axes. At the point where the two axes intersect

(the origin), place a large dot (Point Symbol E).

- Space unit markers along the outside of each axis at equal intervals (a different interval can be used for each axis), with a *minimum* spacing of 1/2 inch (13 mm). Make these markers 1/4 inch (6 mm) in length, using the same line that was employed to form the axes (Line 4). If a grid is not used in the graph, extend the markers 1/4 inch (6 mm) on *both* sides of the axes.
- Do not include more than two or three data curves in the same graph, especially if they intersect.
- Leave a space between adjacent bars in bar graphs, especially if the bars are not textured. Areal Patterns I and II can be used on alternate bars to increase the clarity of adjacent bars.

Helpful Tools:

Acquire a few additional tools if you want to improve the precision of your drawings. Plastic *templates* and French curves are available for the construction of a wide variety of geometric configurations. *Protractors* are excellent for the exact plotting of angles, and *compasses* are very useful for drawing circles of any size. All of these items can be obtained at any place where drafting equipment is stocked.

Economics:

If the size of a particular graphic display is considerably smaller than the 11 x 11 inch (28 x 28 cm) foil square, cut the foil into pieces, using only the amount that is needed. The piece of foil containing your graphic can then be glued onto a sheet of braille

paper with rubber cement or glue stick. Do not coat the entire piece of foil with glue. Dab it on in several spots. This will allow the foil to expand and contract without buckling when subjected to the heat used in thermoforming.

Low Vision Readers:

Tactually enhanced graphic materials can be very useful to low vision readers who experience difficulty in discriminating visual graphics. By inking the various point, line, and areal patterns in the Brailon with different colors of ink (using commercially available felt-tip pens), you can greatly enhance a graphic for the low vision reader. Presentation of the same information in *both*

tactile and visual form will increase the readability of a graphic display.

Final Comment

It should be apparent by this time that a good tactile display requires forethought and preparation. Unless the graphic is very simple, it is always a good practice to design the display on paper before transferring it to the foil backing. There is simply no substitute for good planning and design. And remember to design your displays for tactual rather than visual clarity. By carefully inspecting the tactile images with your own fingertips, you will come to recognize the potentialities and limitations of the sense of touch. So, when designing and proofing an embossed display, *think tactile*.

Section III

Introducing Blind Students
to Reading Tactile Maps

Tactile Graphics Kit

The purpose of this section is to provide the teacher with a framework for introducing students with little or no useful vision to the reading of tactile maps. The primary problems, concepts, and skills necessary for tactile map reading will be discussed. The teacher will be presented with the basic information necessary to initiate a program of instruction for blind students who have no previous experience in reading tactile maps.

Orientation to Environment

Any map is an abstract representation of a real environment. Before blind students can use maps that represent environments with which they have had no direct experience, they must learn that *maps can represent their own personal environments*. When blind children enter

school, they often have an inadequate knowledge of their environments, the objects in them, and the spatial concepts necessary for understanding the physical relationships between objects and people. Introducing blind students to tactile maps before they have sufficient comprehension of their environments often results in confusion and lack of motivation to use the maps. Consequently, the teacher's first task is to *orient students to their environments*. This should include a detailed physical examination of the school, particularly the classroom.

There are three important aspects to orienting students to their environments. First, the students need to be able to identify objects in the environment by name (example: desk, radiators, windows, closets, door) and to examine them in a

systematic way with their hands. Second, the students need to learn a set of basic concepts and terms that will enable them to describe their environments. One set of concepts relates to the description of the physical relationships among objects, using terms such as far, near, next to, on top of, under, beside, left, right, and between. One commonly used product for informal assessment of a student's understanding of basic concepts is *Tactile Treasures: Math and Language Concepts for Young Children with Visual Impairments*, published by the American Printing House for the Blind.

A third aspect of orientation pertains to the students' ability to get about in the immediate environment. It is essential to train blind students to navigate from one location to another. For example, blind students

should be able to travel independently from any point in the classroom to any other point in the classroom. Blind students should also be able to travel from the classroom to significant locations in other parts of the school building, such as the bathroom, exits in the building, and water fountains.

Basic Tactual Skills

Research and observation of blind children examining tangible objects and tactile displays indicate that they exhibit serious deficiencies in their tactual perceptual skills. There are several specific actions that can remedy this situation. When a tactile display is first presented to blind students, the students should *define the size and extent of the display* by tracing the perimeter of the display with both hands. They should then be

taught to *examine the display in a systematic way* in order to ensure complete coverage of the display and to determine the nature of its symbology. (Refer to Figure 10 while reading the following description.) One recommended procedure is to have students search the display from top to bottom using two hands. Both hands are placed side by side in the upper left-hand corner and moved down the display toward the body. When the hands reach the bottom of the display, they are returned to the top left of the display. Both hands are then moved to the right, approximately the width of two hands, so they can search the next section of the display. The process of searching down the map and moving to the right is repeated until the entire display has been examined.

Most tactile displays use raised lines to represent various physical and political features. Consequently, it is important that blind readers be able to *trace a line* with a great deal of skill. Despite the seeming simplicity of this task, many blind students have difficulty with this basic skill. One effective procedure for tracing a line is to use the index fingers of both hands. The lead index finger follows the line and determines the direction it is going. The other finger serves as a reference, trailing behind and maintaining contact with the line. Thus, if the student loses his place with the lead finger or becomes confused by other symbols near the line, he can return his lead finger to the reference and proceed from there.

In examining any tangible object or tactile display, it is important for the student to systematically *analyze* the materials by observing *distinctive features* and integrating them into a whole. For example, in learning the shapes of the United States, the student should note the features that distinguish one state from another. For example, one of the prominent features of the state of Oklahoma is the “panhandle.” Systematic tracing of the state might lead a student to describe the shape of the state as a “rectangle with a handle in its upper left-hand corner.” Inspection of many raised line maps will quickly suggest that

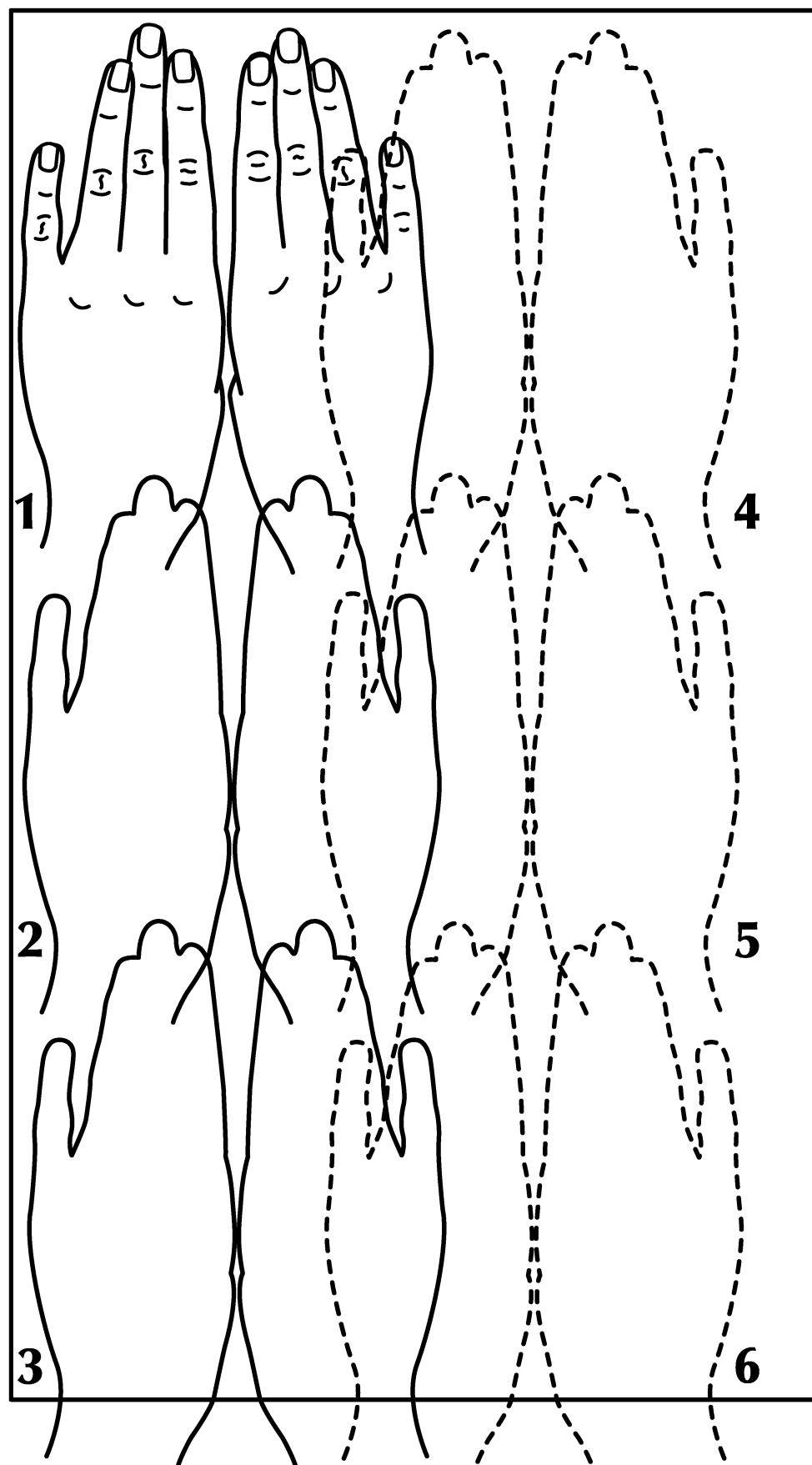


Figure 10: Systematic examination of a tactile display.

many states or countries can be characterized by their distinctive features. However, some may not lend themselves as easily to this type of analysis and other criteria can be used, such as overall size and proximity to other states or countries. Once a student has learned the distinctive features of a shape, he can locate and identify the shape merely by remembering and *searching for two or three distinctive features*. It should be emphasized that a student should examine, remember, and search for shapes on the basis of their distinctive features rather than attempting to look for the whole shape. In examining raised line shapes, students should choose one distinctive feature that will serve as a *reference point* so that as the index fingers trace around the shape, the students will know where they began and when they have made one complete tracing of the shape.

The concepts and skills described above could be introduced by using simple geometric forms in raised line form embossed on a braille page or on a thermoform sheet. The students could then practice *systematic searching, line tracing, distinctive features analysis, and locating reference points*.

Representation of Three-Dimensional Objects on a Two-Dimensional Surface

An important transitional point for the effective understanding and utilization of maps is for the student to realize that *real objects can be presented abstractly on a two-dimensional surface*. One way to approach this topic is to use real objects and represent them on a tactile display in raised form. For

example, solid wooden shapes (triangle, square, circle) can be presented simultaneously with raised line representations. The student's singular task would be to relate the solid object to its raised line representation. A second step would be to show the student that real objects can be represented by symbols on a display. For example, a circle could be represented by the letter C in braille or raised line capital letter, a triangle by a letter T, etc. It is also important to use common objects such as spoons, bottle caps, or coins, which can be represented in the same way on a tactile display, with a letter or braille symbol for each.

After the student has acquired the idea that *objects* can be represented abstractly on a tactile display, the next step is to show that the *spatial relationships between objects*

can be represented on a tactile display. To accomplish this, the teacher should place three small objects on a desk, in a column spaced about 2 inches (5 cm) apart. The spatial relationships between the objects can then be described by the teacher while the student examines them with his hands. For example, if a spoon, a bottle cap, and a coin were placed next to one another in a vertical column on a table, the spoon could be described as being above the bottle cap and the coin below the bottle cap. The objects should be rearranged several times so that the student will use a variety of terms to describe different relationships such as left, right, far, near, between, and next to.

Once the student is able to describe the spatial relationships between physical objects, the next step is to exhibit these relationships and their tactile

representations at the same time. The teacher can present the student with a series of three objects, simultaneously showing the tactile display, which uses the first letters of the names of the objects as symbols. The teacher can then substitute point symbols for the first letter of the name so the student will begin to become familiar with the use of a different symbology. The student could then be asked to describe the relationship between the objects while pointing to the symbols on the display. The objects and their corresponding symbols can be arranged in a variety of ways to provide the student with practice in describing relationships.

The Student's First Map

At this point the student should be ready for his first map. This first map should represent an environment with which the

student is thoroughly familiar, such as the classroom. It would be wise at this point to give the student another guided "tactual" tour of the classroom. The map should represent desks and other furniture in the classroom with geometric shapes such as squares, rectangles, and circles or with the point symbols included in the list. It is important that this initial map be kept as uncluttered as possible. The student should first learn the shape and name that each symbol represents by participating with the teacher in a tactual tour of the map and describing what is found. It should be emphasized that the tactual skills mentioned previously should be taught here; namely, a systematic exploration of the map from top to bottom, the tracing of the lines of the shapes with the two index fingers, and a distinctive features analysis of the shapes and symbols.

After the student has systematically examined the map and is able to name and describe the spatial relationships between the symbols, three types of tasks can be introduced.

1. The student can be taken to a specific piece of furniture in the room and then asked to locate it on the map. For example, the student can be taken to the teacher's desk and then asked to point to it on the map.
2. The student can be shown a specific symbol on the map and then physically locate it in the room. For example, the teacher could point to the symbol on the map representing the clothes closet (without naming it), and ask the child to identify it and go to it.

Once the student is able to identify all symbols on the map and locate them in the

room, he should be asked to suggest a few additional symbols to be added to the map. For instance, the teacher could label each student's desk on the map with the first letter of each student's name in braille or in raised line capital letter. Again, the student should locate both the new symbols on the map and their corresponding objects in the room.

3. The student should be introduced to the concept of routes (i.e., how to travel from one point in the classroom to another). The student should physically perform the task first and then show the teacher with his fingers on the map how he navigated from one location to the next. Also, the student and/or the teacher can trace the student's finger from one symbol on the map to another and then ask the student to

physically navigate that route in the classroom. In performing these tasks the student should be asked to verbalize the relative position of symbols on the map and objects in the room. For example, when sitting at my desk the door to the classroom is *toward* the *front* of the room on the *right* side, *opposite* the teacher's desk. This will enable the student to learn to give directions as well as understand directions.

Expanding the Map

Once the student has demonstrated his understanding of the initial map, it can be expanded to include the hallways and floor plan of the building near the student's classroom. Again, significant features such as bathrooms, exits, water fountains, and main offices,

should be represented at the beginning. The same procedures should be followed: giving the student a tactual tour of the hallways, followed by a tactual tour of the tactile map, naming the significant features on the map, and completing the navigation tasks. More details can be added to the map at the student's suggestions.

Maps can be made of other areas of the school, such as the playground, cafeteria, and dormitory. However, a thorough familiarization and detailed examination of the physical environment should precede the introduction of any map. It is important that the teacher not assume that students are familiar with an environment just because they appear to be competent in performing certain tasks within it. For example, just because the blind student is able to enter the dining hall, find a

seat, and eat gracefully, does not mean that the student has a concept of the objects and physical characteristics of the *whole* room.

Only after students have had extensive practice with maps that represent their own environment can the teacher begin to introduce maps of environments with which they have never had contact.

Summary and Conclusions

Primary problems, concepts, and skills necessary for reading tactile maps have been discussed and include the following:

1. Orientation to personal environments
2. Identification of objects and their physical relationships
3. Geographical concepts

4. Defining the extent of the map
5. Systematic search
6. Line tracing
7. Analyzing distinctive features
8. Searching for distinctive features
9. Reference points
10. Tangible representation of three-dimensional objects on a two-dimensional surface
11. Tangible representation of spatial relationships
12. Use of symbology
13. Student's first map
14. Routes
15. Expanding the first map

The teacher may note that many of the concepts and skills necessary for reading tactile maps are important for reading other types of tactile displays, such as graphs and diagrams.

Appendix A

Samples of Tactile
Graphic Displays

Tactile Graphics Kit

In order to give you a better idea of how to design an effective tactile display, several samples have been included in this section. It should be noted, however, that these examples are intended only as helpful tools to get you thinking about tactile design and do not pretend to cover all of the design problems which may arise. Each sample includes

- A. A poor tactile representation of a particular graphic,
- B. An analysis of the problems which make it a poor tactile image, and
- C. An improved tactile representation of that graphic.

Begin with Sample A. Carefully examine the first tactile display with your eyes and fingers and think about ways that it might be improved.

Then go to the next page and compare your analysis with the author's. Finally, examine the improved display with your fingertips, noting the greater tactual clarity that is achieved through good design. Repeat this procedure for Samples B and C.

Sample A: Poor

The tactile display on the next page involves a graph of fictitious data that demonstrates the relationship between heart rate, type of task (for example, different forms of exercise), and time on task. This graph is an example of poor tactile graphic design. Ask yourself what problems exist within the graphic and how would you remedy them. See page 67 for suggested solutions.

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Thermoform SAMPLE A (Poor)

FRONT
pg 65

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Thermoform SAMPLE A (Poor)

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SAMPLE A: Problems and Solutions

Problem 1: The major drawback of this display is clutter, due to the crowding of symbols and the lack of sufficient contrast between adjacent symbols.

Solution: Enlarge the display and use lines that better contrast with one another.

Problem 2: The axes do not contrast well with the braille numerals or the grid.

Solution: Use a wide solid line for the axes.

Problem 3: The braille numerals are too close to the axes.

Solution: Place unit markers along the axes and position braille numerals next to them, maintaining 1/8 inch (3 mm) spacing.

Problem 4: The grid lines are too prominent and too close to the data curves, making it difficult to follow the data curves tactually.

Solution: Use Line 6 for the grid; maintain 1/8 inch (3 mm) spacing between the data curves and the grid lines.

Problem 5: It is tactually difficult to connect the labels with the data curves to which they refer.

Solution: Use a key.

Problem 6: The "Heart Rate" label for the y-axis (ordinate) is oriented vertically, making it difficult to read.

Solution: Orient the label horizontally.

Problem 7: The display has no title.

Solution: Place a brief title above the display.

Sample A: Good

The tactile display on page 69 is an improved representation of the graph. It incorporates the solutions recommended for each problem encountered in Sample A: Poor.

Sample B: Poor

The tactile display on page 71 shows the continent of South America. Information concerning the political boundaries of the South American countries, their capital cities, and the regional distribution of rainfall is depicted. In the original visual display, three different colors were used to denote the amount of rainfall occurring in various parts of the continent. Ask yourself what problems exist within the graphic and how would you remedy them. See page 73 for suggested solutions.

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Thermoform SAMPLE A: Good

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pg 69

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Thermoform SAMPLE A: Good

BACK
pg 70

Attention: Large Type
Remove this page and insert
Thermoform SAMPLE B: Poor

FRONT
pg 71

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Thermoform SAMPLE B: Poor

BACK

pg 72

Sample B: Problems and Solutions

Problem 1: The major problem with this display is its complexity. Too much information is packed into the display, resulting in a good deal of clutter.

Solution: Make *two* separate maps, one showing the political boundaries of the countries, the other showing the rainfall areas. Include the capitals in *both* maps so that they can be used as reference points for cross comparisons between the two maps.

Problem 2: The point symbols used to depict the capitals are placed too close to the linear symbols and the areal patterns.

Solution: Gain additional space by enlarging the maps, using as much of the foil as possible.

Problem 3: The shapes of the rainfall areas depicted by the different areal patterns are not easily discerned.

Solution: Outline the boundaries of the various rainfall areas with a linear symbol.

Problem 4: The labels and guidelines increase the map's clutter.

Solution: Use a key.

Problem 5: Complex directional compass.

Solution: Simplified North indicator.

Sample B: Good

The tactile displays on pages 76, 77, and 79 illustrate how to divide a complicated graphic into separate parts. The first thermoformed page shows the key/legend that provides the meaning for each abbreviation, point symbol, and line path encountered in the Sample B (Part 1). This graphic display shows only the capital cities of each South American country. Notice how the key/legend is on the facing page, to the left of the actual tactile map.

Sample B (Part 2) shows the distribution of average annual rainfall in South America. Braille abbreviations of the countries are not repeated in this graphic. The key/legend that appears on the same page as the tactile map indicates the meaning for each areal pattern.

Sample C: Poor

The tactile display on page 81 illustrates the refraction of light beams by convex and concave lenses.

Sample C: Good

The display on page 83 shows an improved version of Sample C. Line 7 (*directional* line) is used instead of visual arrows to represent the paths traveled by the beams of light.

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Thermoform SAMPLE B: Good

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pg 75

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pg 76

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pg 77

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pg 78

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pg 79

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pg 80

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pg 81

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Thermoform SAMPLE C: Poor

BACK

pg 82

Attention: Large Type
Remove this page and insert
Thermoform SAMPLE C: Good

FRONT
pg 83

Attention: Large Type
Remove this page and insert
Thermoform SAMPLE C: Good

BACK

pg 84

Appendix B

APH Tactile Graphics
Guidelines

Tactile Graphics Kit

The following guidelines were developed out of an APH workshop involving Nancy Amick, Jane Corcoran, and Frederick Otto in July 1997.

Guidelines for Design of Tactile Graphics

General

1. Decide if a tactile graphic needs to be made at all. Omit the graphic if it doesn't convey essential content.
 - a. Consider using a description to replace all or part of a graphic.
 - b. Remember that children need to build up tactile skills with simple figures. Consider providing graphics in children's books even if they are not needed for content.
2. Graphics should be tactually clear and contain only relevant information, based on an understanding of what is being taught and what the student's task is. Visual information that is irrelevant to the meaning or purpose should be omitted.
3. Graphics should be redrawn in two dimensions where possible, with the exception of some mathematical and scientific diagrams.
 - a. Replace three-dimensional figures with cross-sections or front-side-top views whenever possible.
 - b. Look for perspectives that allow you to redo a 3-D print picture in 2-D.
4. Follow the Braille Authority of North America's (BANA) "Guidelines for Mathematical Diagrams." In cases where a graphic has been replaced by a table or chart, use "Braille Code for Columned Materials and Tables."

Design

1. Avoid clutter and simplify.
 - a. “Clutter” occurs when different symbols and lines are so close or so similar that they become hard to distinguish. Spacing is the key to avoiding clutter.
 - b. Symbols and lines closer than 1/4” may be hard to tell apart, depending on the medium and tools being used.
 - c. Shapes with sides less than 1/2” long may not be recognizable.
 - d. Distort the spacing or shape of the original picture if necessary to allow uncluttered spacing of the tactile elements, providing this would not violate the purpose of the picture.
 - e. “Simplify” means to eliminate unnecessary elements of the original

picture. Focus on the relevant parts and omit details that are purely decorative or distracting.

- f. When the print picture includes people, animals, objects, etc., replace them with simple lines, symbols, and/or labels (e.g., use the label “hand” instead of drawing a hand).
2. Split complicated graphics into separate drawings showing layers of information, or into an overview and detailed view.
 - a. Explain the separation in a transcriber’s note.
 - b. Carry over some labels and common points from one drawing to another for reference.
3. In general, use texture sparingly and only to add information.
4. When necessary to avoid confusion or to give important

information, differentiate between bodies of water and land on maps by using a different areal symbol (texture).

- a. Use a very low, closely spaced texture for water.
- b. An areal texture indicating ocean should extend far enough to be perceived as a continuing expanse, but need not fill the entire page.

Symbols (Lines, Points, and Textures)

1. Limit the lines, points, and symbols on a drawing to ones that can be easily identified one from another by touch.
 - a. Use the most prominent symbols for the most important features in the graphic. Don't allow high or "noisy" textures to draw attention away from the key features.
2. Be consistent in using symbols within graphics of the same type within the same transcription (e.g., always use the same symbol for water on maps).
3. Use different tactile symbols for different types of information (e.g., in a map of the United States, the tactile line used to indicate state borders should be different from the tactile line used to indicate international borders).
4. Lines, points, and braille must be physically separated by at least 1/8."
 - a. This may need to be 1/4," depending on the medium and symbols used.

- b. Apply the 1/8" separation rule to all features that are separate, even if doing so introduces some spatial distortion.

Lead Lines

1. Use lead lines only as a last resort. Use keys or notes as alternatives.
2. Do not use arrows as lead lines.
3. The linear symbol used for lead lines should be different from any other lines used in the graphic and should be tactually distinctive but less prominent.
 - a. A lead line should begin as close as possible, without causing interference, to either the first or the last letter in the label, and should end as close as possible to the feature being labeled.

- b. Break the lines of the graphic to allow lead lines through.

Labels

1. Explain and define all graphic symbols, either on the same page, facing page, or special symbols page.
2. Identify all important features (e.g., capitals, bodies of water, even things not labeled in the print version. Place titles at the top of the page. Do not make unlabeled graphics. (There may be exceptions in some testing situations.)
3. Place labels in a manner that leaves the reader no doubt as to what is being identified. Single letters on the graphic should be preceded by either the letter sign or the capital sign.

4. Use two-letter U.S. postal codes where applicable (and other two-letter codes where postal codes are not applicable) for labels on maps.
5. Words in labels need not be capitalized if their meaning will not be confused.
6. Use Grade 2 braille contractions in labels.
7. A two-cell braille symbol is preferable to a one-cell symbol for labels.
8. Try not to break the integrity of a shape with a braille label (e.g., the border of a state with its braille label).

Indicators and Scale

1. In a transcription where north is at the top of the page on all maps, indicate this in a preface and do not indicate north on each map. On single maps, or when north is not

the top of the page, indicate direction by using a simple arrow labeled N.

2. Position scale and other indicators as consistently as possible, preferably at the top of tactile graphics.
3. When it is necessary to change the scale, this fact may need to be indicated in a transcriber's note.

Preliminary Information

Place all titles, keys, and legends before the graphic. Author's keys and legends precede the transcriber's keys and legends. If there is not room on the page with the graphic, place on preceding page.

Remember: Feel every graphic you make before sending it on. If you can't identify its features, your reader probably can't either!

Appendix C
Sources of Tactile Graphic
Related Products

Tactile Graphics Kit

Tactile Graphic Related Products Available from APH

Basic Tactile Anatomy Atlas (1-08845-00)

Study the human body with this two-volume set of thermoformed graphics. The skeletal, muscular, nervous, endocrine, cardiovascular, lymphatic, respiratory, digestive, urinary, and reproductive systems are all tactually diagramed and complemented by braille descriptions and braille and print labels.

Braille Transcriber's Kit: Math (1-04100-00)

Transcribe figures common to elementary math books with this collection of embossed drawings. The included master sheets

contain raised line drawings of rulers, number lines, protractors, thermometers, clock faces, and can be thermoformed to provide multiple copies.

Feel 'n Peel Stickers

Assorted (1-08843-00)

Point Symbols (1-08846-00)

Faces (1-08847-00)

Reward Statements (1-08848-00)

Braille/Print Alphabet (1-08849-00)

This collection of adhesive-backed, colorful, and tactile stickers are easy to use and fun, too! Just peel them off and apply them to a variety of surfaces for labeling purposes in the classroom or at home.

Geometry Tactile Graphics Kit (1-08841-00)

This set of 26 white plastic thermoformed sheets will help the user represent concepts, figures, and relationships common to most geometry textbooks. Housed in a three-ring binder, the sheets contain a total of 52 drawings, which are large enough for students to measure. Also included are two specially adapted protractors and a teacher's guide in print and braille.

The Good Tactile Graphic: A Two-Tape Video Presentation and Booklet (1-30006-00)

This presentation and booklet will help transcribers make a better tactile graphic! *The Good Tactile Graphic* kit includes two VHS videotapes, *The Good Tactile Graphic* (20 minutes) and *Creating the Good Tactile Graphic* (25 minutes).

O & M Tactile Graphics (1-20100-00)

This set of materials provides a platform for teaching and practicing such necessary mobility concepts as compass directions, clock locations, navigating rooms and hallways, and navigating streets and sidewalks.

Picture Maker: Wheatley Tactile Diagramming Kit (1-08838-00)

This interactive, multipurpose kit comprises a felt-covered board and over 100 pieces of colorful Velcro® backed pieces. The Velcro backed pieces represent a multitude of shapes, sizes, and textures, and can be arranged upon the board to illustrate a variety of concepts, such as maps, charts, shapes, and art.

Quick-Draw Paper (1-04960-00)

Made of material that responds to water-based writing tools, Quick-Draw Paper provides a quick and easy way to create a temporary tactile graphic. Just draw on the Quick-Draw paper with a water-based marker, and whatever is drawn will swell, becoming instantly tactual.

Swail Dot Inverter (1-03610-00)

Designed for embossing single dots, this kit includes a special metal stylus and a 12 x 12 inch rubber pad with which the user can construct simple charts, diagrams, graphs, and maps.

Tactile Graphics Starter Kit (1-08839-00)

This is a simple, user-friendly kit for those who have minimal

experience in making tactile graphics. Kit is ideal for making maps of countries and continents, bar graphs, pie charts, and other illustrations.

Tactile Treasures: Math and Language Concepts for Young Children with Visual Impairments (1-08842-00)

One may use the program as an informal assessment and teaching tool for children possessing little or no vision and who are at the preschool, kindergarten, or elementary level. Containing 79 thermo-formed sheets and other materials, *Tactile Treasures* can be used to teach more than 90 concepts (shape, size, amount, page position, etc.) helpful in building the student's preliminary math and verbal skills.

Tangible Graphs **(1-08860-00)**

Designed to teach students to read tactile graphs, *Tangible Graphs* can help familiarize students to bar graphs, circle graphs, and line graphs. This comprehensive kit includes a three-volume braille student text, a two-volume student graph test, test answer sheets, and regular print teacher's guides to the student text and graph tests.

Other Sources

American Thermoform Corporation

1758 Brackett Street
La Verne, CA 91750
Phone: (800) 331-3676 or
(909) 593-6711
Fax: (909) 593-8001
Web site: www.atcbrleqp.com

Supplier of Swell-Form Graphics Machine; Swell-Touch Paper, Brailon®, and thermoform machines.

Freedom Scientific, Inc.

11800 31st Court N.
St. Petersburg, FL 33716
Phone: (800) 444-4443 or
(727) 803-8000
Web site:
www.freedomscientific.com

Provider of Graph-It software to be used with notetakers and PCs.

Howe Press

Perkins School for the Blind
175 N. Beacon Street
Watertown, MA 02172
Phone: (617) 924-3490
Fax: (617) 926-2027
Web site:
www.Perkins.pvt.k12.ma.us
Supplier of tracing wheels and raised line drawing pad.

HumanWare, Inc.

175 Mason Circle
Concord, CA 94520
Phone: (800) 722-3393
Fax: (925) 681-4630
Web site: www.humanware.com
Provider of Pictures in a Flash (PIAF) and capsule paper.

Repro-Tronics, Inc.

75 Carver Avenue

Westwood, NJ 07675

Phone: (800) 948-8453 or
(201) 722-1880

Fax: (201) 722-1881

Web site: www.repro-tronics.com

Supplier of Tactile Image
Enhancer, Thermo Pen II,
Flexi-Paper, and
Tactile AudioGRAPHICS

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