TACTILE DIAGRAM MANUAL

2002 Edition

Tactile Access to Education for
Visually Impaired Students

A Division of the
Office of the Dean of Students

Purdue University
West Lafayette, IN

Tactile Diagram Manual

2002 Edition

TAEVIS
Purdue University
1149 South Campus Courts-E
West Lafayette, IN 47907-1149

braille@purdue.edu
www.taevisonline.purdue.edu

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An Equal Access/Equal Opportunity University

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DISABILITY SERVICES AT PURDUE

Purdue University is a state-assisted, preeminent research institution with historical strengths in engineering and agriculture. Over 38,000 students are enrolled at the West Lafayette, IN, campus. The school supports a comprehensive effort to provide equal access for students with disabilities.

ADAPTIVE PROGRAMS

Accommodations for students with disabilities are arranged through Adaptive Programs, a unit within the Office of the Dean of Students. Staff members identify individualized accommodations for students with physical, emotional and learning disabilities. Once disability specialists determine that braille or electronic text is a suitable accommodation, TAEVIS staff members are notified and materials are procured for transcription.

ALPS LAB

The ALPS Lab, within Purdue's Information Technology structure, is a computer lab containing fully accessible equipment. Students with disabilities can utilize a variety of alternative devices and programs which provide the computer access essential to today's student.

TAEVIS

In 1996 Purdue University began a concerted effort to provide braille materials to two blind students who were enrolled in chemistry courses. The loosely structured effort quickly grew into TAEVIS (Tactile Access to Education for Visually Impaired Students) an organized unit which now supports students in a wide range of classes. The group routinely provides alternative access to liberal arts courses, calculus, engineering, chemistry, foreign languages, mathematics, etc. In addition to braille, the group provides students with electronic text and tactile diagrams.

ABOUT THIS MANUAL

Print diagrams are designed for visual readers and often contain features which are not easily presented to the braille reader: perspective, overlapping lines, color, print tags, etc. The tactile illustrator must carefully transcribe the diagram to preserve the original intent while providing the braille reader equal access to the subject information.

This booklet contains collected guidelines and techniques used by TAEVIS illustrators to transcribe print diagrams into tactile images on microcapsule paper. It is used in the TAEVIS facility as both a training manual and a reference book.

These standards have been refined over six years while creating, on average over 1000 diagrams per semester. TAEVIS has built on the research and drawing principles developed for other media such as thermoform, foil, and dot images. In addition, TAEVIS has listened closely to Purdue students who have provided direct feedback on what has and has not worked for them as they have read the materials and studied for their classes. Because the students are our clients, the end users of our product, they have had a strong voice in the standards which TAEVIS has adapted.

The guidelines presented in this booklet are just that: guidelines. No one training manual can prepare the tactile illustrator for all diagrams which he or she will be asked to transcribe. The most effective training method is to provide the illustrator with basic guidelines and principles which can be applied to a variety of situations.

I. PRODUCTION

A. DIAGRAM SELECTION CRITERIA

Highly illustrated college textbooks may contain over 1000 drawings and photos. Only a portion of these diagrams provide information toward understanding the material. Some illustrations are present simply to enhance the visual appeal of the page while others may be a visual representation of information in the text.

Purdue braille readers have indicated a strong preference to have only the most essential illustrations as tactile diagrams. They have asked that, whenever possible, the material be described in braille text. This lessens the burden on TAEVIS and provides more streamlined textbooks for the students.

With these facts in mind, TAEVIS reviews all textbooks and transcribes only those diagrams which are essential to the subject matter. For technical expertise, TAEVIS consults graduate students who have a background in the given subject. Staff members are guided by the following questions:

- Does the illustration add informational value or does it simply provide visual appeal?
- Is the information presented in the illustration also described in the text or in the caption?
- If the illustration is described in the text, is that description adequate for the subject matter?
- If the illustration is not described in the text, can it adequately be described in a transcriber's note?
- Is there a similar diagram or diagrams in the text which can be referenced so that only one representative illustration is necessary?
- Is the illustration part of a cumulative series where only the final illustration is required?

An illustration will be rendered as a tactile diagram only if it provides essential information and if it cannot be adequately described in braille text.

B. PREPARATION

1. Designation

Illustrators and transcribers each receive copies of the print pages which contain illustrations to be tactiled. On each copy, the material to be tactiled is circled or highlighted. This allows each person to know exactly what portion of the illustration will be in the tactile diagram. With a quick glance, transcribers know if any portion of the illustration will need to be in the text or in a transcriber's note. Illustrations are linked to the text via transcriber's notes.

2. Titles

Each diagram is given a unique title and an internal tracking number. In the final tactile diagram, the title appears in braille and the tracking number (internally referred to as a Doc. ID) will appear in small print at the bottom of the diagram. A sample template layout is shown in Diagram A-01 of the Appendix.

The title and the Doc. ID are listed on both the illustrator's and transcriber's copy so both workers know the designated diagram title. This is essential because the transcribers will be inserting a note referring to the diagram by title.

Titles are usually composed of the text page number followed by a descriptive title or any figure numbers assigned in the text. If more than one graphic on a print page is selected to become a tactile diagram the page number will be followed by a letter. Titles may differ for non-standard items such as overheads, handouts, etc. The following are samples of diagram titles:

> 235: Figure 9b *(print text page 235, Figure 9b)*
>
> 173c: Circulatory System *(print text page 173, third illustration on that page; print title of the illustration is "Circulatory System")*
>
> Overhead: Graph 4 *(Graph 4 from a group of overheads)*

Inclusion of print page numbers also allows quicker binding. TAEVIS follows textbook formatting guidelines that display the print page number in the upper corner of the braille page. Once the print page is located in the braille volume, the transcriber's note for the diagram should be within a few pages. Braille diagrams are bound next to the text page which contains the reference to the diagram.

C. MEDIUM

TAEVIS produces computer generated raised-line diagrams on microcapsule paper.

D. METHOD

1. Drawing

TAEVIS uses standard, commercially available graphics software to trace or redraw all diagrams. The primary goal is to preserve the integrity of the diagram. However, some editing may be required to ensure that the format is suitable for braille readers. This is discussed in more detail in the section on Editing.

The staff have created computer templates such as standard layouts, plot points, graph elements, etc., which help to streamline the drawing process. Illustrators also make maximum use of diagrams which are similar in nature by creating a base diagram and modifying it for individual drawings.

TAEVIS illustrators are cross-trained in Nemeth braille and in the use of translation software. This allows them to generate labels (tags) for their diagrams. Text transcribers are also available to assist if questions arise.

2. Braille Labels

Braille labels (tags) are placed in diagrams as text blocks in the overall graphic. A 24 pt. braille font is required to produce standard braille dots on the microcapsule paper. There may be some differences between papers, but this font size is suitable over a range of media. A scalable braille font, such as that provided with the Duxbury Braille Translator, can be used to generate braille labels. In most graphics programs, the artist will have the option of selecting the font for text boxes. (See **LABELS**, Section VI, for a complete discussion of braille label creation and use.)

Labels can be transcribed manually or electronically. For simple labels, it is easiest to use the ASCII keyboard equivalents for braille symbols. For instance, the illustrator can simply type **,c** for **C** to represent a carbon atom in a chemical structure. The Duxbury Braille Translator or the Nemeth filter for Scientific Notebook can be used to assist in the transcription of more complex labels. The method will vary according to illustrator preference and the material to be transcribed. The diagrams in the Appendix provide several examples of braille labels.

E. PROOFREADING

Tactile diagrams are proofread in a two step process. First, a braille transcriber examines the drawing for labeling accuracy. In the second step, an illustrator checks for graphic content and clarity.

II. TACTILE DESIGN

A. DESIGN PRINCIPLE

It is always the goal of TAEVIS to preserve the scientific integrity and the original intent of all diagrams. However, illustrators reserve the right to make minor modifications in size, layout, form, position, or scale to produce a tactile image that is optimal for the tactile reader. Illustrators consider the following factors when reviewing a diagram:

- The age/grade of the student
- The student's experience with tactile graphics
- The importance of tactile graphics to the student
- The complexity of subject matter
- Previous experience with the subject matter
- Size and composition of the target audience
- Special medical or learning needs
- Frequency of usage of the tactile graphics
- Presence or absence of additional aides (example: professors, lab partners, peers)
- Purpose of diagram (example: study aid, exam)

1. Simplifying

Unnecessary lines, details, decorations, etc., may be reduced in number or eliminated if such "secondary information" is distracting and not relevant to the purpose of the original diagram. Subject expertise is useful to accurately simplify the original diagram, especially in advanced academic materials. The tactile artist is always responsible for preserving the original intent of the diagram.

Diagram A-18 in the Appendix provides a good example of a print diagram that has been simplified in the tactile version. The print illustration shows a car moving up an incline along with some details about the incline slope, etc. The tactile version simplifies the car, but maintains the scientific integrity of the illustration by retaining all mathematical information.

The wheels, windows, and shape of the car enhance the visual appeal of the illustration, but are all secondary information when solving the accompanying exercises. The tactile artist has simplified the car by making it a filled box and adding the label "car". If the artist had transcribed the drawing exactly as it was shown in print, the unidentified shape would have been confusing for the reader.

Unnecessary time would have been spent trying to sort out the car and a sighted assistant may even have been required to explain the details.

When the car is transformed into a box and clearly labeled, the diagram is clarified and the reader can focus on the scientific principles at hand. Descriptive labels should not add any information that is not provided to other students.

Another simplification example is the common rendition of the atmospheric water cycle. Print pictures usually show cities, farms, trees, mountains, clouds, boats, etc. The artist can save time and still present essential relationships in the drawing by using labels rather than pictures for most of these items.

Three-dimensional print diagrams may also be simplified by redrawing them in a 2-dimensional format. This may require additional views (top, side or front), increasing the total number of final tactile diagram pages. (See **Multiple Pages**, Section IV.)

2. Resizing

Tactile diagrams may be enlarged as a whole to include critical detail(s) or to increase clarity. Tactile diagrams may also be enlarged horizontally, vertically, or both to accommodate braille labels, or to increase clarity of a particular area or section.

III. FORMAT

A. TEMPLATES

All TAEVIS tactile diagrams are created on a standard template consisting of the elements listed below. Template features are shown on Diagram A-01 in the Appendix.

1. Header
- dotted header line 5/8" (0.625" or 15mm) from the top of the page
- braille diagram title (24 pt. font), flush left, directly above the dotted header line

2. Footer
- dotted footer line 1/2" (0.5" or 13mm) from the bottom of the page
- print copyright notice (9 pt. font), flush left directly below the dotted footer line
- print title (9 pt. font), centered directly below the dotted footer line
- print TAEVIS document identification number (9 pt. font), flush right directly below the dotted footer line

3. Left Margin
- 1/2" (0.5" or 13mm)

4. Right Margin
- 3/8" (0.375" or 10mm)

Template formats are identical for landscape (horizontal) and portrait (vertical) pages. The braille title and dotted header line indicate the orientation of the page.

B. PAPER SIZE

TAEVIS diagram templates are sized for 8.5" x 11" paper. Although braille text pages are 11" x 11.5" and diagrams would be allowed on the larger paper, the smaller paper can be printed on standard office equipment. Specialized printers would be required to accommodate the 11" x 11.5" braille format.

The diagrams are printed onto regular paper with a laserjet and then photocopied onto microcapsule paper for image processing. TAEVIS uses two sizes of microcapsule paper: standard U.S. paper size (8.5" x 11") and the slightly larger (8.5" x 11.75") paper supplied by some international vendors.

C. DRAWING SIZE

The size of the tactile drawing itself is dependent on the complexity or content of the original print diagram and the necessity of enlargement, resizing, etc., to make it effective.

D. BINDING

TAEVIS braille documents are bound using the 19-hole punch binding system. Posterboard, cut to 11" x 11.5", is used for the front and back covers.

Tactile diagrams are punched and bound next to the braille page that refers to the diagram. Braille and print labels are added to the cover for a completed document, ready for delivery to the student.

IV. MULTIPLE PAGES

If a print diagram contains excessive graphic or text information, it may be necessary to place part of the material on additional pages using one of the methods listed below.

A. OVERVIEW

Description
The first page contains a basic overview with little or no detail to show the reader the overall shape or connectivity of the material. Diagrams on additional pages illustrate smaller segments showing greater detail.

Examples
- An array of lab equipment with many components: the overall scheme would be shown on the first page with individual glassware components on the following pages.
- A complex chemical reaction: the first page would show the overall reaction with simple labels for the various components while the detailed molecular structures of those components would be shown on subsequent pages.
- A nature cycle (life cycle of a moth, environmental water cycle): the first page would show the cyclical view with braille labels for the components; the following pages would contain detailed drawings of each portion of the cycle.

B. ENLARGEMENT

Description
It is necessary to enlarge a portion of the original diagram for increased clarity. The first page shows the entire shape with little detail. The enlarged section (or sections) is placed on the following pages.

Examples
- A long molecule highlighting the last few atoms in the sequence: the basic structure is on the first page and the detailed view of the last sequence is on the following page.
- A graph showing long-term trends with details of recent trends: the long-term view is shown on the first page with no details for the recent period; the recent period is drawn as a separate graph and placed on the following pages.

- A human body is shown with details of the lungs: the body is shown on the first page and the general location of the lungs is indicated; a detailed drawing of the upper abdomen is presented on the following page.

C. LAYERING

Description
A print illustration is highly detailed and contains several types of information. There are simply too many labels, symbols, etc., to render everything in braille. The basic form of the object is illustrated on the first page and repeated on the following page(s) with different types of information on each page.

Examples
- A map: the overall shape is shown on the first page with little or no detail; that shape is repeated on subsequent pages with physical features, major cities, population density, climate, etc. on separate pages.
- Illustration of the human body showing circulatory, skeletal, and pulmonary systems: each system is shown on a separate page.

D. FOLD-OUT

Description
In some situations a single diagram can be drawn on two pages and the pages taped together, creating a fold-out section. The tape should be wide and strong enough to hold the two pages together and withstand expected use. The student can read the pages without the interruption of a page break. The TAEVIS Doc. ID is placed on both pages and the folded page is trimmed slightly to facilitate binding.

Examples
- The Periodic Table of the Elements: the structure of the table is scientifically significant so it is helpful for the reader to see the entire layout at one time.
- A map: allows the student to see the entire area without page breaks and allows the illustrator to include more detail in a single drawing.
- A flow chart or tree structure: these can become quite extensive and it may be helpful for the reader to see the full system at one reading.

E. NUMBERING MULTIPLE PAGES

An indicator is added to the diagram title of each multiple page: Fig. 1 - 1 of 3; Fig. 1 - 2 of 3; and Fig. 1 - 3 of 3. This facilitates binding and tracking of the sheets. The document ID number remains the same on all three pages because they represent the same graphic.

V. ARROWS

Arrows frequently accompany scientific and technical print illustrations. TAEVIS illustrators have developed standards to reliably and consistently present this information to tactile readers. These standards are illustrated on drawings A-02 to A-04 in the Appendix.

A. HEAD

The TAEVIS arrowhead is a triangular solid black fill with a 90° angle at the tip and wide base. The TAEVIS standard arrowhead measures as follows: 1/2" base, 3/8" sides, and 1/4" in height from tip to base. The maximum reduction for this arrowhead is 75%. Further reduction of the arrowhead creates an arrow that is difficult to distinguish from a line. A detailed drawing of the TAEVIS standard arrowhead is shown on Diagram A-02 (See Appendix).

B. SHAFT

When the arrow is an inherent part of the diagram the shaft is a solid line.

> Example: The arrow between the reactants and the product of a chemical reaction is an essential part of the diagram. Without the arrow, the diagram would not represent a chemical reaction.

When the arrow is not an inherent part of the diagram, the shaft should be a dashed line.

> Example: An arrow can be used to highlight the distance between two points on a print graph. The arrow is helpful, but the information in the diagram could still be understood without it. In this case the arrow is not essential to the basic elements of the diagram and would be shown with a dashed shaft.

The shaft of the arrow must <u>not</u> be interrupted or broken by a label or an intersecting line.

The shaft can be thick (while leaving at least 1/8" from shaft side to the shoulder point of the head), thin (not less than 1.5 pt. in width), and/or textured. This is a subjective judgment based on the original print diagram, use of other textures in the tactile diagram, and the need for other lines in the tactile diagram. (See **LINES**, Section VII, for more information on line use.)

C. SPACING

If an arrow must be located within a textured or filled area, a white space of 1/16" (0.0625" or 1.5 mm) should be created around the arrow. This gives the reader a clear division between the arrow and other areas of the diagram. (See **TEXTURED FILLS**, Section VIII, for more information on fill selection and use.)

The tip of the arrowhead should not touch its chosen point on the diagram, but should be located 1/16" (0.0625" or 1.5 mm) away from it. If the print arrow extends into the subject, the tactile diagram should be modified to fit these standards.

D. LABELS

Labels should not interrupt the arrow shaft but should be placed between the arrow and the edge of the page. Labels should not be positioned between the object and the arrow. The general rule followed by TAEVIS illustrators is to place labels around the perimeter of the diagram. (See **LABELS**, Section VI, for a more complete discussion of label creation and use.)

Labels should be centered horizontally along the length or at the base of the arrow's shaft.

Some computer design programs allow the user to easily and quickly align text into a vertical or diagonal format. This creates interest and variety for the print reader, but braille readers report that such changes are difficult to follow in tactile diagrams. In response, TAEVIS presents labels exclusively in the horizontal format.

E. SIMPLIFYING

When arrows on the original print diagram indicate a general area versus a specific point or smaller area, arrow use may be restricted to prevent confusion and clutter. Arrows can be replaced with letters or numbers and listed in a key. (See **KEYS**, Section X**,** for more information on their use.)

VI. LABELS

A. SPECIFICATIONS

1. Codes

Both Literary Grade II and Nemeth Braille Code are used to create braille labels for tactile diagrams. If a diagram will be bound in a book, the illustrator should use the same braille code as the transcribers have used for the book. If a diagram will stand alone, the illustrator will need to select an appropriate code. To make this decision, the illustrator should consider other codes used in the class, the nature of the diagram, and, if the student is known, his or her reading abilities.

2. Size and Font

Print labels can be reduced in size, printed in a distinct color, placed over portions of the diagram, and rendered in a unique font. These options are simply not available to the tactile illustrator. All braille text tags must use a 24 pt. font to produce standard braille dots on the microcapsule paper. As a result, it is often necessary to alter label locations when creating a tactile version of the illustration. Alterations must be made with care, because the original intent of the print diagram must be preserved and conveyed to the braille reader.

Braille labels are placed in diagrams as text blocks in the overall graphic. A scalable braille font, such as the one provided with the Duxbury Braille Translator, can be used to generate braille labels. In most graphics programs, the artist will have the option of selecting the font for text boxes.

3. Transcription

Labels can be transcribed manually or electronically. For simple labels, it is easiest to use the ASCII keyboard equivalents for braille symbols. For instance, the illustrator can simply type **,c** for **C** to represent a carbon atom in a chemical structure. The Duxbury Braille Translator or the Nemeth filter for Scientific Notebook can be used to assist in the transcription of more complex labels. The method will vary according to illustrator preference and the material to be transcribed.

4. Position

Labels are always written horizontally never vertically. They are positioned to clearly indicate the element they are labeling. Whenever possible, labels should be placed in a consistent position throughout the diagram. For example, labels might be placed on the left side of the illustration, around the edges of the diagram page, or inside each area that is labeled. The illustrator must make a judgment that preserves the meaning and integrity of the original drawing. Examples of braille labels can be seen throughout the Appendix.

B. EDITING

Descriptive labels may be substituted for photographs, drawings, etc. in situations where such substitutions do not alter the meaning of the original print illustration.

Examples

- The print diagram of a physics book shows a car moving down an incline. The student is asked to calculate distance and speed. The illustrator can easily convey the meaning to the student by using the braille word "car" instead of drawing a representation of the car.
- An illustration of the water cycle shows a body of water, a land mass (complete with farms and a city), clouds, sun, and rain. All of this detail would be very confusing when rendered in braille. The original meaning of the print illustration can be conveyed to the braille reader by using labels for these objects rather than a detailed drawing of each.
- A chemical chain contains several repeats of a single molecular structure. The illustrator may draw one or two sets of the basic structure and use a braille label to indicate that the structure repeats. (See **Multiple Pages**, Section IV, for information on using multiple pages to render complex drawings.)

The illustrator can occasionally substitute lowercase letters for capital letters used in the print illustration. Illustrators are cautioned to use extreme care in making such changes to ensure that the original meaning of the diagram is preserved. It may be preferable to divide the drawing into multiple pages. (See **Multiple Pages**, Section IV.)

Example

- The print illustration of a chemical structure is complex and the tactile version would be easier to read if it were all on one page. The entire structure will fit on one page if the illustrator uses lowercase letters instead of the uppercase letters commonly used for chemical symbols (i.e. "he" instead of "He", "c" instead of C). A significant amount of space would be saved by not using the capital sign. In this case the illustrator might decide in favor of lowercase letters. If the student is at an advanced level and if other diagrams are

transcribed correctly, the student will note the change but the meaning and intent of the original diagram will be preserved. A transcriber's note in the text should be used to clarify the change.

C. SPACING

The minimum space permitted between a label and a graphic element is 1/16" (0.0625" or 1.5mm). If more than 1/2" is required between a label and the element or area it is labeling a lead line should be used to retain reader comprehension. (Examples of label spacing can be seen throughout the diagrams in the Appendix.)

D. LEAD LINES

Lead lines connect labels to a specific point or area on the diagram. (See Diagrams A-05, and A-10 in the Appendix for examples of lead lines.) They are drawn using a 1.5 pt. dashed line. The length of lead lines varies as required by the diagram layout. However, the minimum line length is 1/2" (0.50" or 12.5mm). (See **LINES,** Section VII, for more information on line length.) Minimum spacing between a lead line and it's element or label is 1/16" (0.0625" or 1.5mm). Arrows are not used as label lead lines.

The illustrator should use caution to prevent confusing the reader with a large number of lead lines on a given diagram. When several lines are required, it may be better to split the drawing into multiple pages using one of the techniques discussed in an earlier section (See **Multiple Pages,** Section IV). Careful placement is necessary to prevent clutter and maintain easy reading.

Space permitting, lead lines should extend from either the first or last cell in the label to the designated element or area. This allows a natural flow for the reader. When the lead line extends from the center of a word, the reader must read the word and then return to the middle before following the line. This can be confusing if the label is a long word.

E. SUBHEADING LABELS

Additional labels used as subheadings to describe the diagram page as a whole are located at the top left corner. This is the area just below the dotted header line on the standard TAEVIS layout. (See diagrams in the Appendix for examples of subheadings.)

VII. LINES

A. VARIETY

A variety of line types can be used in tactile diagrams. Solid, dashed, and patterned lines are available on most computer graphics programs. In order to standardize the drawings and provide consistency for the reader, TAEVIS uses four distinct lines: 1.5 pt. solid, 4.0 pt. solid, 1.5 pt. dashed and 4.0 pt. dashed. Line choice is determined by the principles below and by the illustrator's own judgment. The line type may or may not have a correlation with lines in the print illustration. Examples of line use can be seen in the diagrams located in the Appendix.

B. LENGTH

Minimum line length is 1/2" (0.5" or 13mm) for a single line. A shorter line could easily be confused with a braille character.

C. PRIORITY

When the print diagram contains several lines, thicker widths indicate greater importance. For example, a 4.0 pt. line indicates higher importance than a 1.5 pt line and solids always have priority over dashed lines. (See Diagram A-06 in the Appendix for an example of lines of lesser and greater importance.)

An exception is made for multiple lines on a graph. In this case, the lines are of equal importance, but must be drawn distinctly so the reader can follow each quantity being shown. The lines would distinguished from each other by using different widths and textures. (See Diagrams A-07 and A-15 in the Appendix for an examples of multiple lines in a graph.)

D. SPACING

When two or more lines of different importance intersect, the lesser line should be broken. The more important line should have the "right of way" and remain solid. A small white space should separate the lines from each other at the intersection point. The white space should measure 1/16" (0.0625" or 1.5 mm) on each side of the predominant line between the two intersecting lines. (See

Diagram A-06 in the Appendix for an example of spacing around intersecting lines.)

Solid lines have priority over dashed lines since dashed lines are already broken (i.e. 1.5 pt. solid will have priority over 4.0 pt. dashed).

White space at intersecting lines may be disregarded if the space creates confusion for the reader or if the lines are of equal importance. This most often happens when lines intersect at a tight angle. Breaking one of the lines may make it difficult for the reader to locate the continuing portion of that line. The broken line could easily be mistaken for two separate lines. In a Cartesian (x,y) graph, the vertices are of equal importance, so both remain solid at the intersection. (See Diagram A-08 in the Appendix for an example of lines intersecting at a small angle.)

E. TIMESAVING HINT

Diagram A-17 describes a graphic shortcut for creating breaks at line overlaps. With the copying function available on computer graphics programs, a white line is created that is an exact duplicate of the original. Portions of the white line can be cut and laid over the black line to generate a line break. See Diagram A-17 for a complete description of the process.

VIII. TEXTURED FILLS

A. VARIETY

A variety of textures, patterns and fills can be created on most computer graphics programs. These fills can be used to clarify and denote items on a tactile diagram. Several of the fills used by TAEVIS are shown on Diagram A-09 in the Appendix.

B. CHOOSING A TEXTURE

The following factors should be considered when choosing textured fills:

1. Size

The area must be large enough for the reader to feel the texture. An extremely small area may be mistaken for a braille dot or not read at all.

2. Adjacent Fill(s)

Similar patterns can be confusing or not distinguishable, especially in close proximity. Patterns that are in adjoining areas should have distinct feels. (See Diagram A-14 in the Appendix.)

3. Directionality

The selected pattern should be distinguished as a fill and not mistaken for additional lines. For instance, a vertical patterned fill in a narrow vertical space may be read as additional lines and not as a pattern. In this case, a horizontal or dotted pattern would be a better choice.

4. Priority/Dominance

Dominant features on the original printed image should be represented with the roughest/coarsest textures on the tactile diagram for emphasis. Lesser features should be represented with smoother textures. (See Diagram A-11.)

5. Number of Fills

A maximum of five distinctive textured fills may be used per tactile diagram. If more than five fills are required, the illustrator should consider breaking the diagram into multiple pages using the techniques discussed in Section IV.

6. Reader Age/Experience

A younger or less experienced tactile reader may not be able to comprehend as many textures per diagram as an older or more experienced reader.

C. CLARITY

Textured fills should be used sparingly in tactile graphics. Excessive use of fills in a diagram can create low contrast areas with indistinct borders. On the other hand, judicious use of fills can provide contrast, highlights and distinctions for the tactile reader. Compare the use of textured fills in Diagrams A-05, A-10 and A-14. Notice the differences in clarity and distinction.

When color is used as an identifier in a print diagram, the same information may be conveyed in a tactile diagram by using textured fills. For instance, chemical drawings use black to indicate carbon atoms. Tactile diagrams can convey the same information through consistent use of textures.

D. WHITE (EMPTY)

White (or empty) is a fill that can be used quite liberally. When two areas are adjacent, the illustrator may feel that both spaces should be textured. However, the diagram may be more easily understood if one area is left empty. The division between a filled space and an empty space has a higher contrast for the reader than the line between two fills. Diagrams A-05 and A-11 in the Appendix contains an example of the strategic use of white or empty space. Had the illustrator chosen to fill all enclosed spaces in Diagram A-05, the result would have been cluttered and confusing for the braille reader.

E. CONSISTENCY

Once a textured fill has been selected, it should be used consistently through the series of diagrams in that particular set or series. For instance, a dotted pattern may be used each time the heart is shown in a series of biological drawings. The reader can quickly recognize the heart on any diagram in the group.

F. SPACING

A white margin or space of 1/16" (0.0625" or 1.5 mm) should separate one fill from an adjacent fill or line if the line is smaller than 4.0 pt. in width. Each fill area should be outlined by a solid line.

G. FILL KEY

Each textured fill represents distinct information. If there is not enough room on the diagram to label the fill and provide necessary information, a fill key may be necessary.

The fill key, on a separate sheet of image paper, will provide a small sample of each fill and a braille label stating what it represents. For example, in the heart fill mentioned above in Section C, a key should contain a small square of the fill pattern along with the braille label "heart". (See **KEYS**, Section X, for more information on making and using keys.)

IX. GRAPHS

A. TYPES OF GRAPHS

1. Bar Graphs

The bars of a tactile bar graph should all be the same width. Textures are preferred for the bars over solid fills.

The amount of space between bars should be set relative to the layout of the original print diagram. If necessary for tactile clarity, and space permitting, distances can be modified on the tactile version. The minimum space between bars should be 1/2" (0.5" or 13mm). (Diagram A-12 in the Appendix is an example of a bar graph.)

2. Cartesian (X, Y) Graphs

Cartesian graphs consist of two axes which intersect at right angles forming four individual quadrants. Labels along the horizontal, or x-axis, should be placed opposite the tick mark and below the axis line. Labels along the vertical or y-axis should be placed to either the left or right of the axis line and spaced 1/8" (0.125" or 3mm) from the tick mark. (Diagram A-13 in the Appendix is an example of a Cartesian graph.)

3. Circle Graphs (or Pie Charts)

Textured fills with an accompanying label or key are the preferred format for circle graphs in braille. If there is a large amount of text information, a separate page may be required for a key or the information may need to be provided in the text as a transcriber's note. With short print labels, a braille text label on the diagram will be adequate. (Diagram A-14 is an example of a circle graph. See **KEYS**, Section X, for more information on keys.)

Labels can be located either on the outside or inside (depending on available space) of each "wedge" of the pie. Label placement should be consistent for all sections of the diagram. (See **LABELS**, Section VI, for more information on braille labels.)

4. Line Graphs

In line graphs, lines are used to connect data points. The result often shows a trend or a spike in the data. Multiple lines can be used to illustrate different sets of data and the relationship between them.

Since the graph lines have the highest importance in a line graph, they are drawn thicker than the grid lines of the background. The grid lines can be broken while the graph lines have the "right of way" and remain unbroken. (See **LINES**, Section VII, for more information on line intersections.)

Each graph line should be a different width and/or texture. If a grid is used, a 1/16" (0.0625" or 1.5 mm) white space separates the graph line(s) from the grid lines. (Diagram A-16 in the Appendix is an example of a line graph.)

5. Pictographs

In a pictograph, representative pictures are used to show statistics or data points. Numerical values and patterning are important, not the detailed accuracy of the pictures representing the information. Therefore, easily identifiable symbols such as circles, squares, triangles, etc. may replace the detailed pictures on a pictograph.

The information represented by the pictograph may also be converted to a bar graph or a line graph.

B. GRAPHING ELEMENTS

1. Vertices

The vertices (horizontal and vertical axes) should be 1.5 pt. solid lines, in contrast to the contents of the graph. Since the vertices are of equal importance, both lines are solid at the intersection point.

The horizontal or "x-axis" should be labeled even with (to the right), or below the axis line, depending on the content of the graph. The label may be even with the axis line (for a numerical label) or centered below the axis (for a text label). (See **LABELS**, Section VI, for more information on braille labels.)

The vertical or "y-axis" should be labeled above or to the upper left of the axis line. (Diagram A-13 in the Appendix shows intersecting vertices.)

2. Tick Lines (or Measurement Lines)

Tick lines are line segments that divide the vertices into equally measured parts. Tick lines can be individual marks, or they may also be an extension of a grid

used in the background of the graph. Tick lines should be 1.5 pt. in width, the same width as the vertices that they divide. The vertices and tick lines are of equal importance to the graph, so both elements remain solid at the intersection. (Diagram A-13 in the Appendix shows axes with tick lines.)

Tick lines may be of equal or unequal lengths. An example of unequal marks would be a graph that has long tick lines for 100, 200, 300, etc., and short tick lines for 150, 250, etc. The long/short pattern of tick lines on a tactile diagram must follow the pattern in the print diagram.

Tick lines should be centered across the horizontal or vertical axes. If the print graph shows the tick marks extending only on one side of the axis, the illustrator should modify them in the tactile version.

Labels along the horizontal or x-axis should be placed below the axis line and aligned with the tick mark. Labels may be "staggered" in a regular sequence along the axes where there is not sufficient space to place them on one line. (Diagram A-12 in the Appendix shows staggered axis labels.)

Labels along the vertical or y-axis should be placed between the axis and the left page margin. The label should be aligned with the tick mark it describes. The last cell of each label should be aligned along an imaginary vertical line and spaced 1/8" (0.125" or 3mm) from the tick mark.

Where there is not enough space to accommodate a label for each tick mark, the illustrator may modify the label sequence to the available space. For instance, the illustrator might label only the tick marks for ten units (10, 20, 30, etc.) and not those for five units (5, 15, 25, etc.). If possible, the tick marks should remain on the graph without labels. Since this change has the possibility of altering the fundamental nature of the graph, the illustrator should make alterations only in extreme situations and with an understanding of the material that is being shown on the graph.

3. Grids

A grid is a network of evenly spaced horizontal and vertical lines that allow the reader to easily locate specific points. The lines of a tactile grid should be drawn smaller than the graph lines to prevent confusion. The grid lines should break when the graph line, the line of higher importance, passes over them. (See **LINES**, Section VI for a discussion of line breaks.)

Tick lines must be separated by a minimum space of 1/2" (0.50" or 13mm). The illustrator may need to enlarge the graph or limit the use of labels to accommodate this requirement. (See "Where there is not enough space…." above.)

Generally, TAEVIS does not include grids on tactile graphs unless specific points are unlabeled and must be located by the reader.

4. Plot Points

If plotted points are displayed on lines or grids, a white space of 1/16" (0.0625" or 1.5mm) should be left between the lines and the point. Point labels should be positioned between the point and the page margin when space allows. (See Diagram A-13 in the Appendix for an example of a plot point label.)

X. KEYS

A. USE

A key can be used whenever labels need to be simplified on a drawing. This may happen when the print labels are long, when the diagram is complex, or when a tactile illustrator judges that the labels are creating excessive clutter and confusion. (Diagram A-16 is an example of a diagram with an accompanying key.)

To make a key, the illustrator should select an appropriate lettering, numbering, or symbol system to represent longer labels on the diagram. The label should be listed on a second diagram page or as a text transcriber's note with the full label.

Examples

- When drawing a map of the United States, the illustrator may use the two-letter abbreviation for each state to save space or reduce clutter. The abbreviation and the full name of the state would be listed in an accompanying key.
- In a drawing of the human skeleton, the illustrator could number the major bones and list the number and name on a key. The foot would be numbered "4" on the diagram. Both the number, "4", and the full name, "metatarsals", would be listed on the key.

In both examples above, it is easier for the illustrator to insert the short symbol and the drawing remains uncluttered. If the reader needs more detailed information, a multiple page format could be used as discussed in Section IV.

B. FORMAT

The key may be either a horizontal (landscape) or vertical (portrait) page format according to the space needed for the length of the key.

A key is identified in the braille title where it will be stated as "key of ____ ". If a diagram is more than one page, the key should specify which page is referenced.

On a TAEVIS diagram, the title of a diagram is shown in braille in the top left corner of the page above the dotted header line. The word "Key" is used as a subheading label flush left 1/8" (0.125" or 3mm) below the dotted header line.

(See Diagram A-16 for an example of correct title placement when a key is used.)

The body of the key begins on the line immediately following the "Key" subheading. The body should begin flush left in cell 1, followed by one blank cell (space) then the appropriate illustration tag. All runovers of each key item must begin in the third cell from the left margin.

When necessary for clarification, textured fill samples and/or symbols may be incorporated into the key. The fill sample should be indicated by an outlined rectangle of the texture that is at least 1/2" x 1/2". The equivalent of one cell space should be left between the sample and the explanation or description. (See Section VII for more information on textured fills.)

If both text items (letters and/or numbers) and graphic element (textures and/or symbols) are required in the same key, be sure to keep them grouped accordingly. For example, list all text items first followed by the graphic elements then the numbers.

C. LABELING

Key labels should be limited to two-cells and presented in alphabetical or numerical order, depending on the content of the diagram. Alphabetical keys should be listed in alphabetical order and numerical keys in numerical order. (See Section VI for more information on labels.)

It is preferable to use key labels that are logically related to the print tags, whether or not these labels correspond to short-form words. But, single-letter and/or number keys may also be assigned. For clarity, each single-letter key must be followed by a braille period.

Do not use the letter indicator before alphabetical keys even when a letter combination corresponds to a braille short-form word. The number indicator must precede each number key, which must be brailled without a period.

D. PLACEMENT

The key is generally placed on a separate page directly preceding and facing the tactile diagram it corresponds to (i.e. bound on the inside or right page edge). If the key consists of more than one page, the additional pages should be bound sequentially after the first key page.

The key may be placed on the same page as the tactile diagram only if it contains a few items and there is adequate room to include it.

XI. Appendix of Diagram Examples

All diagrams shown in the Appendix have been reduced
by 10% to fit on the manual pages.