

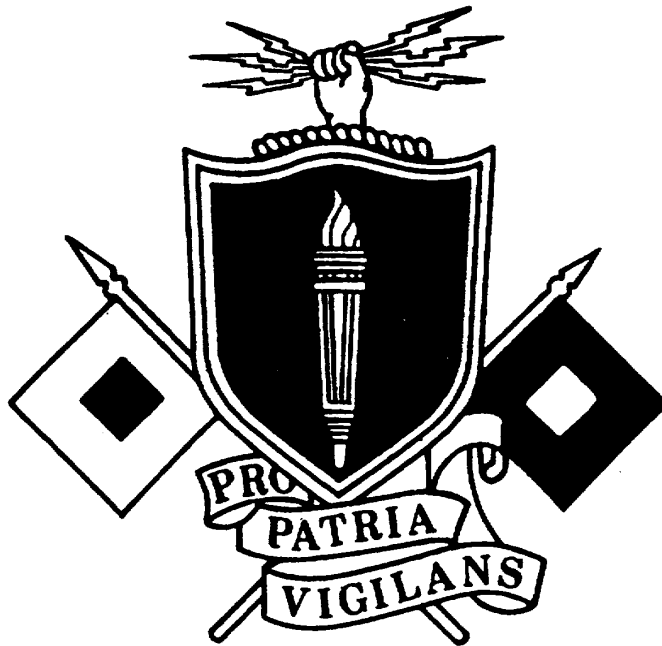
**SUBCOURSE  
SS0530**

**EDITION  
A**

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# **DESIGNING AND PREPARING PRESENTATION MATERIALS**

**EDITION DATE: SEPTEMBER 1994**



**THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT  
ARMY CORRESPONDENCE COURSE PROGRAM**

**A  
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**READINESS /  
PROFESSIONALISM**



**THRU  
GROWTH**

# DESIGNING AND PREPARING PRESENTATION MATERIALS

Subcourse Number SS0530

EDITION A

United States Army Signal Center and School  
Fort Gordon, GA 30905-5074

7 Credit Hours

Edition Date: September 1994

## SUBCOURSE OVERVIEW

This subcourse presents the different types of charts and tables used to present data, lettering techniques, and computer imaging systems. This subcourse also represents the various means available for reproducing graphics, copy layout, projection equipment, printing processes, and the methods used to prepare overlays for graphics and maps.

There are no prerequisites for this subcourse.

This subcourse reflects the doctrine which was current at the time it was prepared. In your own work situation, always refer to the latest official publications.

Unless otherwise stated, the masculine gender of singular pronouns is used to refer to both men and women.

## TERMINAL LEARNING OBJECTIVE

**ACTION:** You will demonstrate the ability to identify techniques, materials, and methods used to design visual aids, from a Visual Information Work Order, for effective presentation of ideas and decision graphics.

**CONDITION:** You will be given information from Department of the Army Pamphlet (DA Pam) 325-10, Field Manual (FM) 101-5-1, and Soldier's Training Publication (STP) 11-25M13-SM-TG.

**STANDARD:** To demonstrate competency of this task, you must achieve a minimum score of 70% on the subcourse examination.

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## LESSON 1

### METHODS OF PRESENTING DATA

Critical Tasks: 113-579-1037  
113-579-5060  
113-579-8004

### OVERVIEW

#### LESSON DESCRIPTION:

In this lesson you will learn the procedures used to accept a VI work order, the process used to prepare the different types of charts, and how to letter graphic projects manually and/or mechanically. You also will learn the basic terminology used in computer operations, and the various software programs that provide computer generated graphics.

#### TERMINAL LEARNING OBJECTIVE:

- ACTIONS:
- a. Identify and review a Visual Information Work Order, DA Form 3903 for completeness and accuracy and learn the procedures used when reviewing the work order with the client.
  - b. Explain the various types of charts to present statistical data.
  - c. Explain the use of decision graphics.
  - d. Describe the standard lettering tools.
  - e. Explain the standards for legibility, including uniformity, proportion, and stability of lettering.
  - f. Describe the mechanical means available to produce letter graphics.
  - g. Describe the hardware necessary to produce computer-generated graphics.
  - h. Explain the terms used with computer equipment and operations.
  - i. Explain the capabilities of software programs to create and modify graphic data.

CONDITION: You will be given information from DA Pam 325-10, FM 101-5-1, and STP 11-25M13-SM-TG.

STANDARD: Describe the methods of presenting data in accordance with DA Pam 325-10, FM 101-5-1, and STP 11-25M13-SM-TG.

REFERENCES: The materials contained in this lesson were derived from the following publications: DA Pam 325-10, FM 101-5-1, and STP 11-25M13-SM-TG.

## INTRODUCTION

As an Army graphics documentation specialist, part of your responsibilities include preparing and lettering the charts used in command briefings and in the training presented by Army training activities. Traditionally, most people think of these activities taking place in a garrison environment. However, you will find that these activities take place in a combat environment as well. In a combat environment, how well you prepare the graphics used for a briefing has a direct bearing on the success or failure of a unit's mission.

### PART A - USING CHARTS TO ILLUSTRATE DATA

#### 1. Visual Information (VI) Work Order, DA Form 3903-R.

Like any other Army function, a visual information facility must have a base document from which it performs its work. A VI facility uses DA Form 3903-R (figures 1-1 and 1-2) as this document. In the visual information facility, this document serves a multi-purpose function. When properly completed, the VI work order provides an audit trail for each project the facility undertakes by documenting the requester, time required to complete the project, materials used, and the number of people and their skills participating in the project. The VI work order also serves as a communications tool between the requester and the VI facility.

The completed VI work orders also serve as a source of information for completing annual reports. Additionally, the information recorded on the VI work order also helps the facility manager justify money for equipment, materials, and personnel to operate the VI center.

NOTE: Use figures 1-1 and 1-2 to follow the discussion of DA Form 3903-R.

<b>VISUAL INFORMATION (VI) WORK ORDER</b> <small>For use of this form, see AR 25-1; the proponent agency is ODIC4</small>		1. WORK ORDER NUMBER  2. SECURITY CLASSIFICATION <div style="text-align: center;">Unclassified</div>															
SECTION I - REQUIREMENT																	
3. TO (VI Activity)  Visual Information Facility Fort Stephenson, VA 80230-9000		4. FROM (Unit or Activity) Cdr, 7th Trans Gp Fort Stephenson, VA 80230-9000  5. ACCOUNT NO 4321-567-999															
6a. REQUESTER (Name)  S.W. Conquest	b. GRADE  MWS	c. PHONE NO.  878-9999	7. DATE REQUESTED  1 Feb 99														
8. ALTERNATE POC  CW4 Dennis P. Yonker			9. DATE REQUIRED  1 Apr 99														
10a. DESCRIPTION OF WORK (Attach diagrams, etc., and list enclosure(s))  10 multicolor high quality VGTs as per attached examples. Full color unit crest and title area will be standard on all 7th Group VGTs.			b. CHECK APPLICABLE BOX <table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>(1) Still Photo</td><td></td></tr> <tr><td>(2) Graphic Art</td><td style="text-align: center;">X</td></tr> <tr><td>(3) TV</td><td></td></tr> <tr><td>(4) Audio</td><td></td></tr> <tr><td>(5) Motion Picture</td><td></td></tr> <tr><td>(6) Presentation Services</td><td></td></tr> <tr><td>(7) Other (Specify)</td><td></td></tr> </table>	(1) Still Photo		(2) Graphic Art	X	(3) TV		(4) Audio		(5) Motion Picture		(6) Presentation Services		(7) Other (Specify)	
(1) Still Photo																	
(2) Graphic Art	X																
(3) TV																	
(4) Audio																	
(5) Motion Picture																	
(6) Presentation Services																	
(7) Other (Specify)																	
<div style="font-size: 4em; font-weight: bold; letter-spacing: 0.5em;">SAMPLE</div>																	
11. JUSTIFICATION FOR REQUESTED SERVICE  15 May briefing for the new commander.		12. Requested service is for official purposes and is required by stated deadline.  VALIDATION SIGNATURE <i>Stephen W. Conquest</i> S.W. Conquest MWS, USA Assistant Adjutant															
SECTION II - WORK RECEIPT (Sections II Through VIII for VI Activity Use Only)																	
13. ITEM/SERVICE	14. SIZE	15. AMOUNT	16. DATE COMPLETED														
17. CUSTOMER NOTIFIED (Date)		18a. RECEIVED BY (Signature)															
b. DATE																	

DA FORM 3903-R, AUG 88

DA FORM 3903-R, SEP 78 IS OBSOLETE

Figure 1-1. Visual information work order DA 3903-R (front)

SECTION III - JOB ASSIGNMENT					
19. DATE RECEIVED 1 Feb 99	20. DATE ASSIGNED 1 Feb 99	21. JOB APPROVAL (Signature) <i>Robin J Blackwelder</i>			
22. SPECIAL INSTRUCTIONS Touch up masters for unit crest as needed					
23. WORK AREA	24. WORK TO BE PERFORMED	25. START	26. COMPLETE	27. WORK-HOURS	28. SUPERVISOR
Graphics	10 color VGTs	0800	1000	10	JAB
SECTION IV - SUPPLIES					
29. DESCRIPTION					30. TOTAL COST
50 Diazo Foils					
10 VGT Frames					
SECTION V - CONTRACT SERVICES					
31. ITEM DESCRIPTION					32. COST
SAMPLE					
SECTION VI - MANAGEMENT REPORT DATA					
33. VI ACTIVITY NAME	34. DVMN	35. FY	36. WORK ORDER NO	37. FUNCTIONAL AREA SUPPORTED	
TYPE OF SERVICE	a. IN HOUSE		b. CONTRACT		c. OVERHEAD
	(1) WORK HOURS	(2) PRODUCTS MINUTES/ITEMS	(3) COSTS	(4) COSTS	(5) PRODUCTS MINUTES/ITEMS
38. Still Photo					
39. Graphic Art					
40. Audio					
41. Video					
42. Motion Picture					
43. Other					
44a. REQUESTING COMMAND			b. ACCOUNT NO		c. TOTAL WORK ORDER COST
SECTION VII - DISPOSITION					
45a. DISPOSITION OF ORIGINAL VI MATERIAL					b. DATE

REVERSE OF DA FORM 3903-R, AUG 88

Figure 1-2. Visual information work order DA 3903-R (rear)

a. VI Work Order Screening Process. As a representative of a VI center, your responsibilities include screening VI work orders.

(1) Analyze job requirements. When a unit presents the VI facility with a work order, you must first analyze the job requirements and ensure the requester has properly completed block 2 and section I (Requirement) of the work order. When analyzing the job requirements, you must consider if the VI facility has the required personnel, equipment, and materials to complete the project. You also must consider if the VI facility can complete the project by the date requested (block 9 of the work order).

(2) Review for security requirements. Once you establish that the facility has the resources and can complete the project on time, you continue reviewing the VI work order. If the work requested has a security classification, you must ensure the requester has annotated the correct security classification (i.e., confidential, secret, top secret, etc.) in block 2.

(a) You must have an entry in block 2; therefore, if the project does not have a security classification, the requester must indicate that also. Remember, if the requester has entered a security classification on the work order, then you must follow the proper security procedures for the classification indicated.

(b) Also keep in mind that while constructing the project, if you add classified information to the project, you must then add the appropriate security classification and follow the necessary security procedures.

(3) Completing section I. To finish the screening process, you must check blocks 3 through 12 in section I (Requirement).

(a) Block 3 is self-explanatory; it contains the address of the VI facility.

(b) In block 4, make sure the requester has the complete address of the unit or activity requesting the work, and if the requesting unit has an account number assigned, ensure the requester has entered it in block 5.

(c) Blocks 6 through 9 are also self-explanatory; however, you must ensure the requester has completed them.



(d) The requester uses block 10a to describe the work he wants completed. You must make sure the description contains enough detail so anyone working on the project understands exactly what the requester expects when the VI facility completes the project. The requester's description should answer the questions what, who, when, where, and how many. If necessary, the requester can attach additional enclosures to explain and amplify the project requirements and details.

(e) In block 10b, the requester indicates the type of graphics he wants produced.

(f) Since graphic resources from the VI facility are for official use only, you also must make sure the requester has indicated the purpose and use of the graphics he is requesting in block 11 of the work order.

(g) The validation signature in block 12 of the VI order confirms the work requested is for official use. You must have a signature in this block prior to accepting the work order.

(4) Accepting the work order. Once you have determined the VI facility has the capability to complete the project requested and the requester has the visual information work order completed correctly, you accept the VI work order. To accept the VI work order, you enter the work order into the work order log, using the next available work order number, and enter the work order number in block 1 of DA Form 3903-R. This completes the screening process.

#### b. Sections Completed Within the VI Facility.

(1) You use blocks 19 through 22 in section III of the VI work order to assign the project to the individual or section that will have the responsibility of completing the project.

(a) Blocks 19 (date received), 20 (date assigned), and 21 (job approval) are self-explanatory.

(b) If there are any special instructions for the section or individual performing the work on the project, you enter them in block 22. For example, block 22 in figure 1-2 gives instructions to touch up the masters as necessary.

(2) You complete blocks 23 through 30 when completing the project.

(a) Block 23 indicates the work area of the VI facility that completed the work (more than one work area can work on a project).

(b) Block 24 indicates the work each work area performed, and blocks 25 and 26 indicate the work start and stop times for the project, respectively.

(c) You show the total workhours each work area dedicated to the project in block 27, and the work area supervisor's initials in block 28 to validate the information given.

(d) The supervisor also indicates the supplies consumed during the production of the project in block 29.

(3) Take a moment and review figure 1-2 again, paying particular attention to blocks 23 through 29. At this time you should recognize the graphics section (block 23) produced 10 VGTs (block 24), started work at 0800 and ended work at 1000 (block 25 and 26), and they spent a total of 10 hours to produce the VGTs (block 27). The section supervisor has initialed the information to show that it is correct and accurate (block 28). Additionally, the graphics section used 50 diazo foils and 10 VGT frames for this project (block 29).

(4) If, for any reason, a contract service takes part in the production of a project, you indicate this information in block 31, and the cost of the contractor's services indicated in block 32. This subcourse does not cover blocks 33 through 45 (Section VI).

c. Quality Control and Delivery. With the project and the VI work order completed, you must perform quality control checks prior to notifying the requester that the VI facility has completed the project and they can pick it up. You must ensure the VI facility has completed all work requested by the work order and the quality of the finished product meets all quality control standards for accuracy and appearance.

(1) After you have ensured the project is ready for pickup, call the requester, and inform the requester the VI facility has completed their project and they can pick it up at the VI facility. Record the date you called the requester in block 17 (Section II, Work Receipt) of the VI work order.

(2) When the requester picks up the project, he acknowledges receipt for the project by signing the VI work order in block 18a (Section II, Work Receipt) and entering the current date in block 18b.

d. Work Order Audit Trail. This completes one cycle of events for the VI work order. If you made all entries accurately, you have an audit trail for this project from the time you accepted the VI work order until the requester received the completed project. Additionally, you have the production dates, manhours expended on the project, and any supplies or contracting services used to produce the project. They all serve as justification for additional equipment and manpower. The work order also serves as an input for annual VI reports.

## 2. Construction, Design and Uses of an Effective Chart.

Almost everyone has daily exposure to charts presenting some type of data. For example, television news and weather reports continuously use charts to reinforce what the broadcasters are presenting, and the newspaper uses charts and tables to present data in a form that you can grasp quickly. As a graphics documentation specialist, you spend a large portion of your time preparing charts for briefings, displays, and training facilities.

Charts used to present data serve four important functions: (1) emphasize the main numerical facts, (2) uncover facts or data the reader may overlook in a text presentation, (3) summarize large amounts of data, and (4) add variety to text that makes the text easier to read and understand. The first two functions are the primary reasons for using charts to present data, and the third and the fourth functions are by-products of the first two.

Using charts to present data has advantages and disadvantages that you must consider when preparing them. Consider the following advantages:

- Quickness - Charts show the main feature of the data at a single glance.
- Forcefulness - Charts carry more emphasis than text.
- Compactness - Charts place a large amount of information in a small area.
- Convincing - Charts prove the point instead of merely stating it.
- Interesting - Charts are easier to look at than text.

Unfortunately, using charts to present data also has disadvantages that you must consider:

- Technical data - Some readers do not have the necessary background and experience to understand the data presented.
- Demanding - Charts prepared to present data require the illustrator to have special training to design them effectively.
- Not precise - You cannot quote most charts the same way you can quote text.
- Limitations - Not all data lends itself to presentation in charts.

When you finish a well-designed and effective chart, the advantages outweigh the disadvantages.

To design an effective chart, you must follow three basic steps: (1) select the type of chart that presents the data most favorably, (2) design the chart so it focuses the reader's attention on the emphasized data, and (3) construct the chart so the intended audience can easily read and understand it.

a. Selecting the Correct Type of Chart. To select the correct chart to present the data, you must have a thorough understanding of the data presented and the various types of charts and their strengths and weaknesses.

(1) Usually the requester indicates the type of chart he wants produced and provides all the data for the chart on the VI work order. Unfortunately, the requester may not have the knowledge and training you have in this area.

(2) After thoroughly reviewing and evaluating the information provided on the VI work order, you may have to meet with the requester to ensure you both have the same interpretation of the data presented by the chart and tactfully introduce any alternate means of presenting the data.

You must remember the selection of a chart is a subjective process and keep an open mind when discussing the selection of the type of chart with the requester. Using the combination of your skills as an illustrator and the requester's knowledge of the data presented in the chart, you can produce an informative, accurate, and attractive chart.

b. Designing and Planning the Chart. When designing a chart, the most important principle you should follow is simplicity.



There are several different tactics you use when following this principle:

- (1) Use the chart for notable facts only.
- (2) Limit each chart to one major idea.
- (3) Break up complex data into a series of simple ideas.
- (4) Omit any unnecessary scale designations, captions, rulings, and arrows.
- (5) Keep the title, captions, and labels short and concise.
- (6) Separate unrelated charts; group related charts.
- (7) When using colors on a chart, ensure they are harmonious, not too numerous, and highlight the important data in the chart.
- (8) Be careful not to use overly bright colors. If you use colors that are overly bright or you use too many colors, they become the point of interest for the reader and the data presented in the chart becomes secondary and loses its importance.

c. Constructing the Chart. When preparing a chart; you normally would use a grid proportion of 2 high by 3 wide. For example, you have chart board cut to 10" high by 15" wide for a project. The shape (grid proportion) of a chart influences the way the reader views the information presented by the chart.

For example, a short, wide chart flattens a curve and makes the change appear to occur gradually. Whereas a tall, narrow chart has the opposite affect. A tall, narrow chart makes the change appear greater or more abrupt.

(1) Selecting a scale. A chart must have a scale that presents the data in the chart accurately and the reader easily understands and applies it to the data the chart presents. Without the correct scale, the best designed chart becomes useless because the reader cannot understand what the chart presents. The chart also loses its eye appeal because it gives the appearance of a mass of uncoordinated information.

Fortunately, you can use rough drafts to determine the scale best suited for the chart you must construct. Most scales start

at the lower left-hand corner of the chart. You use the horizontal lines for the scale and the vertical and horizontal lines for plotting the data on the chart.

When selecting the scale for a chart, you must consider the range of values the chart presents. Usually, the lowest line on the chart represents zero; therefore, the height of the finished chart depends on the range of values presented. The larger the range of the values, the taller the finished chart. Other factors you must consider when selecting the proper scale is that all well-constructed charts (except percentage surface charts) have a space between the largest value plotted and the top of the chart.

Also, research has proven that people comprehend and retain even numbers quicker than odd numbers while reading. Therefore, using even numbers in the scale increases the effectiveness.

To illustrate the selection of the correct scale for a chart, consider a chart that shows the cost of operating Army installations. The chart shows the operating cost of post A as \$3,500,000, post B as \$3,250,000, and post C as \$3,000,000. The actual range of the chart is \$0 to \$4,000,000, which includes the additional space at the top of the chart.

Common sense dictates that you cannot design a chart with 4,000,000 horizontal lines, each representing one dollar. The only logical alternative you have is to design a compressed scale that fairly represents each amount on the chart. To find the best interval for the data you must chart, review the data and find the interval that fairly represents the values you must plot. For this chart, \$250,000 serves this purpose. When using \$250,000 as the major interval on the scale, you must have 17 horizontal lines (which includes the zero line):

$$\$4,000,000 \text{ (largest interval)} + 250,000 \text{ (scale interval)} = 16$$

$$16 \text{ (interval lines)} + 1 \text{ (zero line)} = 17 \text{ (lines required)}$$

You have now determined the major interval you want to use on the chart. You also must determine if the scale fits in the total area you have allotted for the chart. First, you must take away any top and bottom borders from the area. Then, divide the remaining height by the number of spaces required. If the space intervals between the horizontal scale lines are satisfactory, you can use that scale. For example, you are using a chart board that measures 15 x 20 inches. Subtract the

top and bottom margins (1 inch each) and divide the remaining space by the number of lines the scale requires:

$$15" - 2" = 13"$$

$$13" \div 17 = .76" \text{ or approximately } 3/4" \text{ between lines.}$$

You have determined you can use this scale for the chart and the chart will have approximately 3/4 of an inch between horizontal scale lines.

Now that you have determined the scale for the chart, let's take a moment and consider the horizontal lines. These lines serve two purposes: help plot the data on the chart, and help the reader assign values to the data plotted on the chart.

By creating a rough draft of the chart at this point and including the scale (\$250,000) you intend to use, you can determine if the interval between the horizontal scale lines are sufficient for the reader to assign values to the plotted data (figure 1-3(A)).

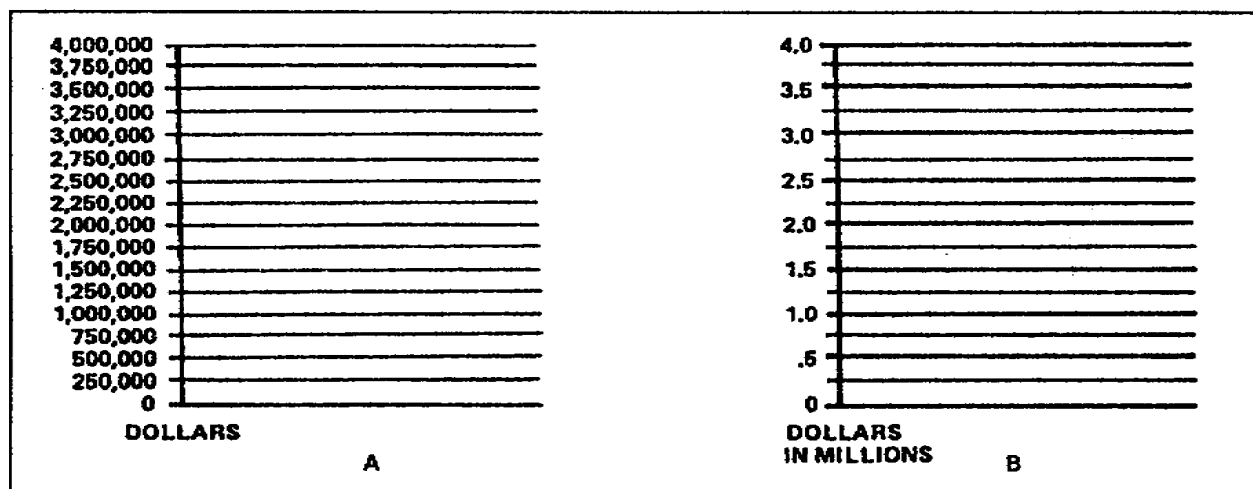


Figure 1-3. Choosing scale and line weight

After studying the draft (figure 1-3(A)) for a moment, you readily can see a \$500,000 interval stands out and reads much easier. But the chart still needs the \$250,000 interval to maintain clarity and help the reader assign values to the data plotted on the chart. To emphasize the \$500,000 interval, you would make its lines heavier than the \$250,000 interval (figure 1-3B).

Though the \$500,000 interval stands out in figure 1-3(A), all the zeros in the scale present a cluttered look, which could confuse the reader. To remedy this problem, you remove the



zeros from the scale and change the heading for the scale to read "DOLLARS IN MILLIONS" (figure 1-3(B)). As you can see, this change makes the chart's scale much easier for the reader to understand and apply; therefore, the reader can apply the values to the data plotted much quicker and easier. Another benefit of changing the chart's scale is the scale is much clearer now and does not present a cluttered, compressed look, which makes the chart more attractive and eye pleasing.

As previously stated, a chart's scale normally starts at zero. If you do not start the scale at zero, the chart does not show the entire range of the data plotted and gives the reader the wrong interpretation of the data presented. In figure 1-4, columns A and C and B and D compare the same quantities. However, when you look at the charts, the quantities in columns A and C and B and D do not appear to have the same values. Additionally, columns C and D present the proportions of two quantities compared correctly; but, since columns A and B do not start at zero and do not show the whole scale, they do not show the proportions correctly. The right-hand side of figure 1-4 illustrates the correct way to present and use a scale. This is particularly important when you must have two charts side by side and the reader must compare information from both charts.

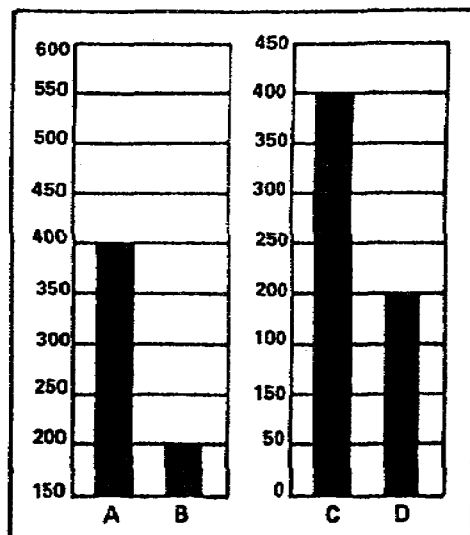


Figure 1-4. Poor selection of scale deceives the reader

Splitting the scale of the chart is another pitfall you must avoid. Sometimes you see a scale divided near the top and starting again after omitting part of the values, especially when the range of quantities shown is large or there is a large interval between quantities. You can avoid this pitfall by using a little imagination when designing the chart's scale.

Figure 1-5, columns A and B, show the adverse affect of splitting the scale. Column A appears to be about 1/2 the height of column B, which is not the desired comparison. When you examine the scale closely and do some simple math, you can determine that column A is actually 1/3 the height of column B. Columns C and D give the correct comparison of the columns because these columns use a better designed scale.

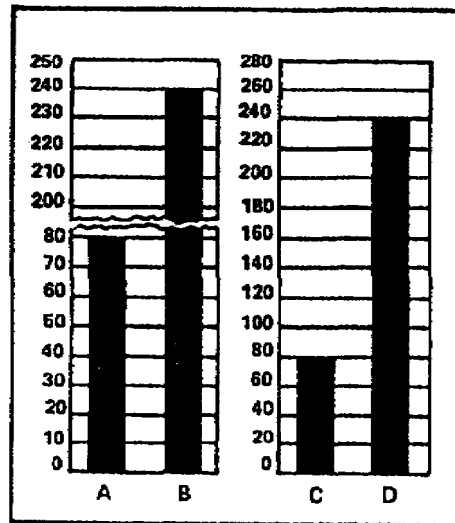


Figure 1-5. Split scales give wrong proportion of the data

The data the chart presents has a direct bearing on the scale you select. When determining the scale, you must pay particular attention to the smallest value the chart shows. There are two extremes you should avoid: choosing a scale with unrealistically small increments and choosing a scale with unrealistically large increments. A well-designed chart scale should fall somewhere between these two extremes.

For example, when a chart presents data with no quantity smaller than 100 units, then you should not use a scale with increments of 5 units. The opposite of this statement is also true. If a chart presents data with increments all below 25 units, you do not use a scale with increments of 50 units. You would find plotting the data using that scale extremely difficult.

Examine figure 1-5 again. You can see the only change made to correct the chart so columns C and D give the correct proportion was the scale. The change doubled the value of the scale's graduations. Changing the scale eliminated the need for splitting the scale, thus, the chart presented the data accurately.

You also must consider the interval between the quantities of the data you must plot on a chart when designing the chart's scale. If the quantities you must use have a small interval between them, the chart's scale also must have small intervals with a large amount of space allocated for the individual units. Again, if you use a scale that is not properly designed, the chart will not give the correct interpretation of the data. Here, using a large scale with small increments of the individual units misrepresents the data by compressing the difference between the values and creates a problem when the reader tries to assign a value to the plotted data. Additionally, you will find it difficult to plot the data on the chart using a scale designed in this manner.

For example, you must construct a chart with the following values: A equals 10 units, B equals 7 units, C equals 9 units and D equals 13 units. After reviewing the data you must plot, the best scale to use has major increments of 5, with the major increments broken into individual units of 1. Figure 1-6 used this scale and has the values plotted. Pay particular attention to the size of the individual increments of the scale. The size of the individual increments allows the reader to assign values to the data presented readily and allow you, as the illustrator, to plot the data easily.

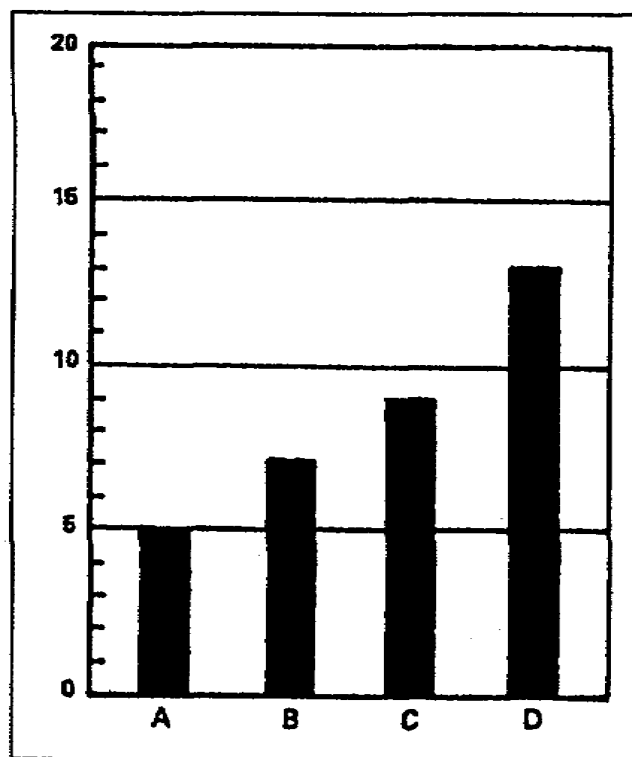


Figure 1-6. Small scale with large intervals



If the values the chart must present are large, you should use a relatively large scale with less space for each individual increment. Figure 1-7 shows units with values of 175, 225, 300, and 350 plotted, all are large values with big intervals between them. When compared with the scale used in figure 1-6, this chart's scale has large increments and a small amount of space for individual increments. As you can see, this chart presents the data fairly, and as the reader, you have no problem assigning values to the plotted data.

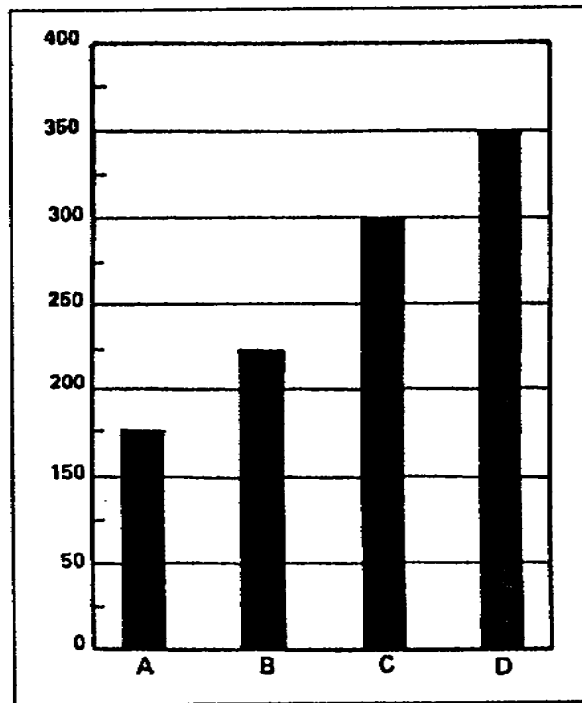


Figure 1-7. Large scale with small intervals

The charts you design and construct must present the data accurately. But you do not have to make them exact, that is no one will measure the bars of the chart before assigning a value to the data. This allows you a small amount of latitude when designing and constructing the chart. If you plan to use a scale where  $\frac{3}{4}$  of an inch represents one dollar, you would have difficulty plotting an amount such as \$175.85. You could avoid this problem by using an engineer's scale with graduations in  $\frac{1}{10}$ th of an inch or the metric system, which uses multiples of 10 as its base.

(2) Selecting a title. You should center the title at the top of the chart and use only upper-case (capital) letters. Ensure the title you select is clear and concise, tells the reader what data the chart contains, and where it applies. You should never sacrifice clarity for brevity. If you have any

doubts about the clarity of the title, you should use a longer title instead of running the risk of having a title that confuses the reader or a title the reader will not understand.

The title should encompass the subject of the chart, the coverage the data provides, and the time period. Look at the following title of a chart and apply all the necessary elements of a title.

MAJOR AIRCRAFT ACCIDENTS  
BY PHASE OF FLIGHT  
U.S. ARMY AVIATION COMMAND  
FORT RUCKER, AL  
FY86

This title shows all the necessary elements: (1) subject of the chart - major aircraft accidents, (2) cross-reference - by phase of flight, (3) the coverage - U.S. Army Aviation Command, Fort Rucker, AL, and (4) time period - FY 86.

You should not break a title in phrases that do not make any sense or are not complete thoughts. Each line of a title should represent a complete thought. If each line of a title is not a complete thought, the title often confuses the reader. Consider using the following as the title for a chart:

MAJOR AIRCRAFT  
ACCIDENTS BY PHASE  
OF FLIGHT

Now compare this title with the title in the preceding paragraph. Each line of the proposed title (above) does not provide a complete thought and often confuses the reader. The other title gives a complete thought in each line and helps the reader understand what data the chart contains. The proposed title is an example of how a title improperly phrased can confuse the reader.

NOTE: This lesson continues its discussion of selection, planning and design, and construction of charts as they apply to the different types of charts as it presents them.

d. Drawing Tools for Charts. When preparing a chart, you use many basic drawing tools, such as a T square, scale ruler, triangles, etc. You use the basic drawing equipment and materials in the production of charts to present data (figure 1-8). Before beginning any project, you must ensure that your tools are clean so they will not leave smudges and ruin the project.

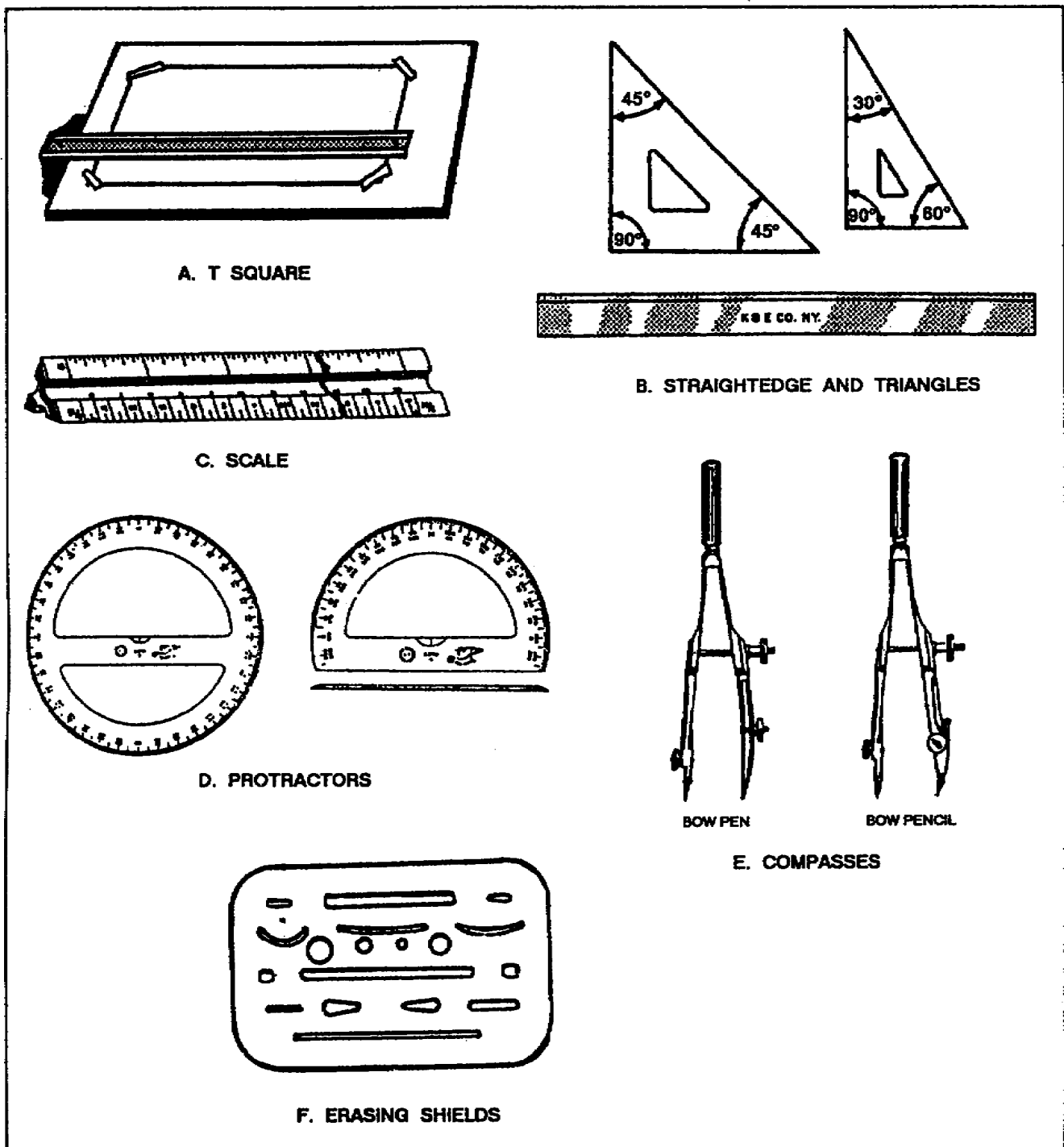


Figure 1-8. Basic drawing tools

(1) T square (figure 1-8(A)). Use the T square to draw horizontal lines on the drawing surface. It also serves as the base for the triangles used to draw vertical lines on the drawing surface. When using the T square, you must ensure the shaft attaches to the head firmly (does not wiggle) and the head is

parallel and in contact with the edge of the drawing table to ensure consistent horizontal lines.

(2) Straightedges and triangles (figure 1-8(B)). You use straightedges and triangles to draw straight lines between two points on the drawing with no change in direction between the two points. You use both straightedges and triangles and they are made of either plastic or wood and come in various sizes. Occasionally, you use a straightedge as a cutting guide when cutting thick illustration board. Never use a plastic straightedge as a cutting guide. You can damage the edge of the straightedge and it will no longer create flawless lines.

You use the triangles to draw vertical lines on the drawing surface by resting the base of the triangle on the T square. You also can use the triangle to draw  $45^\circ$  and  $60^\circ$  angles or put the two triangles together to make increments of  $15^\circ$ .

(3) Rulers and scales (figure 1-8(C)). Rulers and scales provide a means of measuring different distances on the drawing surface. They have different graduations for different applications such as engineering, technical drawing, or drafting. Their intended use determines the graduation scale, 32nd, 16th, and 10th of an inch, or they could measure metrics and have graduations in millimeters, centimeters, or decimeters. Usually you find scales shaped triangularly and rulers flat. You should never use a scale as a cutting guide.

(4) Protractors (figure 1-8(D)). You see round, half-round, or square protractors used to draw graphics. No matter what shape they have, they all have degrees marked on them. You can use protractors to measure and create simple azimuths or angles, construct pie charts, etc.

(5) Compasses (figure 1-8(E)). When creating a graphic, you use a compass to draw arcs and circles. A compass has a handle in the center, a metal point at one end, and either a pencil or pen at the other. When using the compass to draw a circle or arc, place the metal point at the center of the arc or circle, slightly lean the compass in the direction you are drawing, and pull the compass to draw the arc or circle.

(6) Erasing shields (figure 1-8(F)). Erasing shields, made from stainless steel, have patterns cut in them. You use the erasing shield to localize the mistake so you do not remove any of the good area. Place the cut-out pattern that most closely resembles the area to be erased so you can only see the mistake in the pattern; then erase your mistake.





(7) Templates (figure 1-9). Templates are plastic sheets with various forms cut to form a guide for tracing. There are many templates available for use and are tremendous time savers since all you have to do is trace the shape you desire.

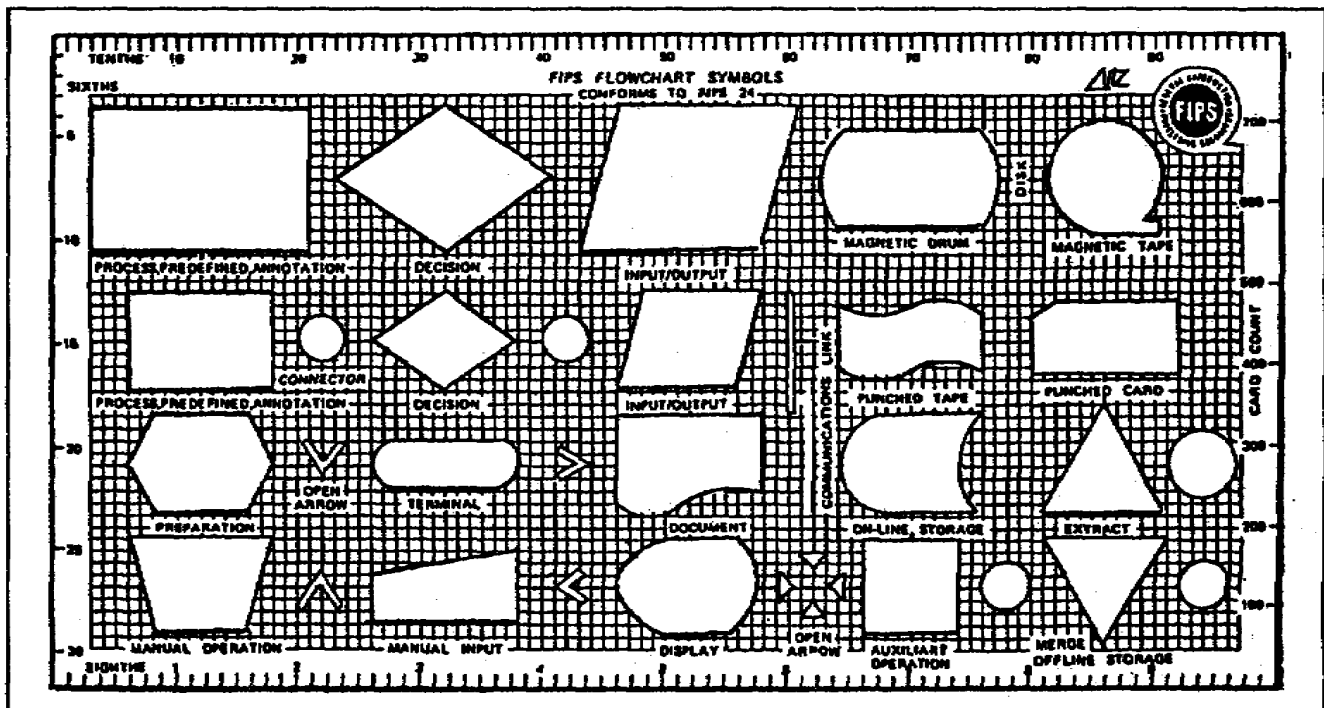


Figure 1-9. Standard flow chart symbol template

### 3. Construction of Various Types of Charts.

a. Bar Charts. Generally, charts show the relationship between several items. There are two types of bar charts. A vertical bar or column chart uses vertical bars or columns to represent the data on the chart, and a horizontal bar chart uses horizontal bars or columns to represent the data on the chart.

(1) Vertical bar or column chart. Generally, you use vertical bar or column charts to compare data for a given item at the same or different times. For example, it could compare the procurements for the month of January or an inventory for 30 June.

A simple column chart has vertical bars extending from the base or zero line to a plotted point. The appearance of the chart is important because a well-designed and constructed chart attracts and holds the reader's attention.

Figure 1-10 shows a poorly-constructed column chart. The chart's title is not properly placed and does not reflect the data contained in the chart; the scale does not have a label. In addition, the designer did not arrange the columns correctly or use a scale that allowed the columns to end near the top of the chart. When arranging the columns, you should arrange them in ascending or descending order, whichever emphasizes the data on the chart. The columns should end near the top of the chart to give the appearance of full quantity. However, the term "near the top" means exactly what it says. You must leave a space between the largest column and the top of the chart.

Figure 1-11 shows a well-constructed column chart. The title reflects the data contained in the chart and the designer has correctly positioned it. The scale has a label that enables the reader to apply values to the data in the chart, the columns have the correct arrangement, in a descending order, and the largest columns ends near but not at the top of the chart.

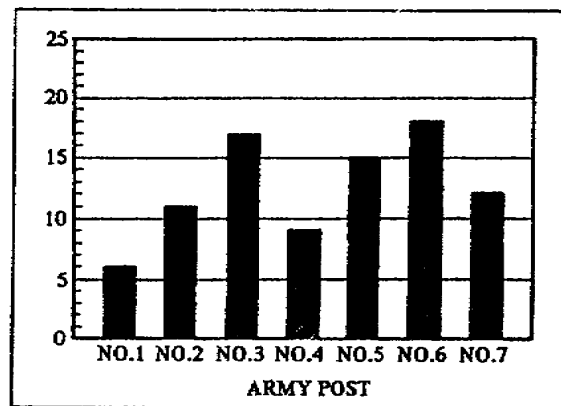


Figure 1-10. Poorly-constructed column chart

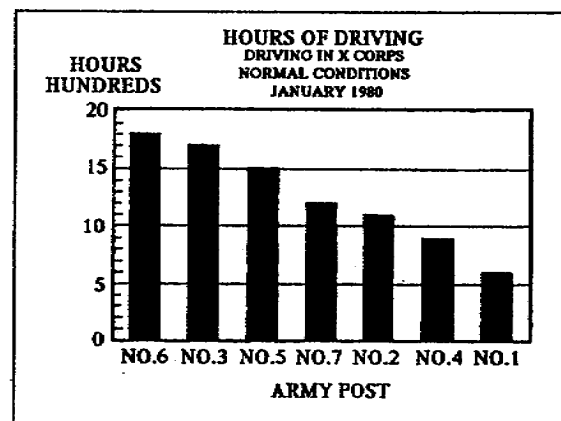


Figure 1-11. Well-constructed column chart

(a) Plotting data on vertical bar or column charts. Prior to drawing the chart, you must select the size of the paper and the proper scale (as discussed earlier in this part of the lesson). The size of the chart determines the size of the paper you must use. The chart should fill the entire work piece proportionally, including space for margins, explanatory notes, and the legend.

When you have determined the size of the paper and scale, you can begin constructing the chart using a nonreproducible blue pencil. When constructing this type of chart, there are two lines that serve as the base of the chart, the Y-axis (vertical line) and the X-axis (horizontal line) (figure 1-12).

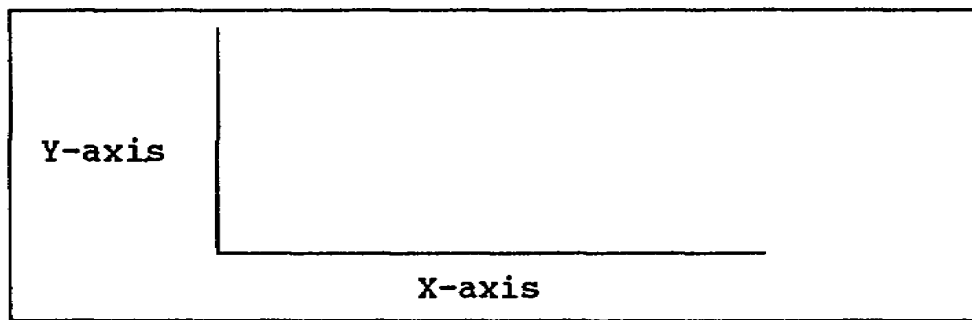


Figure 1-12. X- and Y-axis

To illustrate the steps required to construct a vertical bar or column chart, this portion of the lesson describes the steps required to complete the chart in figure 1-13. This chart shows the base pay of an E-4 with 5 years of service. This chart also shows the base pay every 3 years from October 1, 1958 through October 1, 1970, using the following data:

1958 -	170.00
1961 -	170.00
1964 -	210.00
1967 -	254.00
1970 -	330.00

A column chart uses the X-axis for the data or time element. Reviewing the data given above, you find you must plot 9 years or columns on this axis. You start by marking the required spaces and the columns on the X-axis, except for the front and back space. These spaces equal  $\frac{2}{3}$  of the width of a column (figure 1-14).

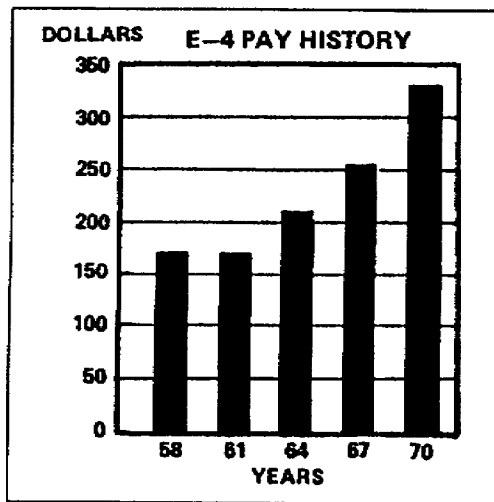


Figure 1-13. E-4 pay history column chart

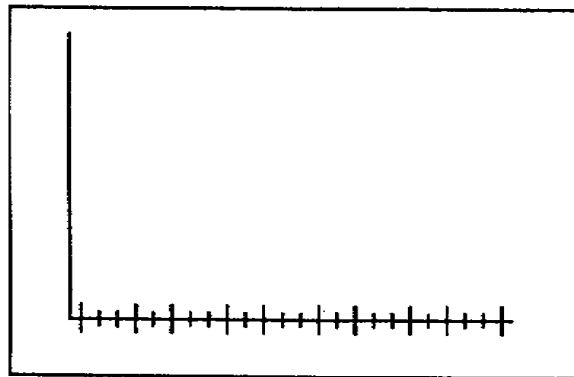


Figure 1-14. Plotting on the X-axis

When constructing a vertical bar or column chart, the space between the columns is  $\frac{2}{3}$  the width of a column. For this chart, you must mark off 23 equal spaces with  $\frac{2}{3}$  of the width of a column before the first mark and an equal space after the last mark. To ensure the correct spacing, you should use a scale to mark off the 23 equal spaces.

Twenty three equal spaces may seem like an excess number of space for a 9-year period. However, you must consider the 2 to 3 ratio for the width of the columns and to the spaces; A single column requires three spaces and a distance between two columns requires two spaces to maintain the 2 to 3 ratio. Therefore, you can determine the number of columns using simple mathematics.

First you find the number of spaces the columns require by multiplying the number of columns by three ( $5 \times 3$ ), then multiplying the number of spaces between the columns by two ( $4 \times 2$ ), and adding the figures together ( $15 + 8 = 23$ ):

The number of spaces the columns require:	$5 \times 3 = 15$
The number of spaces between the columns:	$4 \times 2 = \underline{8}$
The total number of equal spaces required for the chart:	. . . . . 23

You use the Y-axis for the chart's scale (discussed earlier in this part of the lesson). Again, use a scale to mark off the required number of increments for the scale. The best scale for this chart is from 0 to 350, presented in increments of 50, and labeled dollars. The scale for this chart requires seven equal increments (remember to maintain a  $2 \times 3$  for the chart) (figure 1-15).

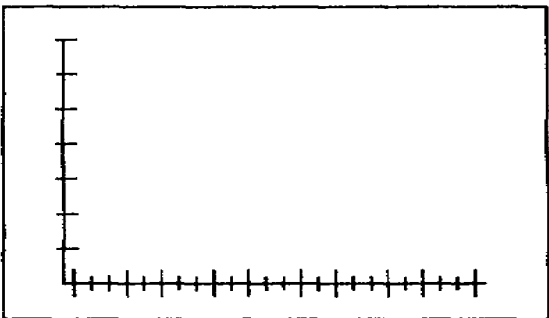


Figure 1-15. Plotting on the Y-axis

With the spaces marked on both the X- and Y-axis, and having ensured the chart is proportional, you finish enclosing the chart and lightly drawing the scale lines (figure 1-16).

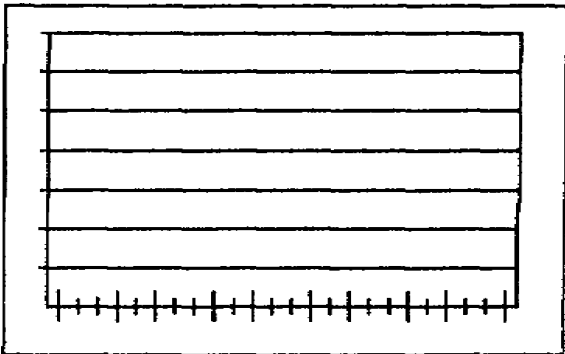


Figure 1-16. Enclosed chart

After you have drawn the scale lines and enclosed the chart, you plot the data on the chart. When you plot columns on the chart, you do not have to make them 100% accurate, they are approximations. Therefore, you round off the values they represent to the nearest whole number. Round off to the nearest dollar for the chart in this lesson. If you want the columns to show 100% accuracy, label each column at the top.

Using the chart's scale, mark the height of the value of the first column, draw a vertical line from the first mark on the X-axis to the height mark, and complete the column by using three spaces on the X-axis. Skip two spaces and mark the height of the next column. Plot the remaining values using the same process. Remember, the distance between columns is two spaces and each column uses three spaces (2 to 3 ratio) (figure 1-17).

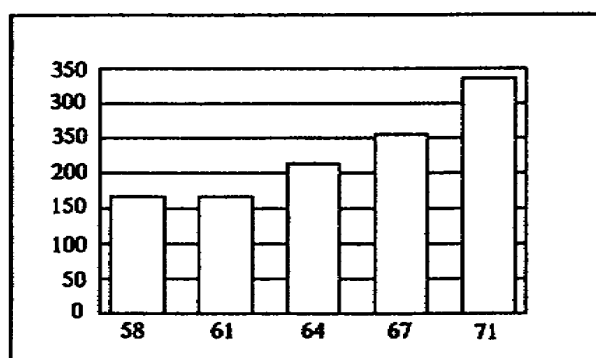


Figure 1-17. Plotting data

After you checked the chart for accuracy and appearance, you can ink the chart. Make the lines forming the outer edges of the chart and the bars thicker than the horizontal scale lines. When inking the chart remember the horizontal scale lines do not pass through the columns or bars.

To add to the visual appearance of the chart and help the reader establish the value of the columns, add pattern tapes, opaque tape, or zip-a-tone patterns. Opaque tapes are available in many colors. The pattern tapes come in regular or irregular hatchmarks or designs. They are helpful in creating a two-dimensional texture on the chart (figure 1-18).

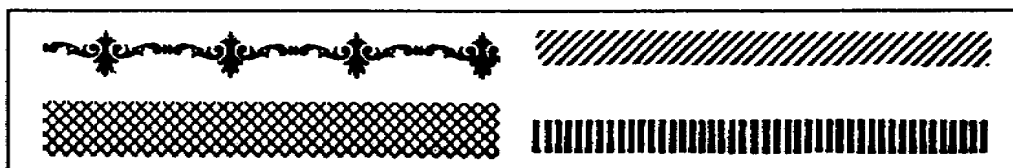


Figure 1-18. Pattern tape

Zip-a-tone patterns are available in sheets covered with different patterns, dots, and lines for solid colors. You add the sheets to the columns to give them different tones (figure 1-19).

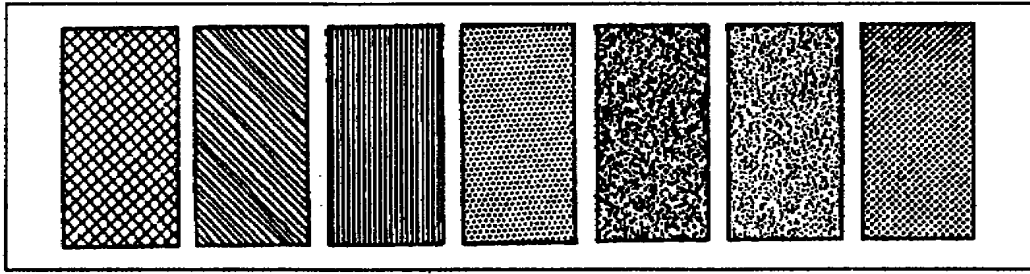


Figure 1-19. Zip-a-tone

The chart is now ready for the lettering. Draw the necessary guidelines and apply the lettering using any of the mechanical methods (Leroy or Wilco lettering sets), or prepared, pressure sensitive letters.

To present data the reader can readily comprehend and assign values to, you could combine the chart with a table and split or use segmented columns to indicate what part of the total they comprise. (We discuss the construction of a table later in this lesson.)

(b) Split bar chart (figure 1-20). A split bar chart uses a bar or column to represent each element of a total presented. For uniformity and ease in locating data on the chart, arrange the columns for each data entry in the same order, even if you do not have an ascending or descending effect. A split bar chart has a legend at the top right corner identifying what each bar represents. For balance, make the largest column of each data entry the lightest, and the tone or colors darker for each smaller bar. The disadvantage for this type of chart is the large numbers of columns needed to present the data. However, it has the advantage of allowing the reader to compare the elements of each total to one another.

(c) Column or bar chart with segmented columns (figure 1-21). This type of chart uses only one column to present the data. However, the column for each element of the data plotted shows the size of elements that make up the total. When using this type of chart, you should present the elements in the descending order, beginning with the largest at the bottom of the column, keeping the order the same throughout the chart. For balance, make the larger area at the bottom of the chart the darkest, and the tone or colors lighter as they approach the top of the bar.



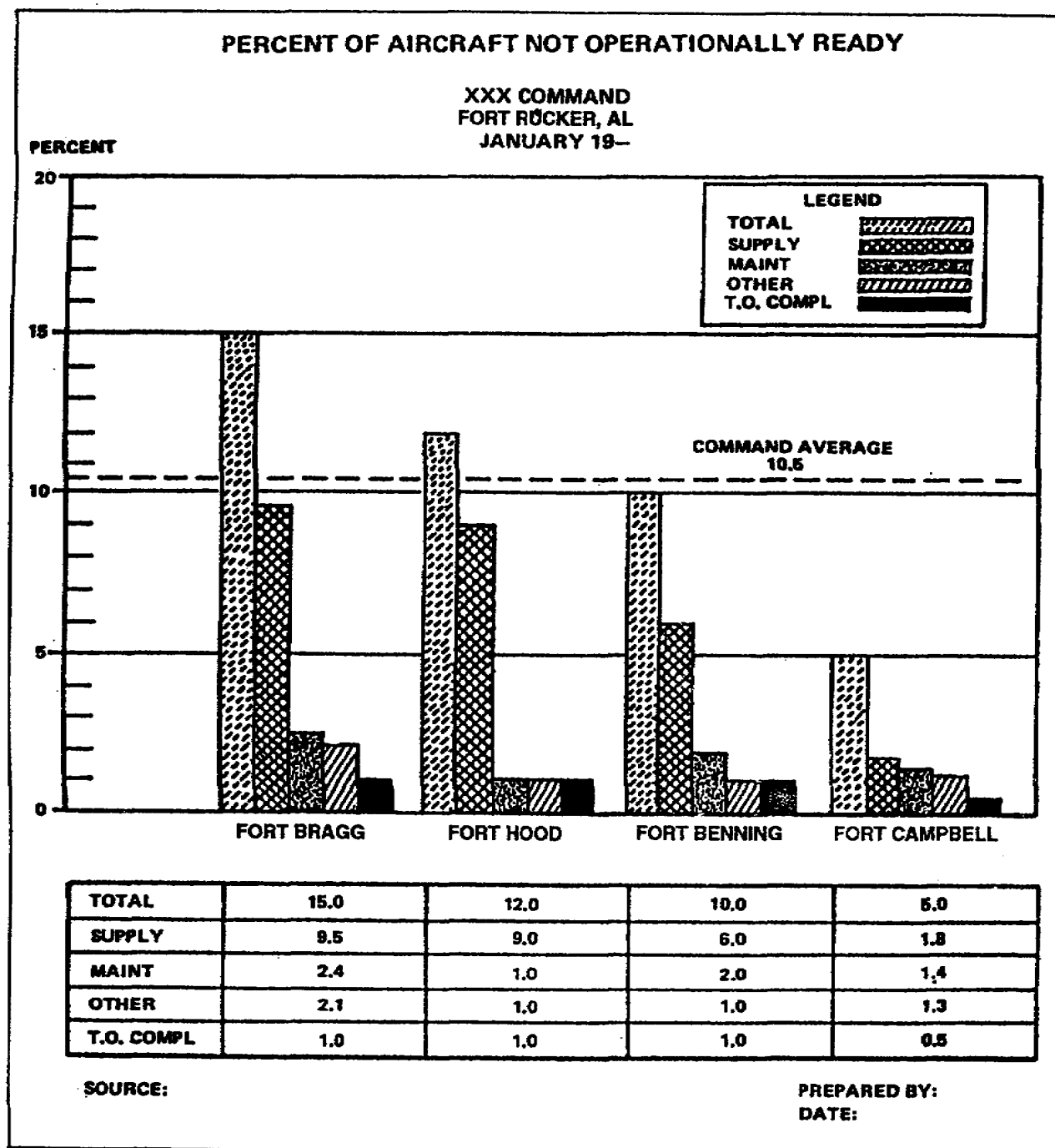


Figure 1-20. Split bar chart

(d) Percentage bar chart (figure 1-22). This type of chart shows percentages, with each bar representing 100%. Each bar has a segment showing what part (percentage) of the whole it comprises. Use the same criteria for arranging the elements and applying tones and colors to columns of this chart as you used with a segmented column chart.

XXX COMMAND  
FORT RUCKER, AL  
JANUARY 19-



**PREPARED BY:**  
**DATE:**

(2) Horizontal bar chart. The other type of bar chart you use is a horizontal bar chart. You would use the horizontal bar chart to compare data for different items during the same time period.

The primary difference between a vertical column chart and a horizontal bar chart is the use of the X- and Y-axis. The bar chart uses the Y-axis for the data or time element and the X-axis for the scale. With this type of chart, you can place the scale at the top or the bottom of the chart.

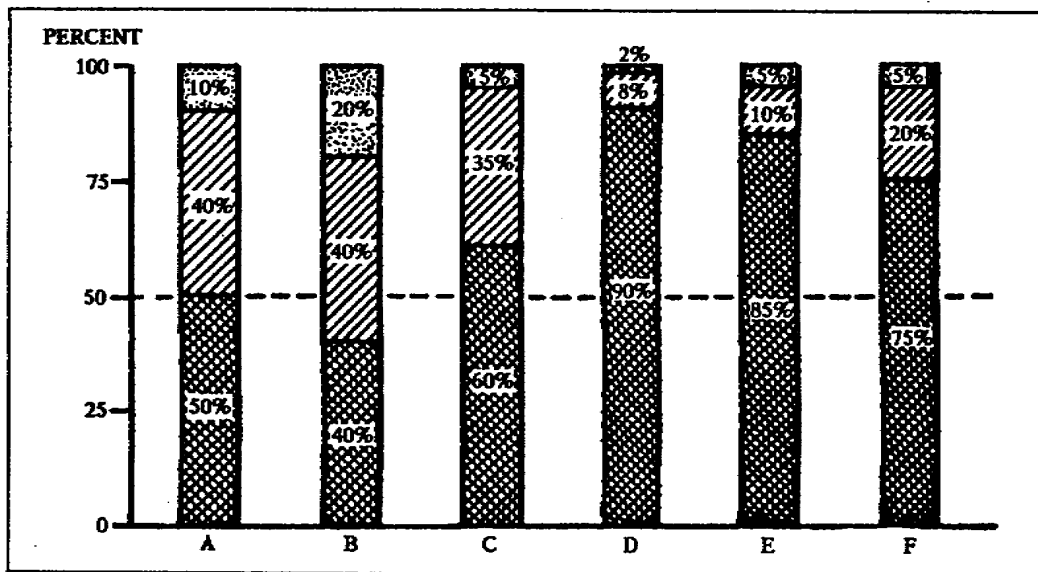


Figure 1-22. Percentage bar chart

When constructing a bar, the space between the columns is  $\frac{2}{3}$  the width of a column, the same spacing as a vertical column chart. You use the same criteria the lesson discussed earlier to select the scale and title. To construct a bar, you use the same procedure used to construct a vertical column chart; however, you must remember to use the X-axis for the scale and the Y-axis for the data, maintaining a 2 to 3 ratio for the chart.

You can also combine this type of chart with a table to help the reader understand the data presented. Figure 1-23 shows a descriptive bar chart comparing the percentage of aircraft not operationally ready (same data as in figure 1-21).

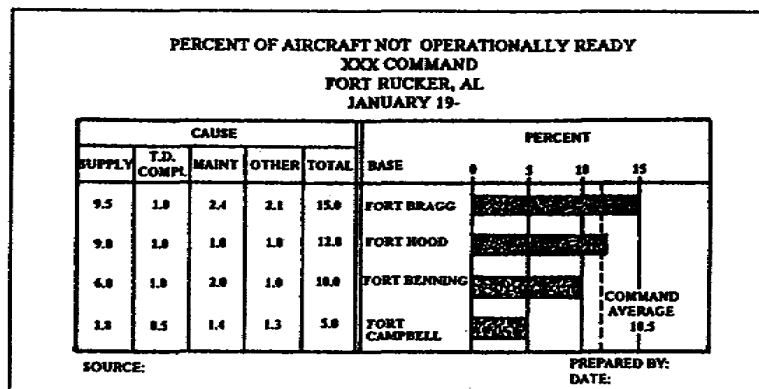


Figure 1-23. Descriptive bar chart

b. Curve or Line Charts. This chart provides a way to present cumulative or noncumulative events that occur over a period of time (time series). Since the person viewing the chart can readily follow a line, the line creates the impression of moving through time and magnitude with the data. For example, you could use this type of chart to show the number of hours spent performing operator maintenance each month. You can design a line chart to show more than one variable, an average, or desired rate line.

When designing a curve or line chart, use the same process you used for a column chart when selecting the scale, title, and chart construction. A completed curve or line chart presents a grid system for plotting the data with the vertical and horizontal line drawn.

When plotting data on a curve or line chart, you plot single points only. The point is the intersection of the data and scale lines when you connect the points using the method desired for the chart. After you have plotted and connected the points, you ink and letter the chart using the same process used for a column chart.

There are several types of curve or line charts: broken curve, smooth curve, and step curve.

(1) Broken curve or line chart. This type of chart presents noncumulative quantities at a given time. This means the values plotted represent the total at a specific time. Even though a straight line connects the points on the chart, you cannot assign any intermediate values from this line. The line shows direction or trend, and it does not assign any values. When using this type of chart, you must take the data from the same day each month. Otherwise, the chart will not present an accurate picture of the totals.

For example, figure 1-24 shows a broken curve chart that presents data showing that 50 people graduated from the on-the-job training program in July, and 60 people graduated from the on-the-job training program in August. Someplace between the plotted points for the two months the line crosses the 55 quantity line. However, that does not mean you can conclude that at that point in time 55 people graduated from the program.

(2) Cumulative (smooth) curve or line chart. When using this type of chart to present data, the reader can assign intermediate values from the running, smooth curve. This type of curve or line is an effective way of presenting the growth or decline of an activity. When you use this chart with a projected curve or line, plotting the actual data shows trend,



which is useful when comparing the desired activity and the actual activity.

Figure 1-25 shows a cumulative curve chart. The first point plotted is the number of graduates (50) in June. The second point plotted is the total number of graduates (100) in July, which represents the total graduates in June (50) and July (50). Each of the remaining points are cumulative totals of graduates. From this chart you can assign intermediate values. That is if the graduation takes place on almost a daily basis, you can go to the point on the curve that represents the date and the scale line that the curve crosses is the number of graduates (total) to that date.

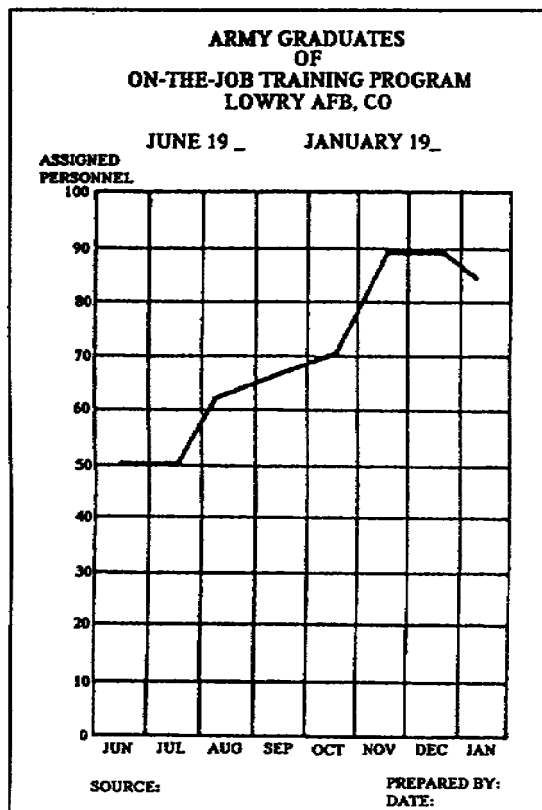


Figure 1-24. Broken curve chart

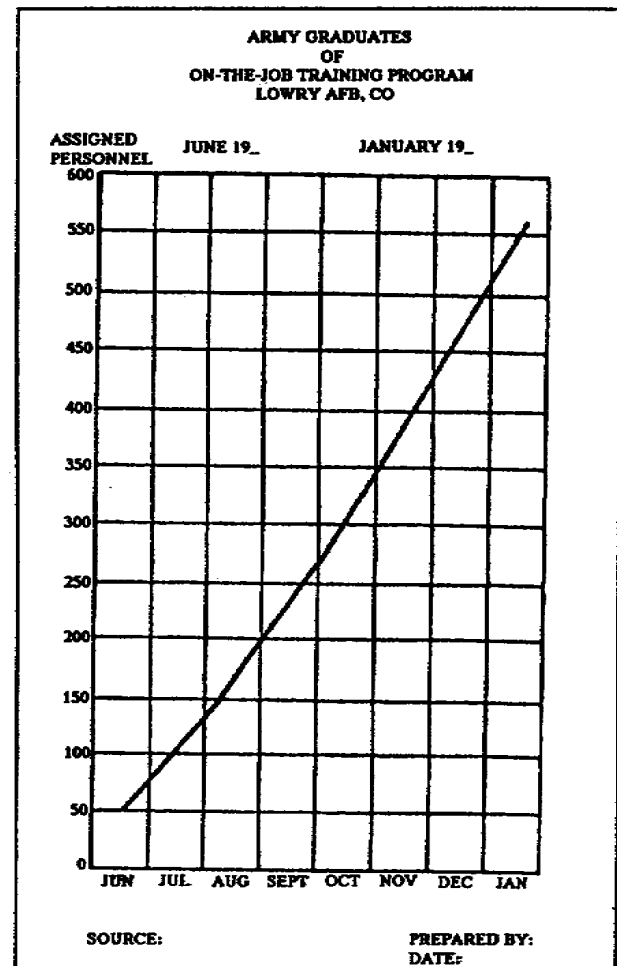


Figure 1-25. Cumulative data line chart

You also can use a cumulative line chart to present consumption of items by plotting two lines on the chart. To do this, you would plot the desired consumption for the time period, and then plot the actual consumption of the item. At a glance the reader



can determine the trend taking place with the item. This type of chart emphasizes the written text or oral presentation because the reader can see the trend visually on the chart. When constructing this type of chart, you must label each line in a way that does not confuse the reader.

Figure 1-26 shows a consumption chart for the fuel used by a motor pool. The funds allotted for fuel bought 300,000 gallons. Because of the need for snow removal and heavy use of equipment during wintertime, the ideal rate of fuel consumption is high for winter months and low for the summer months. The ideal rate is the goal achieved by the motor pool consuming less than 300,000 gallons of fuel. At the end of each month, you add total gallons used to the previous cumulative total and plot it on the chart. You can tell by just looking at the chart if the motor pool has consumed more fuel than allotted for the time period. If the manager does not establish economy measures, the motor pool will not have enough fuel to make it through the end of the time period.

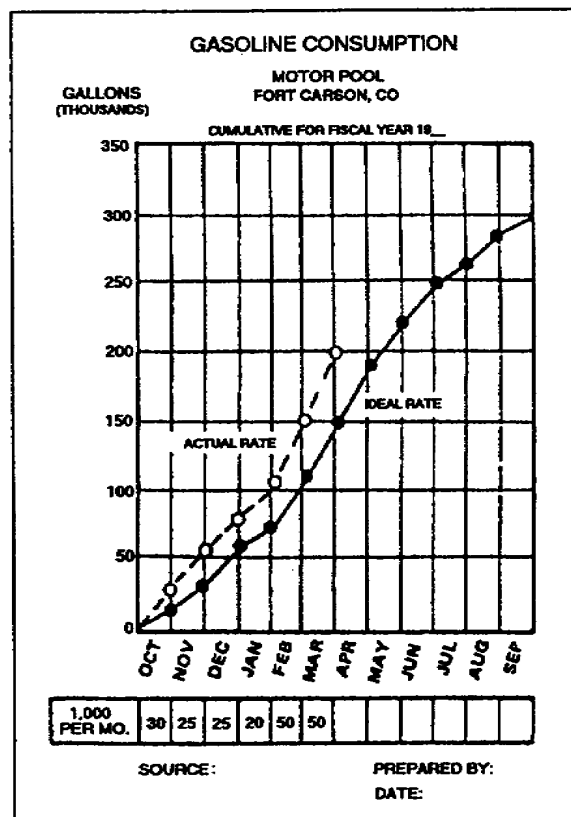


Figure 1-26. Consumption curve chart

You can also use the cumulative line to present two or more variables of data on the same subject. Figure 1-27 shows the



number of students in training, broken into three groups: total in training, total in OJT, and total in formal school.

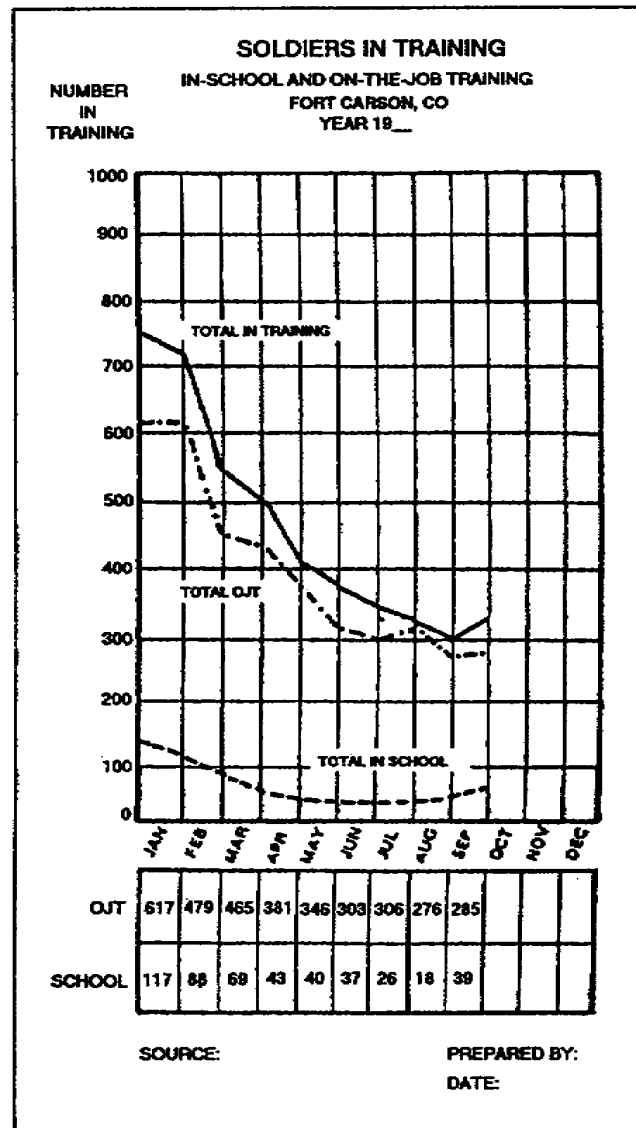


Figure 1-27. Three variable curve chart

(3) Step curve chart (figure 1-28): When the data has abrupt changes, you would use this type of curve chart to present it. However, there are two disadvantages to using this type of chart. The abrupt change in the line causes it to lose the trend or feeling of movement through time. The second disadvantage is when plotting two or more lines on the same chart, they may cross or fall on the same vertical or horizontal grid. This often confuses the reader and the chart loses its effectiveness. When using this Chart to present data, you must ensure that the reader can readily understand and evaluate the data the chart presents.

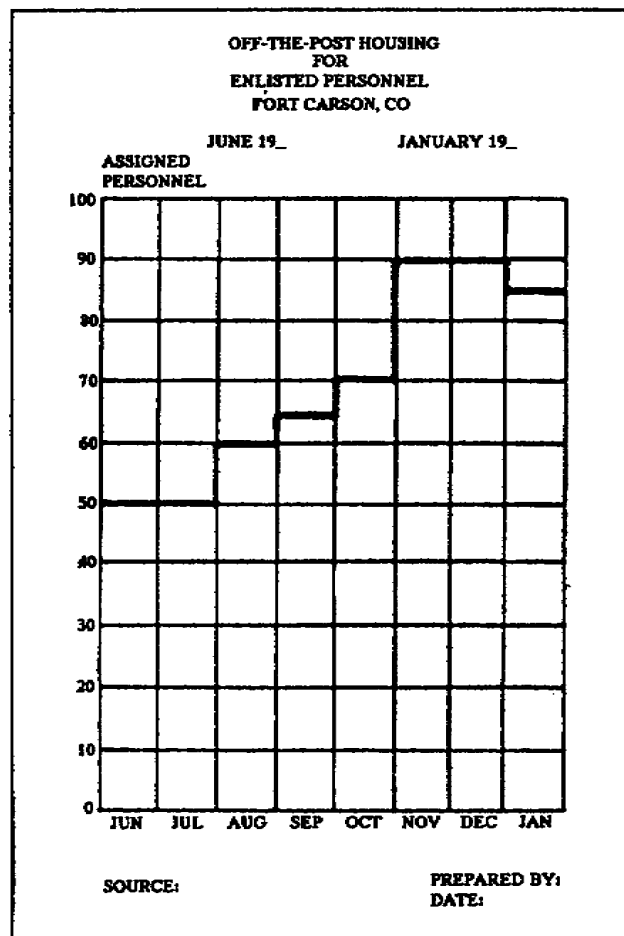


Figure 1-28. Step curve chart

c. Pie Charts. The best comparisons to make with this type of chart is the parts to the whole or the parts of the whole to each other. When preparing a pie chart, you must exercise extreme care not to make the chart so complicated that the reader cannot interpret it at a short glance.

(1) Use of pie charts. The human eye has difficulty making two- and three-dimensional comparisons. Because of this difficulty, you should not make a comparison of sizes using circles. Bar charts make this type of comparison best.

(a) Perception of pie chart (figure 1-29, part A). Figure 1-29 shows the difficulty the human eye has in making a comparison using circles by comparing circles. In part A of figure 1-29, the circle representing \$1,000 has a diameter twice the size of the diameter in the \$500 circle. However, to the human eye, the \$1,000 circle appears much larger than twice the size of the \$500 circle. Here the human eye is correct because the area of the circle representing \$1,000 is four times the area of the \$500 circle.

(b) Perception of pie chart (figure 1-29, part B). In part B of figure 1-29, the area of the circle representing \$1,000 is exactly twice as large as the area of the \$500 circle. Though you know the area of the circle representing \$1,000 is exactly twice as much as the area of the \$500 circle, the human eye again sees it as much larger. In both cases, the human eye does not perceive the comparison correctly. For this reason, you should not make comparisons using circles.

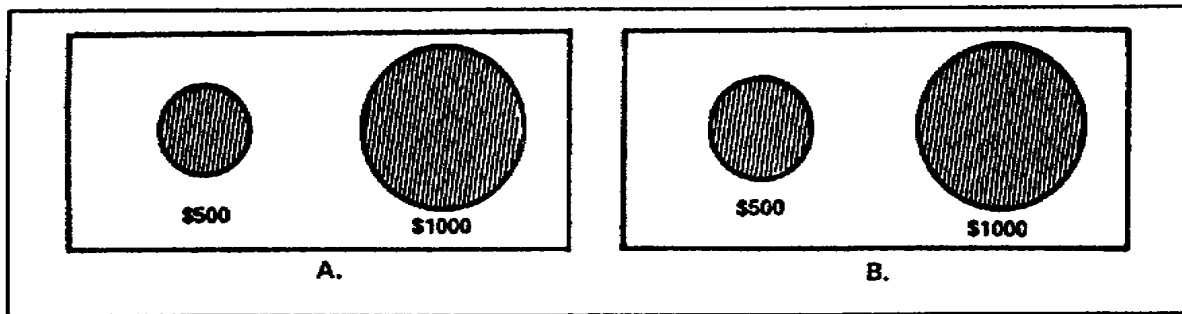


Figure 1-29. Pie chart comparing sizes

(c) Effective pie charts. For a pie chart to have maximum effectiveness, it should stand alone and represent 100% of the compared item. If you must use two or more pie charts on the same presentation, make the pie charts the same size and ensure each represents 100% of the quantity they compare.

(2) Plotting a pie chart. When plotting a pie chart, you need a compass, protractor, and a straight edge. A pie chart begins as a plain circle with a radius drawn from the 12 o'clock position to the center of the circle. You plot the segments of a pie chart beginning at the 12 o'clock position and moving clockwise plotting the largest segment and ending with the smallest segment. From each point plotted, you draw a radius to the center of the circle. If you add colors to the segments, add the colors from lightest to darkest moving clockwise (figure 1-30).

(a) Determining segment sizes. Before you can plot the segments of the pie chart, you must determine the size (the percentage of whole) each segment represents. For this lesson, you will construct a pie chart comparing budget expenditures. The total budget is \$2,000, and of this amount, \$150 is miscellaneous expenses; \$300 is utilities expenses; \$400 is transportation expenses; \$500 is food expenses; and \$650 is housing expenses.

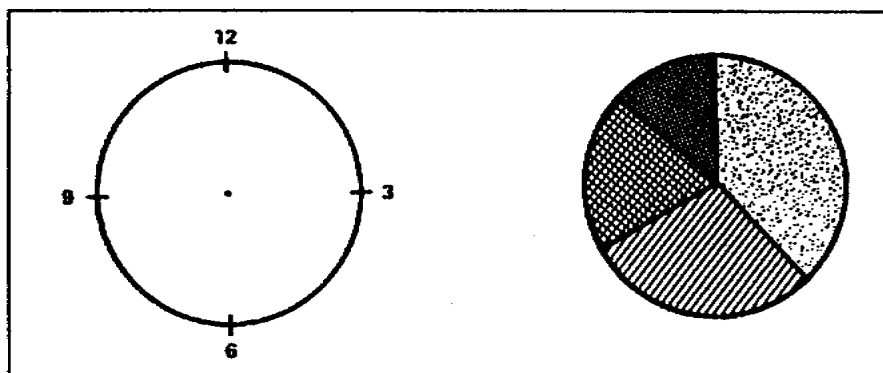


Figure 1-30. Pie chart segments and clock positions

To determine the size of each segment, you must calculate the percentage of the total budget each segment represents. To do this, you divide the amount of the budget expenditure each segment represents (miscellaneous, utilities, transportation, food, and housing) by the total budget amount (\$2,000):

$$\begin{array}{rcl}
 \$150 \div \$2,000 & = & 7.5\% \text{ (miscellaneous)} \\
 \$300 \div \$2,000 & = & 15.0\% \text{ (utilities)} \\
 \$400 \div \$2,000 & = & 20.0\% \text{ (transportation)} \\
 \$500 \div \$2,000 & = & 25.0\% \text{ (food)} \\
 \$400 \div \$2,000 & = & 32.5\% \text{ (housing)} \\
 \hline
 \$2,000 & = & 100.0\% \text{ of the pie chart}
 \end{array}$$

(b) Plotting segments with a percentage protractor. At this point, you have all the information you need to plot the segments on the circle using a percentage protractor. When you use a percentage protractor, you plot the percentage each segment represents. Most percentage protractors have 1/2 percent graduations (figure 1-31).

Since a pie chart starts at the 12 o'clock position, place the "0" graduation there (which places the 50% graduation at the 6 o'clock position). The largest segment of the pie chart is 32.5%, so it is the first segment you plot. You move clockwise from the "0" percent graduation to the 32.5% graduation and plot that point on the circle. Once you plot this section, you plot the remaining segments, largest to smallest, clockwise. When you have plotted all the segments, you draw a radius from each point to the center of the circle.

The first (largest) segment of the pie chart ends at 32.5% graduation; therefore, 32.5% serves as the starting point of the next segment. The next segment you must plot presents 25% of the pie chart. To find the ending point of this segment, you add the starting point of the last segment to the percentage of

the segment. In this case, you add 32.5% and 25%, which equals 57.5%. Continue plotting using the same procedure:

$32.5\% + 25.0\% = 57.5\%$  (the end of the second segment)  
 $57.5\% + 20.0\% = 77.5\%$  (the end of the third segment)  
 $77.5\% + 15.0\% = 92.5\%$  (the end of the fourth segment)  
 $92.5\% + 7.5\% = 100.0\%$  (the end of the fifth segment)

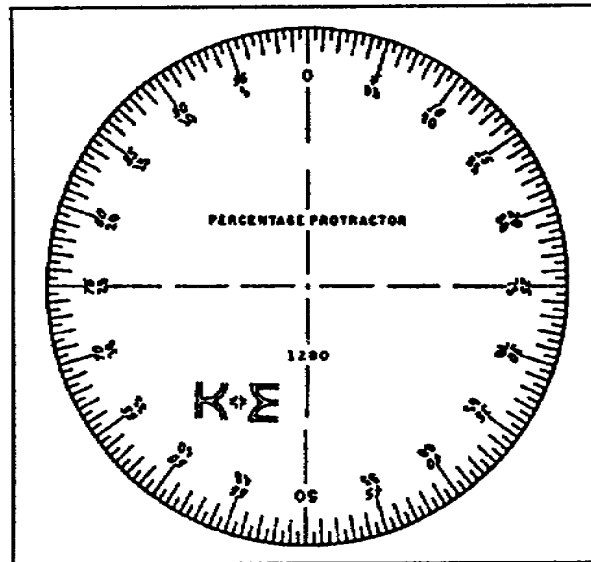


Figure 1-31. Percentage protractor

Before proceeding with the lesson, take a moment and review the plotting procedure used with a percentage protractor. You placed the "0" percent graduation at the 12 o'clock position (which placed the 50% graduation at the 6 o'clock position). You plotted the largest segment first, moving clockwise. The end of the first segment served as the start for the second segment and so on. You plot the segments largest to smallest moving clockwise. The proof that you plotted correctly was that the last or smallest segment ended at the "0" percent graduation. You used 100% of the circle in your pie chart. If the last segment did not end at the "0" percent graduation, you made a mistake, and you must recheck your work.

(c) Plotting segments with a standard protractor. To plot the segments using a standard protractor, you must determine the number of degrees each segment uses. Before you can determine the number of degrees each segment uses, you must determine how many degrees of the circle makeup 1% of the circle. If you divide the total number of degrees in a circle

(360) by 100% (total comparison, you can determine how many degrees of the circle makeup 1 percent:

$$360^{\circ} \div 100\% = 3.6 \text{ degrees in 1 percent.}$$

At this point, you know that 3.6 degrees of the circle equals 1 percent, and you know the percentage each segment represents. With this information, you can determine the number of degrees each segment uses by multiplying each segment's percentage by 3.6 (the number degrees in 1%):

<b>7.5%</b>	<b>x 3.6</b>	<b>=</b>	<b>27.0 degrees</b>	<b>(miscellaneous)</b>
<b>15.0%</b>	<b>x 3.6</b>	<b>=</b>	<b>54.0 degrees</b>	<b>(utilities)</b>
<b>20.0%</b>	<b>x 3.6</b>	<b>=</b>	<b>72.0 degrees</b>	<b>(transportation)</b>
<b>25.0%</b>	<b>x 3.6</b>	<b>=</b>	<b>90.0 degrees</b>	<b>(food)</b>
<b>32.5%</b>	<b>x 3.6</b>	<b>=</b>	<b>117.0 degrees</b>	<b>(housing)</b>
<b>100.0%</b>		<b>=</b>	<b>360.0 degrees</b>	<b>(the total circle)</b>

To plot the segments using a standard protractor (figure 1-32), place the "0" graduation at the 12 o'clock position (this places the 180 graduation at the 6 o'clock position). The largest segment of the pie chart is 1170; therefore, it is the first segment you plot, moving clockwise from the "0" percent graduation and marking that point on the circle.

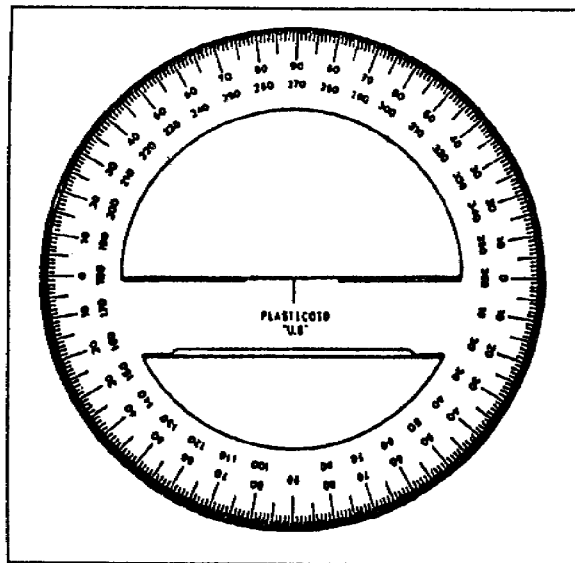


Figure 1-32. Standard protractor

The first (largest) segment of the pie chart ends at 117°; therefore, 117° is the starting point of the next segment. The next segment you must plot uses 90° of the pie chart. To find the ending point of this segment you add the starting point of the



segment to number of degrees the segment uses. You must add  $117^\circ$  and  $90^\circ$ , which equals  $207^\circ$ . Continue plotting using the same procedure:

$$117^\circ + 90^\circ = 207^\circ \text{ (the end of the second segment)}$$

$$207^\circ + 72^\circ = 279^\circ \text{ (the end of the third segment)}$$

$$279^\circ + 54^\circ = 333^\circ \text{ (the end of the fourth segment)}$$

$$333^\circ + 27^\circ = 360^\circ \text{ (the end of the fifth segment)}$$

When you have plotted all the segments, draw a radius from each point to the center of the circle.

Take a moment and review the plotting procedure used with a standard protractor. You placed the "0" graduation at the 12 o'clock position (which placed the 180 graduation at the 6 o'clock position). You plotted the largest segment first, moving clockwise. The end of the first segment served as the start for the second segment and so on. You plotted the segments largest to smallest moving clockwise. You used all of the circle's 360 degrees for your pie chart. If the last segment did not end at the "0" graduation, then you made a mistake and you must recheck your work.

(3) Lettering the pie chart. With all the segments of the pie chart completed, your next step is to letter the pie chart. When lettering the chart, you show what each segment represents (i.e., housing, food, transportation, etc.) and what percentage of the total the segment represents.

You do NOT show the number of degrees a segment contains. If the size of the segment does not allow you to place the lettering inside the segment, place the lettering close enough to the segment so the reader can read it without taking their eyes off the chart. Use a leader line to ensure the reader knows which segment the information pertains. When the size of the pie chart prohibits any lettering, or you use colors or patterns to replace the lettering, use a legend in the lower right-hand corner.

(4) Adding contrast to a pie chart. To add contrast to the pie chart, you can add crosshatch or color to the segments.

(a) How to add color or patterns. Remember, when adding patterns or colors to the chart, you apply them light to dark, moving clockwise, and starting with the largest segment. Additionally, you must ensure the patterns or colors added to the chart do not cover any lettering on the chart. Since this often makes the lettering hard for the reader to see and comprehend.





Take a moment to review figure 1-33. This pie chart represents the pie chart developed in the lesson. This pie chart compares each expenditure to the total budget. You can see the largest segment starts at the 12 o'clock position and the designer has plotted the segments from largest to smallest, moving clockwise. Each segment has its relationship to the budget and its percentage of the total indicated.

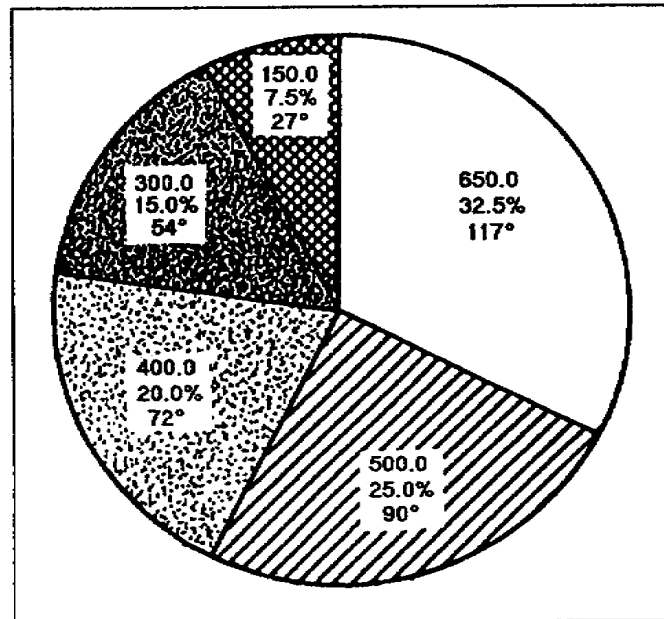


Figure 1-33. Budget expenditure pie chart

(b) Shading in a pie chart. Additionally, shading provides contrast to the segments. The designer added shading from light to dark, moving clockwise, and did not obscure the lettering on the chart. Whenever possible, the pie chart was lettered in the appropriate segment. However, when the segment was too small to accommodate the lettering, the designer placed the lettering so the reader can see it without taking his eyes off the chart. The designer also used leader lines to identify segments to which the information belongs.

(5) Pie chart comparing size of segments. You also can use a pie chart to make a comparison between the size of the individual segments. To prepare this type of chart, you use the process described in the preceding paragraphs. You must calculate the percentages and the number of degrees in each and plot this information the same way. With the information plotted, you must draw the pie with the proper perspective and depth, and slightly separate each segment. Figure 1-34 shows a pie chart comparing the size of the segments to each other.

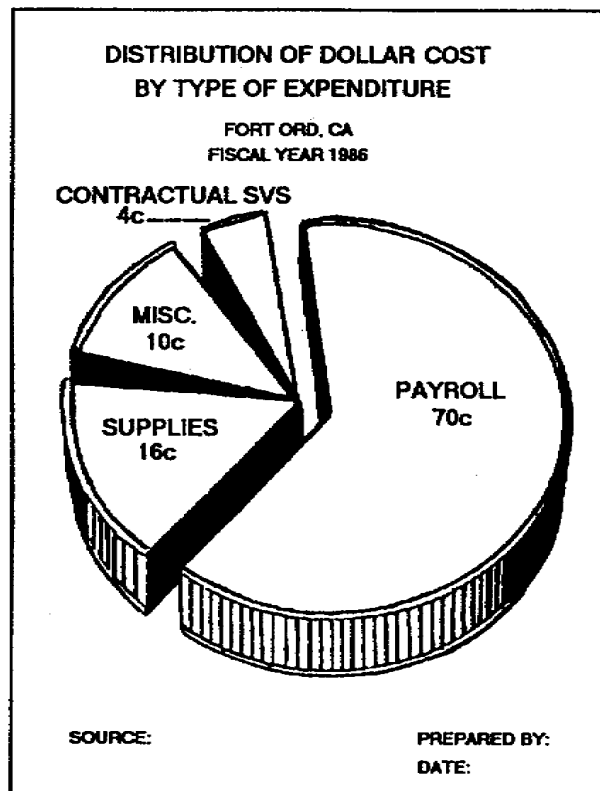


Figure 1-34. Pie chart comparing size of segments

d. Flow Charts. You would use these charts when presenting the progressive steps of a process or operation because they clearly present each step of an operation. There are two different types of flow charts: logic symbol and illustrative (figures 1-35 and 1-36).

(1) Types of flow charts. A logic symbol flow chart uses standard logic symbols or simple shapes, never both, to represent the steps in the flow chart. An illustrative flow uses pictures to present the steps in the flow chart. You should not mix the elements of the two types of flow charts together.

(2) Preparing a flow chart (rough draft). When preparing a flow chart, the steps of the process usually start at the top left-hand side and moves left to right as well as top to bottom. If for any reason the flow does not follow that path, you must use arrowheads to show the direction and starting point of the process.

The primary flow lines are always heavier (darker) than the symbol lines. You also must use uniform symbols throughout the chart. That is, if you use one type symbol for a decision point, then use that symbol for all decision points in the flow chart.

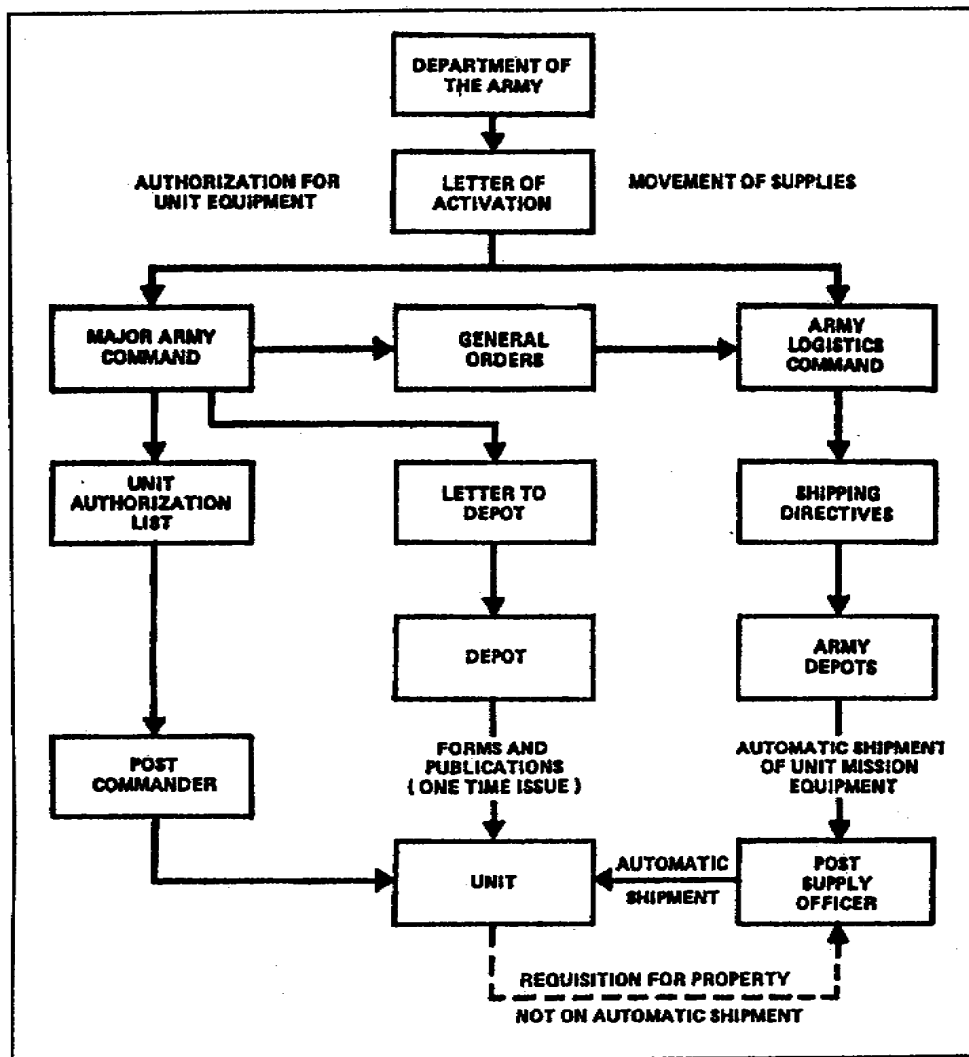


Figure 1-35. Logic symbol flow chart

To prepare a flow chart, start with the sketch or details on the VI work order and draw a rough draft of the flow chart. Keep refining the rough draft until you have a balanced, easy-to-follow illustration of the process. The majority of the time, this process requires you to make several rough drafts. Do not forget to consider the illustration ratio of the chart. If it is the master for a 35mm slide or viewgraph, then you must use a 2 to 3 ratio.

(3) Preparing a flow chart (final). With a final version of the rough draft completed, you start the actual flow chart using a pencil to draw the primary flow lines. Make sure you leave enough room for the largest symbol and additional notes, lines, arrowheads, etc. Next you add the symbols for the various steps of the process. Then check your drawing to ensure it still presents the process as shown in the final version of

the rough draft. When you are satisfied the chart presents the process, ink the primary and any secondary flow lines and symbol lines. Remember, the primary flow lines are the heaviest (darkest) lines on the flow chart.

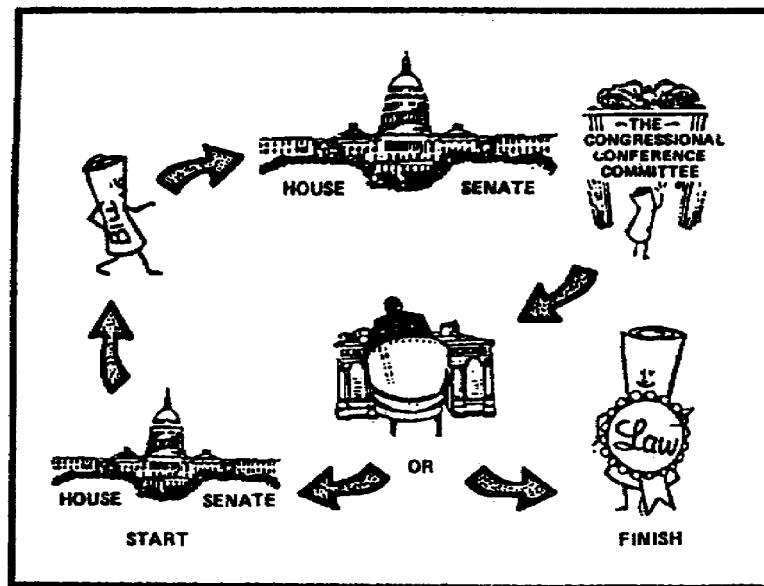


Figure 1-36. Illustrative flow chart

(a) Lettering the flow chart. The flow chart is now ready for the lettering. Draw the necessary guidelines and apply the lettering using the freehand method, any of the mechanical methods (Leroy or Wilco lettering sets), or prepared, pressure sensitive letters.

(b) Reviewing the finished flow chart. The flow chart you produce should present the process and each step in the process. It should also have balance, symmetry, proportion, and clear flow lines. Take a moment to review figure 1-35, the flow chart supplying the unit that the DA has just activated. This chart presents each step in the process, has balance, symmetry, proportion, and clear flow lines. By following the flow lines you understand each step in the process.

Follow the authorization for unit equipment in the chart. It starts at the top of the chart and shows that the Department of the Army issued a letter of activation for the unit. Following the flow line that shows authorization for unit equipment (the left side of the chart), you see the next step in the process is the major Army command. The chart shows that the major Army command has three functions it must perform: (1) prepare a general order and forward it to the Army logistics command for



issue of the organizational equipment, (2) prepare a letter for the one-time issue of forms and publications and forward it to the depot responsible for issuing the publications to the unit, and (3) prepare and forward the unit authorization list to the post commander who in turn forwards the authorization list to the unit.

If you designed and prepared your flow chart well, you can follow it as easily as the flow chart in figure 1-35.

e. Organizational Charts. Every organization needs a means for showing lines of authority and communications, duties, relationships, and responsibilities. This portion of the lesson discusses how an organizational chart does just that.

(1) Types of organizational charts. There are three basic types of organizational charts:

(a) Structural (figure 1-37). As its name implies, this type of organizational chart presents organizational planning by showing control relationships and reporting responsibilities. This type of chart uses the minimal amount of written information. You can use this type of organizational chart to depict any size unit.

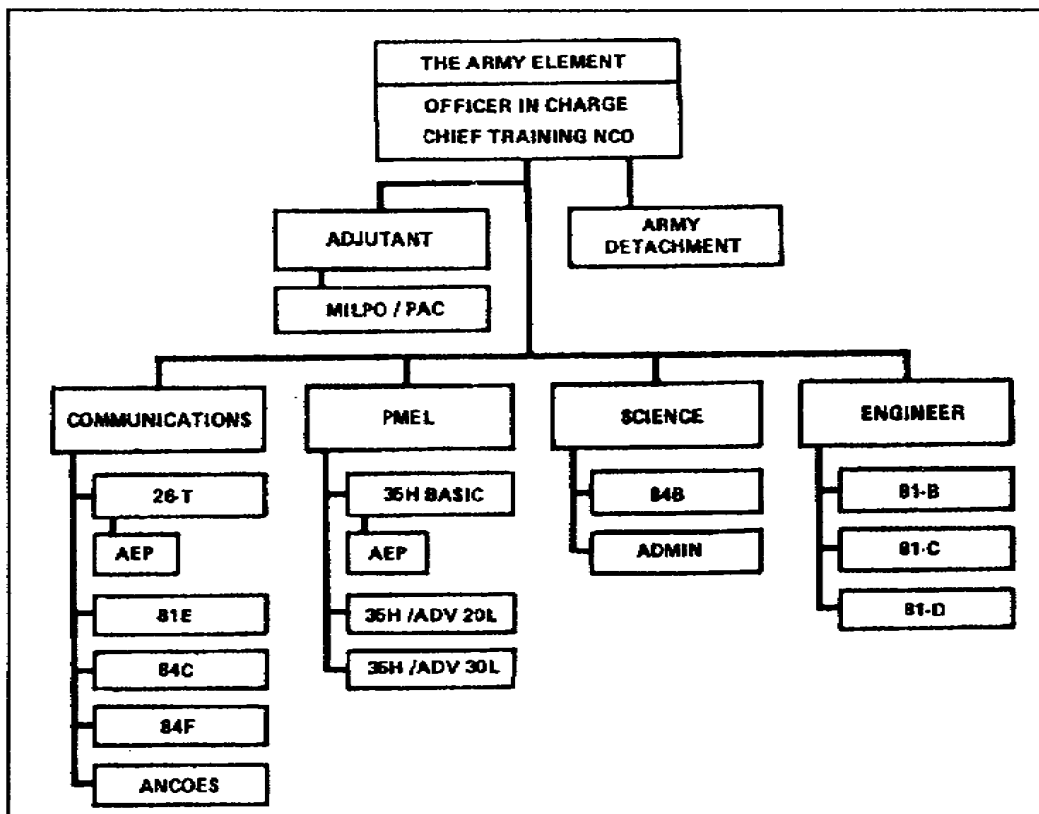


Figure 1-37. Structured organizational chart

(b) Functional (figure 1-38). You would use this type of organizational chart to show the components of a unit and what they represent. The blocks used to represent the components of a unit have a written statement describing what it does within the unit.

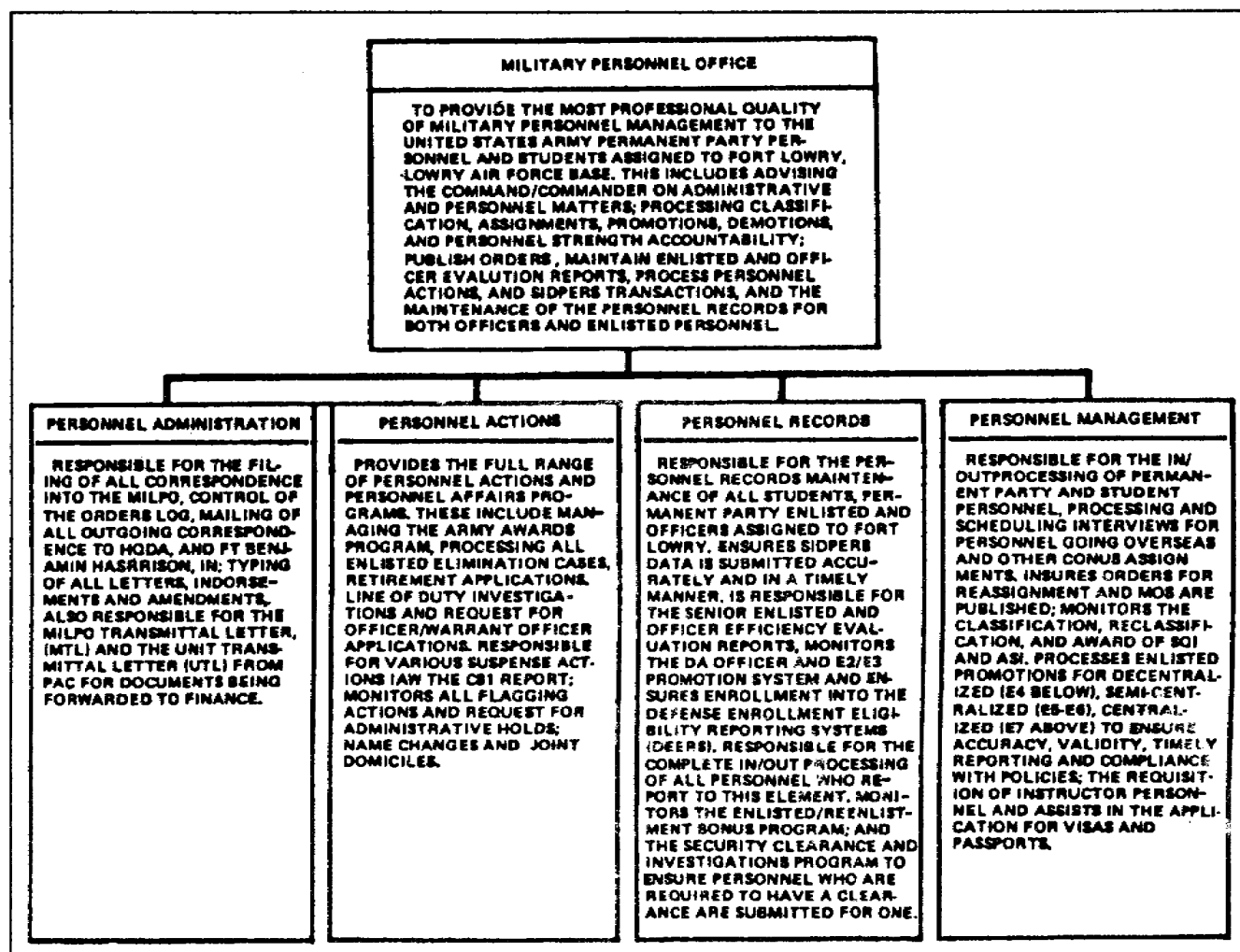


Figure 1-38. Functional organizational chart

(c) Position (figure 1-39). This type of organizational chart shows all individual positions authorized by a unit's manning document. The chart shows how each position fits into the organization, the title of the position, and the authorized grade. It also can show the name and grade of the individual currently assigned to the position, as deemed necessary by the requester.



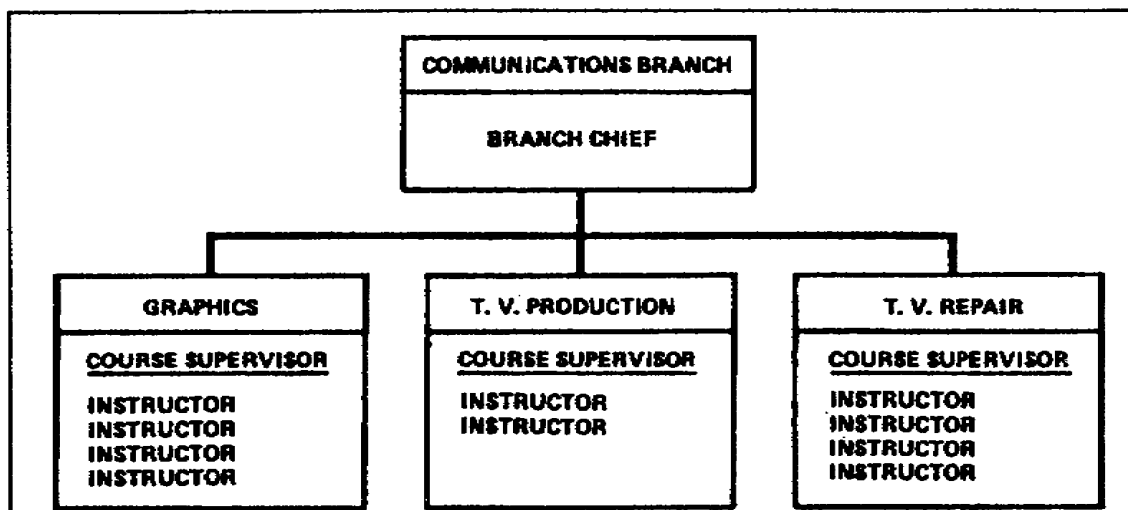


Figure 1-39. Position organizational chart

You may also encounter organizational charts that are a combination of any of the three basic types (figure 1-40).

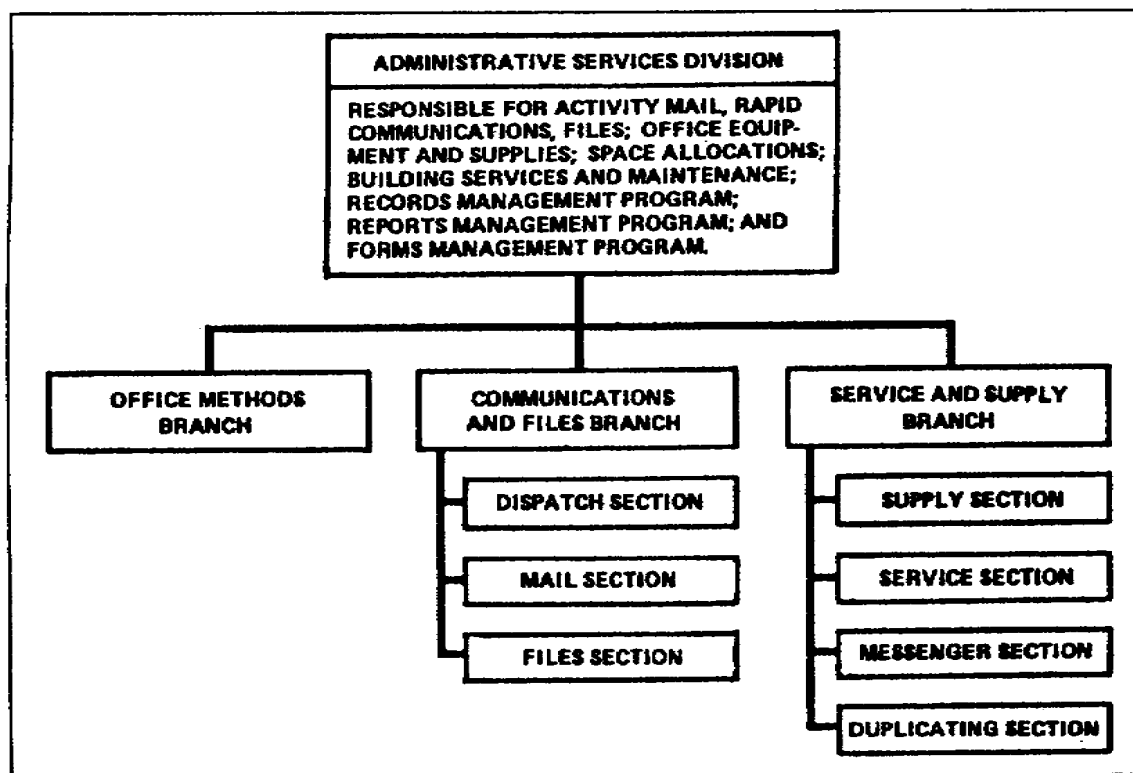


Figure 1-40. Combined organizational chart

An organizational chart presents a graphical representation of the names, titles, departments, or responsibilities of an organization. You also can design this chart so it presents the chain of command or outlines responsibilities. When designing

and preparing an organizational chart, there are guidelines that apply to all three types of charts you must follow to ensure effectiveness:

(2) Use of rectangles. Use rectangles to represent units or persons on the chart. Make the rectangle representing the key figure or authority the largest and centered on the chart. Make the rectangles that represent units or people on the same level the same size. Rectangles above and below the key figure are one size smaller, and the rectangles representing each lower-level are one size smaller than the preceding level.

For full-time subdivisions, you should use rectangles constructed of solid lines, and use broken (hidden) lines for the rectangles representing a permanent full-time subdivision that may be created. To indicate a full-time subdivision that is to be eliminated, use a rectangle constructed with alternating dot-dot-dash lines. If the chart has a subdivision whose functions are currently performed by another activity or will be manned on mobilization, construction of the rectangle is a dotted line.

Whenever you construct a rectangle using lines other than solid, explain their use in a legend. Locate the legend in the upper-left corner with the date.

(3) Command or authority lines. Normally, command or authority lines enter a rectangle at the top and exit at the bottom from center of the left side. However, under certain conditions command or authority lines enter the rectangle from the center of the left side. Command or authority lines do not pass through the rectangles.

The chart on the left-hand side of figure 1-41 shows the preferred method when a section has two or more subordinate units under it. The chart on the left-hand side shows the two sections as equal and under the control of the enlisted records section.

If you constructed the chart as shown on the right-hand side of figure 1-41, the chart does not present the facts the same way. The chart on this side of the figure gives the impression that the enlisted records section controls the records control unit and the records control unit controls the records vault, which is not a factual representation of the structure of the unit.

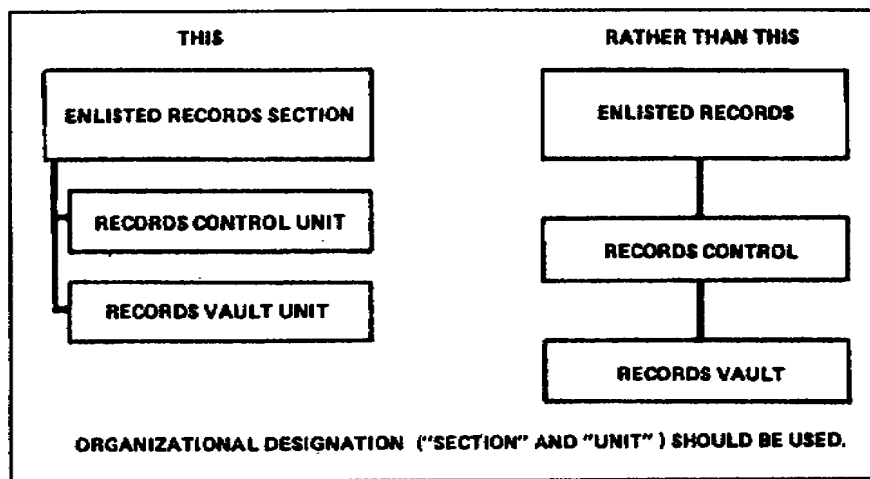


Figure 1-41. Alignment and authority lines

(4) Organizational chart effectiveness. When completing the organizational chart, you must ensure the command or authority lines are the heaviest (darkest) on the chart. To ensure the effectiveness of any of these organizational charts, you must limit the information they present to: (1) lines of authority, (2) responsibility, (3) spans of control, and (4) functional authority. An effective organizational chart has simplicity, clarity, completeness, symmetry, and unity.

(5) Simplicity and clarity. Simplify an organizational chart by removing confusing or complicating elements. However, do not remove required information just for simplicity or to make it easier to read. For an organizational chart to present the unit correctly, it must have all the elements.

Simplicity and clarity has a direct relationship. For an organizational chart to have clarity, lines of authority should not cross and present a crossing effect. Additionally, each block should have a label or title.

Figure 1-42 shows simplicity and clarity in an organizational chart. Look at the differences between the two charts. Not only is the top chart much easier to read, but it does not use diagonal lines, and the lines do not cross. Also the section is drawn vertically, under the responsible authority.

(6) Completeness. One goal for a well-designed organizational chart is identifying or showing how all sections relate to each other. However, do not sacrifice clarity for completeness. Place any additional information (e.g., subsidiary activities, additional duties, inactive functions, etc.) required to

complete the chart in the upper-right hand corner, with the date.

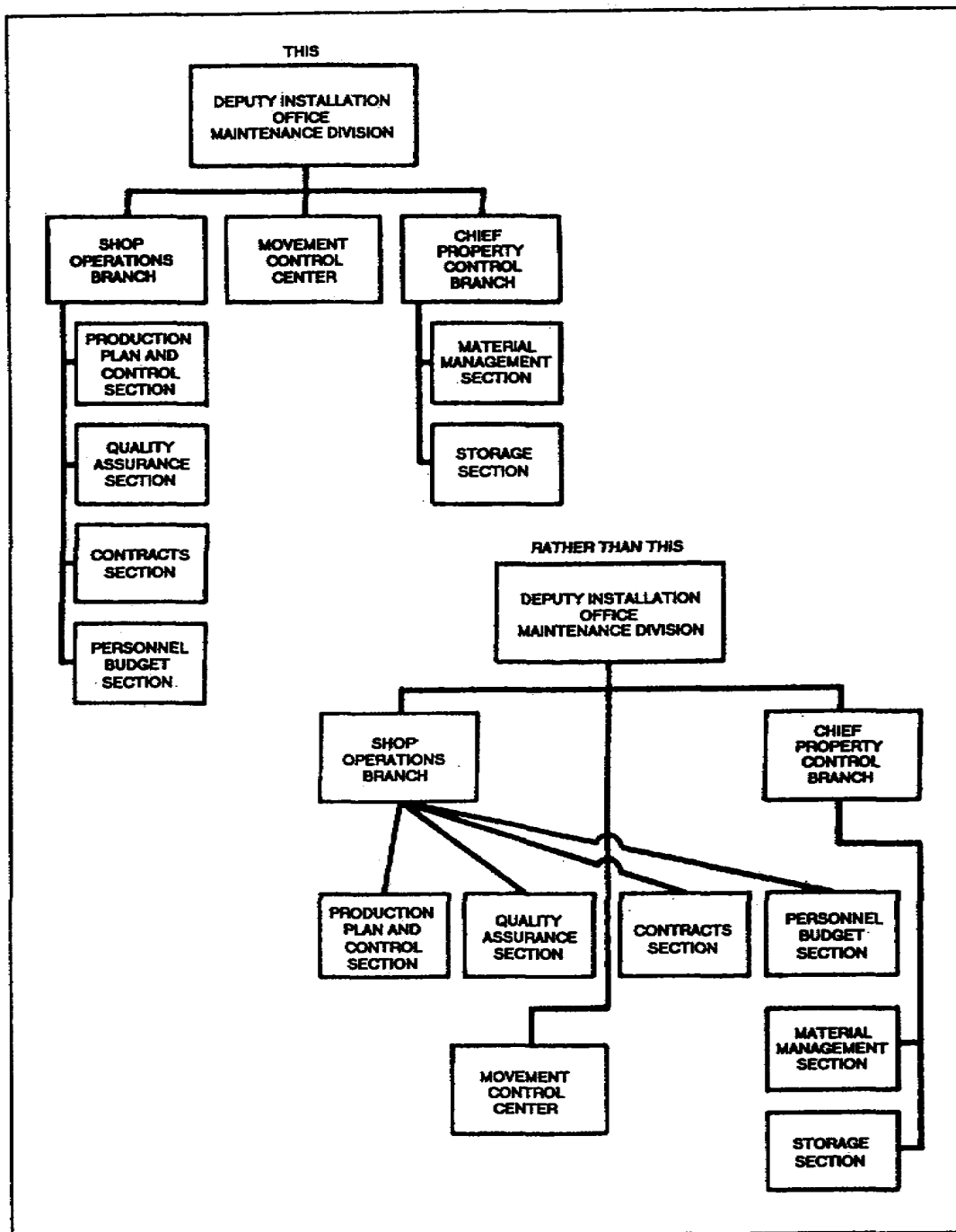


Figure 1-42. Simplicity and clarity in an organizational chart

(7) Symmetry and balance. The thesaurus defines symmetry as beauty of the form or arrangement arising from balanced proportion. Therefore, a balanced chart is a symmetrical

chart. It presents a uniform, eye pleasing appearance with the sizes of the rectangles proportional to each.

Figure 1-43 shows two ways to present the same information in a balanced, symmetrical chart. When looking at the unbalanced chart at the lower-right side of the figure, it gives the appearance that the athletics division, arts and crafts, and youth activity are set aside by themselves. In reality, they have equal status with the recreation division under morale, welfare, and recreation.

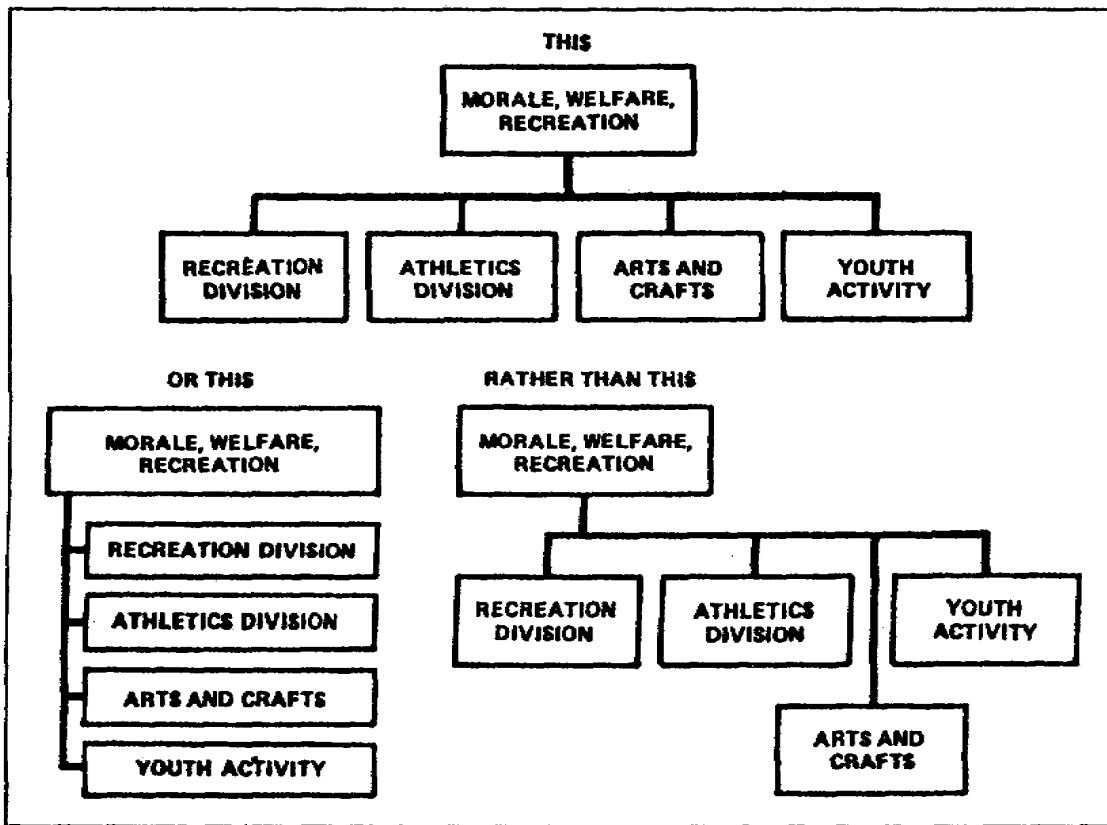


Figure 1-43. Balance and symmetry in an organizational chart

Another means of giving the chart symmetry and balance is to stagger the subdivisions. This not only gives symmetry and balance, it adds simplicity and saves space (figure 1-44).

(8) Unity. When an organizational chart has unity, it shows how each component interrelates by connecting lines or through other organizational elements. No element or branch of the chart exists by itself. The chart must also clearly show how the elements interact from their position in the command structure.

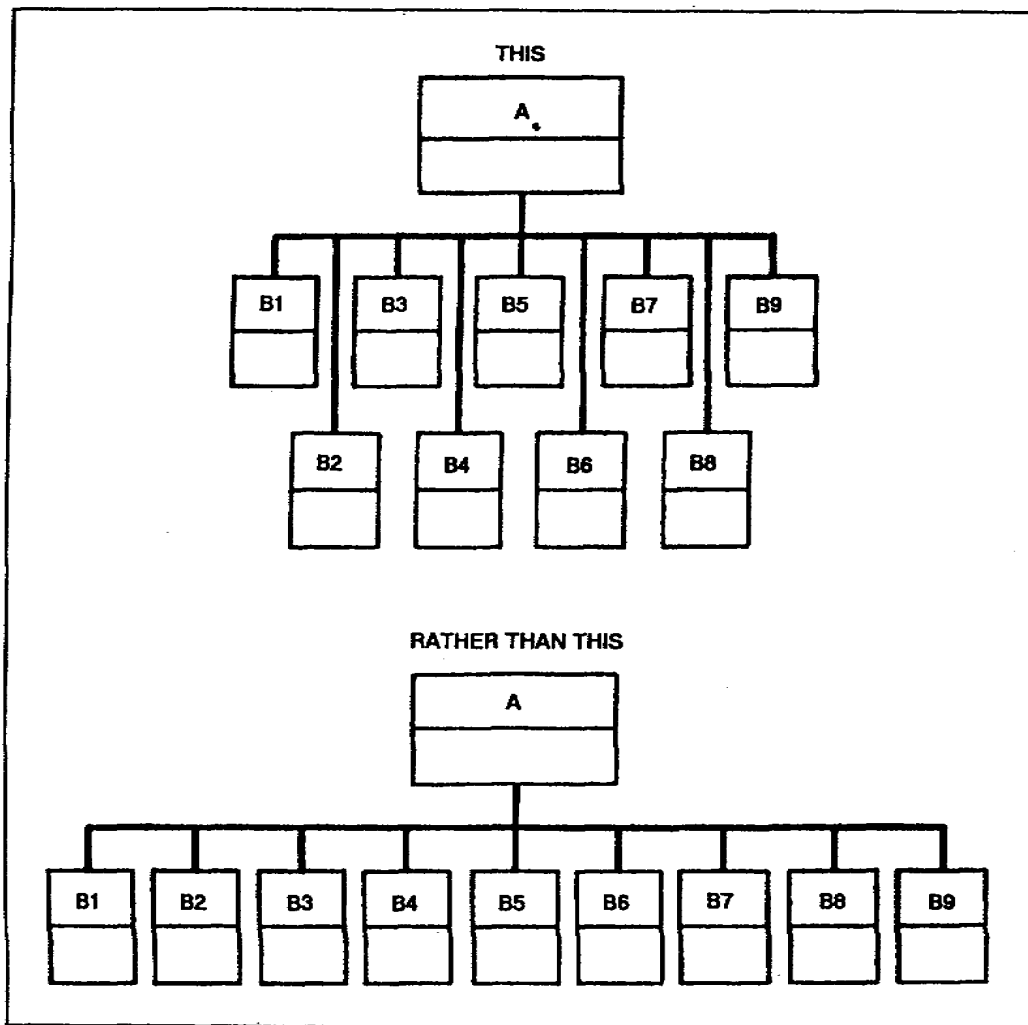


Figure 1-44. Staggered subdivisions

When constructing an organizational chart, you may find a situation where the same position (person) supports more than one section. To show this situation clearly, you would place a rectangle under each section that the position supports, label the rectangle, and place an asterisk at the end of the label. Then in the legend, explain the meaning of the asterisk.

Figure 1-45 shows how an administrative assistant supports three different sections. Each section has a rectangle for this position and the legend has notes explaining the split function.

(9) Preparing an organizational chart. To prepare an organizational chart, you start with the sketch or details on the VI work order and draw a rough draft of the chart. Keep refining the rough draft until you have a balanced, easy-to-follow illustration of the organization. The majority of the

time, this process requires you to make several rough drafts. Do not forget to consider the illustration ratio of the chart. If it is the master for a 35mm slide or view graph, then you must use a 2 to 3 ratio.

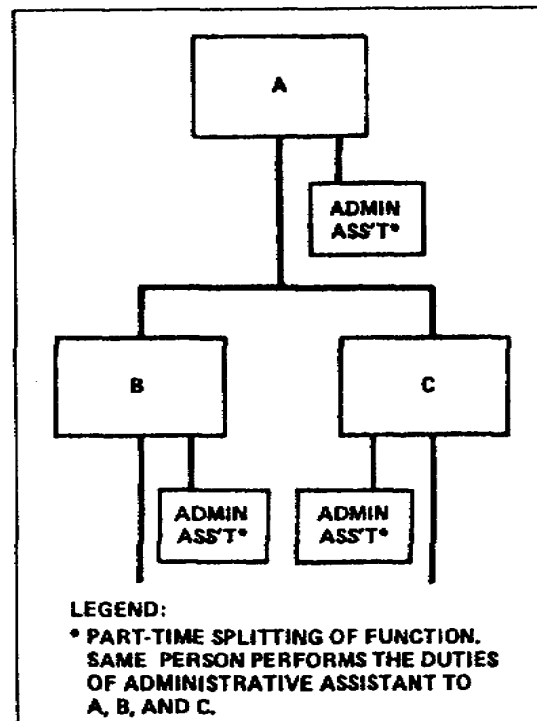


Figure 1-45. Splitting functions

With the final version of the rough draft completed, you start to develop the actual chart using a pencil to draw the rectangles representing the subdivisions and the authority or command lines. Then, check your drawing to ensure it still presents the organization as shown in the final version of the rough draft. When you are satisfied the chart presents the organization, then ink the rectangles and the authority or command lines. Remember, the authority or command lines are the heaviest (darkest) line on the organizational chart.

The chart is now ready for the lettering. Draw the necessary guidelines and apply the lettering using any of the mechanical methods (Leroy or Wilco lettering sets), or use prepared, pressure sensitive letters.

f. Decision Graphics. For commanders to plan effectively for any combat scenario, they must have up-to-date information in a concise, easy-to-understand format that allows them to react to the changes of mission, enemy strength and position, terrain, available troops, and the time available to complete

the mission. Decision graphics are one presentation method used to present this information as a single element of information.

(1) Information needed by a commander. A commander must have two types of information available when analyzing a situation map: quantities and measures of equipment and personnel assessments, and make-up of the different task forces under his command. The Army uses the horizontal bar chart as its standard for displaying quantities of measure because bar charts provide a means of comparing critical maneuver indicators to each other or to an established level or reference point. Bar charts also provide flexibility to the display and different types and combinations of information presented to the commander (figure 1-46).

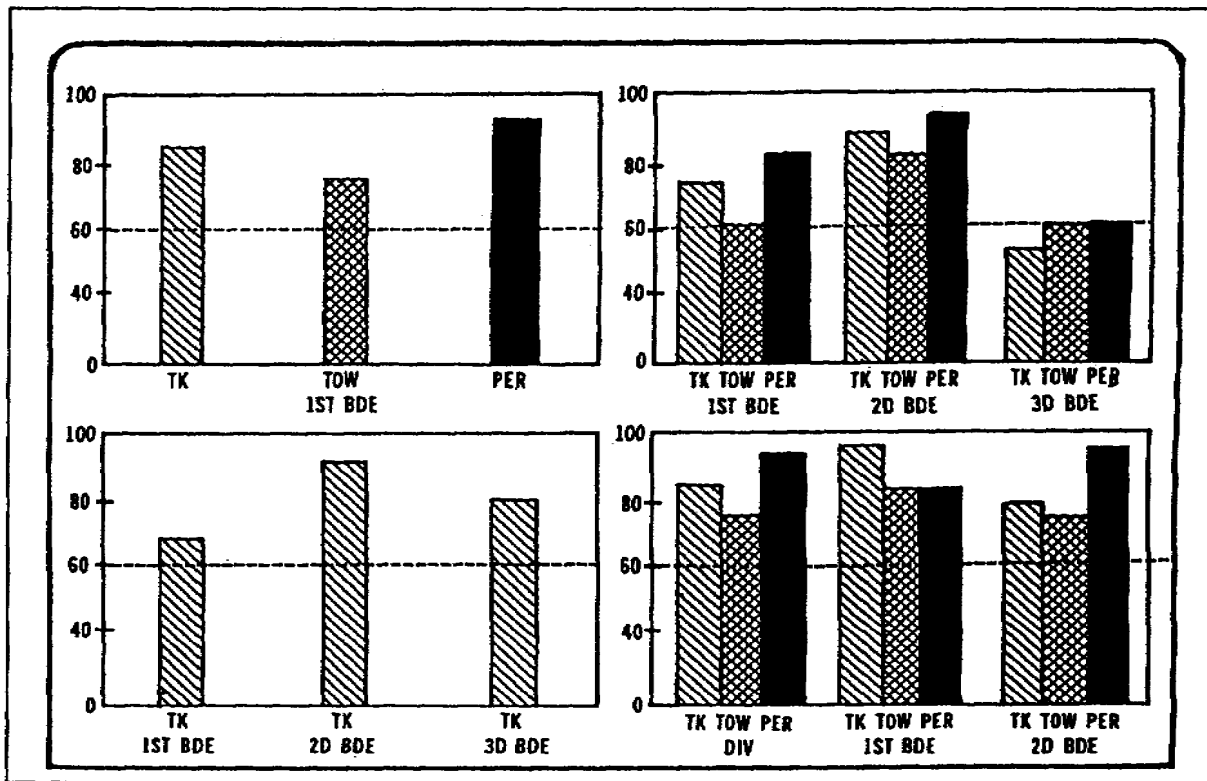


Figure 1-46. Examples of bar charts

When using the standard operational symbol to show the composition of a task force, it does not provide enough of the required information for decision makers to make precise, informed decisions. The standard operational symbol does not show the type of units that make up the task force and selected areas of interest (figure 1-47). Even though a commander has this information available through reports, charts, and briefings, he





loses the impact of having all the information available and combined as a single element. Decision graphics help overcome this problem.

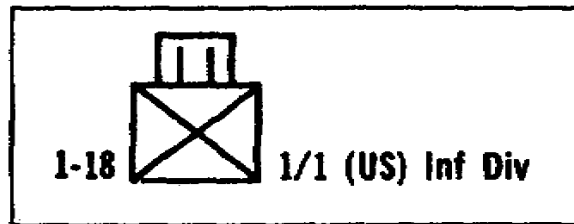


Figure 1-47. Standard operational symbol for a task force

One element of a decision graphic is combat effectiveness. Task force commanders have the responsibility of determining the combat effectiveness of the task force they command. A task force commander analyzes the status of fuel, ammunition, vehicle availability, and personnel reported to them by their staff in the number of different formats. After the task force commander has analyzed this data, he determines the task force's ability to perform its mission.

(2) Showing overall combat effectiveness. You can express the task force commander's decision as a decision graphic. The decision graphic shows the overall combat effectiveness of the task force and the status of four selected items of interest, as determined by the task force commander (e.g., personnel, ammunition, POL, or weapons system).

(a) Parts of a decision graphic. The combat effectiveness portion of a decision graphic uses two circles. One circle, divided into thirds, shows the task force commander's combat effectiveness assessment, and the other circle, divided into fourths, shows the areas of interest affecting their decision. Additionally, the selected areas of interest have the titles of the four areas indicated so it presents a clear picture of its portion of the task force's status (figure 1-48).

Figure 1-48 shows how a decision graphic indicates the four combat effectiveness rating a task force commander can use. When a commander decides their task force has "no problem" performing its mission, you do not fill in any portions of the effectiveness or selected information graphics (circles). However, when a task force commander indicates their task force has "some difficulty," or "major problems," or "cannot" perform its mission, you fill a portion of the effectiveness graphic (circle) and the portion(s) of the selected information graphic (circle) that indicates the area(s) in which a task force commander feels he has a problem.











Commander's Assessment to Perform Mission	Effectiveness Graphic (1)	Selected Information Graphic (2)
<b>"No Problem"</b>		<b>Personnel</b> <b>POL</b>  <b>Ammunition</b> <b>Weapon Systems</b>
<b>"Some Difficulty"</b> <b>Personnel</b>		
<b>"Major Problems"</b> <b>Weapon Systems</b>		
<b>"Can't"</b> <b>Personnel</b> <b>Ammunition</b> <b>Weapon Systems</b>		

Figure 1-48. Combat effectiveness and selected information graphics

When task force commanders indicate their unit has "some difficulty" performing its mission, you fill in the bottom third of the effectiveness graphic. If task force commanders indicate their unit has a major problem performing its mission, you fill in the right-hand and bottom two-thirds of the graphic. Should task force commanders indicate their unit "cannot" perform its mission, you fill in the entire effectiveness graphic. With each preceding effectiveness decision, you would fill in the portion(s) of the selected information graphic that a task force commander used to make his decision (figure 1-48).

(b) Symbols show maneuver assets. The standard operational symbol for a task force does not show the task force's maneuver assets (composition). When a commander requires this information, you use a decision graphic to fulfill this requirement. In the decision graphic, you place graphics to represent the various units that make up the task force. Figure 1-49 shows the standard symbols used to represent tank, mechanized, armored, and an infantry company/teams.

To indicate any other company-sized elements that make up the task force, you place the unit's branch symbol in the decision graphic. Figure 1-50 shows examples of other-company-sized units using branch symbols. FM 101-5-1 provides a list of branch symbols you use for the graphic.







Type Company/Team	Composition Graphic
Tank company/team	
Mech company/team	
Armored cavalry troop	
Infantry company/team	

Figure 1-49. Standard composition graphics

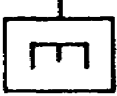

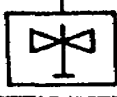

Engineer company	
ADA battery	
Helicopter company	
Air cavalry troop	

Figure 1-50. Indicating company-sized unit with branch symbols

The completed decision graphic shows the combat effectiveness and composition of a task force. Take a moment and review figure 1-51. This figure shows task force 1-18 INF is a battalion-sized task force, composed of two mechanized infantry, company/teams, one tank company/team, and one engineer company. Task force 1-18 has "no problem" performing its mission.

(3) Adaptability of decision graphics. The simplicity, symbology, and adaptability of decision graphics allow its use at many levels of a command. The decision graphic used to this point in the lesson shows a battalion-sized task force. However, if a battalion has formed a company-sized team for a specified mission, they could use a decision graphic on their situation map to represent the team.



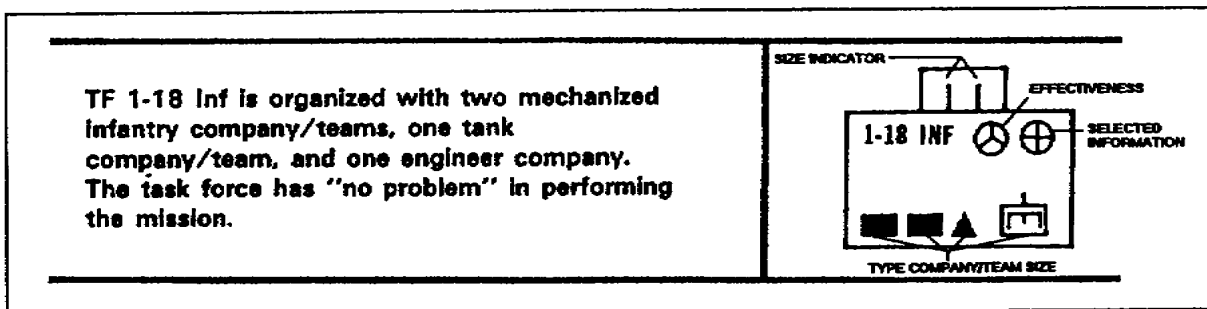


Figure 1-51. Completed decision graphic

For example, the 1st Battalion, 21st Infantry has formed a company-size team, team A. Team A consists of two mechanized infantry platoons, one tank platoon, and has "some difficulty" performing its mission due to the weapons systems (figure 1-52). (For clarity and simplicity, the composition of the team remains the same as above, except for the size of the units.) The only change in the decision graphic is the unit size indicator.

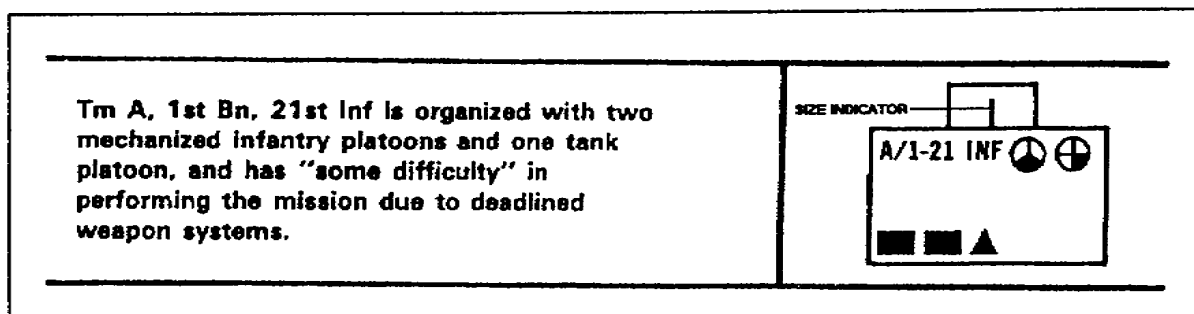


Figure 1-52. Decision graphic, company-sized team

Special units (task forces or teams) consist of units one size smaller than the special unit designation. For example, a battalion task force has companies or company-sized teams, and a company-sized team has platoon-sized elements. When a task force has a division task force designation, then brigade-size elements would make up the task force. Figure 1-53 shows the basic operational symbol with different unit size indicators. For a complete list of unit size indicators see FM 101-5-1.

#### 4. Preparation and Construction of Tables.

In your daily life, you constantly see the different types of tables. Once again, the television serves as a prime example of the use of tables to reinforce the spoken word. Additionally, any books you read use tables to arrange large quantities of data into a form that you can quickly comprehend. Studies have



proven that individuals retain approximately 13% of what they hear; however, they retain approximately 75% of the information read or seen. That is one reason you use tables to present data.





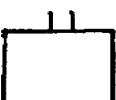

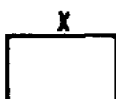

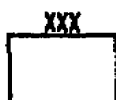
UNIT SIZE		
The size of units and installations is shown by placing the appropriate size indicator directly above the basic symbol.		
US Description	STANAG 2019 Description	Symbol
Squad/crew	Smallest unit/UK section	
Section or unit larger than a squad but smaller than a platoon	Unit larger than a US squad/UK section but smaller than a platoon equivalent	
Platoon or detachment	Platoon/troop equivalent	
Company, battery, or troop	Company/battery/squadron equivalent	
Battalion or squadron	Battalion equivalent	
Group or regiment	Regiment/group equivalent	
Brigade	Brigade equivalent	
Division	Division	
Corps	Corps	

Figure 1-53. Task force size indicators

a. Different Types of Tables. There are two different types of tables used to present statistical data: general-purpose and special-purpose. You can use either type of table to supplement charts, graphs, and text presenting difficult or complex data.

(1) General-purpose table (figure 1-54). This type of table presents a wide range of data on a specific subject, and is not the type of table requiring viewers to read the entire table to understand the data it presents. When designing a general-purpose table, you arrange the data so the reader can readily find the different data entries. Think of a general-purpose table as a "figure file" where the reader finds data using the same procedures used when finding a word in a dictionary.

**MAJOR AIRCRAFT ACCIDENTS**  
BY PHASE OF FLIGHT\*  
U.S. ARMY AVIATION COMMAND  
FORT RUCKER, ALABAMA  
FY 86

ARMY AIR FIELD	TOTAL	TAKE OFF	IN FLIGHT			FINAL APP. AND LAND	TAXING	ENGINE RUN NOT TAX.	MISC.
			NORM	GO AROUND	PATT.				
TOTAL AAVCOM	30	2	6	1		20	1		1
AAF 1	2					1	1		
2	3		1			2			
3	5		1			4			
4	5	1				4			
5	2					2			
6	3			1		1			1
7	7		2			5			
8	1					1			
9	1		1						
10	1	1							

\* INCLUDES TENANT ORGANIZATIONS:  
SOURCE: SOURCE

Figure 1-54. General-purpose table

(2) Special-purpose table (figure 1-55). A special-purpose table shows selected data arranged to focus the reader's attention on important comparisons and relationships. For the reader to understand the data presented in this type of table, they must read the entire table. Usually you find this type of table with text and used as part of a summary.

b. Constructing a Table. To prepare a table, you start with the sketch or details on the VI work order and draw a rough draft of the table. Keep refining the rough draft until you

have a balanced, clear, and simple table. The majority of the time, this process requires you to make several rough drafts. Do not forget to consider the illustration ratio of the table. If it is a master for a 35mm slide or view graph, you would then use a 2 to 3 ratio. You must consider each component of the table when constructing it.

<b>NUMBER OF AIRCRAFT ACCIDENTS DUE TO FINAL APPROACH &amp; LANDINGS*</b>			TITLE
<b>U.S. ARMY AVIATION COMMAND FORT RUCKER, ALABAMA FY 88</b>			
<b>ARMY AIR FIELD</b>			CAPTIONS
<b>FINAL APPROACH AND LANDING</b>			
<b>PERCENT OF TOTAL</b>			
<b>TOTAL AAVCOM</b>			TOTAL
<b>AAF 1</b>			
<b>2</b>			
<b>3</b>			
<b>4</b>			
<b>5</b>			
<b>6</b>			
<b>7</b>			
<b>8</b>			
<b>9</b>			
<b>10</b>			

\* INCLUDES TENANT ORG  
 SOURCE:

BOXHEAD  
 STUB  
 FOOTNOTE  
 SOURCE

Figure 1-55. Special-purpose table

When constructing a table, you must organize the body of the table so it presents the data simply, clearly, and emphasizes the important data in the table. Because Western cultures read from left to right and top to bottom, this is the first place the eyes go to when reading the table. Therefore, the top left of the table is the best place to position the data that the table emphasizes. Additionally, you should design the entire table so all data, stub heading, and boxhead caption read horizontally.

Take a moment and review figure 1-54. As you can see, this table emphasizes the total number of major aircraft accidents. Therefore, the designer placed the totals in the top left corner of the table. There are many other instances when you could design the table with the totals at the bottom, which is perfectly acceptable.

NOTE: Use figures 1-54 and 1-55 to follow the discussion of the parts of a well-constructed table. Both figures provide an example of a well-constructed table.

(1) Title. You should center the title at the top of the table and use only upper-case (capital) letters. Ensure the title you select is clear and concise, tells the reader what data the table contains, and where it applies. You should never sacrifice clarity for brevity. If you have any doubts about the clarity of the title, you should use a longer title rather than running the risk of having a title that confuses the reader or the reader will not understand. Use the selection criteria used for titling a chart when titling a table.

(2) The body of the table. The body of the table has five main parts:

(a) Columns. The columns contain the vertical listings of the table. Columns with no entries tend to confuse the reader. To prevent any misunderstanding or confusion, each column must have an entry. If the column does not require an entry, use a footnote to indicate that fact.

(b) Rows. The rows contain the horizontal listings of the table. Just like the columns, each row must have a heading and an entry.

(c) Captions and stubs. There many different systems you can use when constructing the captions and the stubs. You can arrange the data alphabetically, geographically, chronologically, etc., or in any logical order that presents the data the way the requester desires. If you choose to list the data alphabetically, use the subject as the order of presentation. When listing the data geographically or chronologically, choose the best way suited to emphasize the data that the table presents.

For example, when listing the data geographically, you could size, either increasing or decreasing, as the determining factor for the order the table presents the data. When using chronological order as the determining factor, you arrange the data in order of interest, oldest to newest, or any customary classification. No matter what system you use to organize the data, you must reach a final decision before you construct the table.

The captions used for the table must relate to the title and present a precise, clear meaning of the data in the columns. Because the title and the captions have a very close relationship, you can use short, brief captions when you have a detailed title. At the other end of the spectrum, you must use captions



that contain enough detail to eliminate the chance of the reader misunderstanding any of the data.

The stub contains the list of captions, on the left-hand side of the table, describing each row of the table. Every stub line should have a heading.

(d) Boxhead. The boxhead contains the captions (title) of the vertical listings. Once you have selected the captions, you insert them in the boxhead. Usually the boxhead is two lines larger than the largest caption. This allows a space between the largest caption and the lines of the boxhead. The boxhead should be two spaces wider than the longest caption; again this allows for a space between the lines and the start and end of the longest caption. When you place the captions in the boxhead, center each in their respective box. When the caption has two or more lines, you can use the pyramid or invert pyramid style for these captions.

c. Lettering the Chart. Draw the necessary guidelines and apply the lettering using any of the mechanical methods (Leroy or Wilco lettering sets), or use prepared, pressure-sensitive letters.

## PART B - LETTER GRAPHIC-PROJECTS

### 5. Construction of Freehand Lettering.

Freehand lettering is an art in itself requiring study and practice. Lettering differs from handwriting. You draw letters using standard forms and strokes. Even if your handwriting is not particularly good, through practice you can draw good, legible letters. As a graphics documentation specialist, it is extremely important for you to develop and perfect your lettering skill, since this is one skill you use almost daily.

No matter what type of graphic project you must work on, there are basic steps you follow to produce effective, legible, and readable lettering. To have effective lettering, you must produce legible letters. For legible letters, you must have uniformity, proportion, and stability.

a. Letter Uniformity. The height, inclination, and spacing affect the uniformity of lettering. When lettering a graphic project, all lettering must appear the same when used in phrases, sentences, or presentations. If the lettering for a project lacks uniformity, it distracts from the eye appeal of the project and often distracts the reader of the intended message.

You cannot have one extended or wide letter when the other lettering appears condensed or thin. Lettering a project in this

fashion lacks uniformity. Your lettering must have the same height, style, and size. Lettering is an art that you must practice to obtain proficiency and continue practicing to maintain proficiency.

Guidelines serve as an aid to creating uniform lettering. Guidelines are light pencil lines that provide the means to achieve the consistency needed for uniformity. When you apply only upper-case lettering, you use only the base and cap guidelines. When lettering consists of upper- and lower-case letters, you must use the cap, waist, base, and drop guidelines (figure 1-56).

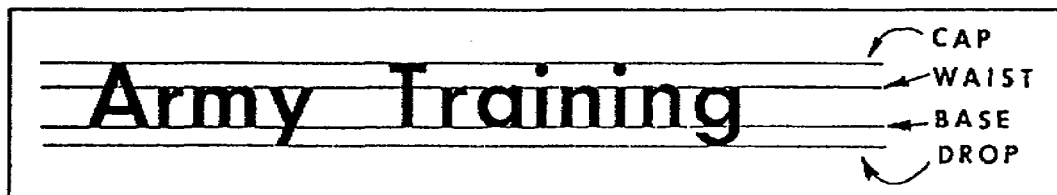


Figure 1-56. Guidelines for lettering

When laying out guidelines for upper- and lower-case letters, the height of upper-case lettering is  $1\frac{1}{2}$  times the distance "A" (figure 1-57). When establishing the guideline for lettering, set a compass or divider to distance "A" and mark the distance you have selected above and below the midline. These two marks establish the cap line and the drop line (figure 1-57).

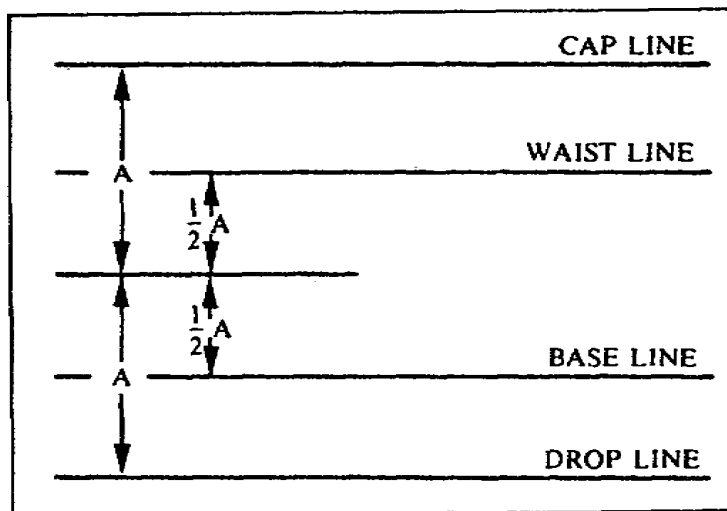


Figure 1-57. Layout of guidelines

Next you must locate the base and waist lines. To locate these lines, set the compass or divider to  $\frac{1}{2}$  of "A." Then using the same midline, mark the distance  $\frac{1}{2}$  of "A" above and below the

midline. These two marks establish the position of the base and waist lines (figure 1-57).

You also can use vertical guidelines with horizontal guidelines. When used, space vertical guidelines randomly along and parallel to the horizontal guidelines. Vertical guidelines provide a reference point to the vertical plane that you can use to ensure your lettering remains vertical.

For inclined lettering, you can use inclined guidelines, known as "direction lines," with the horizontal guideline. Use the angle best suited for the lettering project. Normally, direction lines slant no more than 68°.

b. Proportional Lettering. When lettering is proportional, all letters are the same height and width. When lettering a graphic project, the lettering must have the same proportion when used in phrases, sentences, or presentations. If the lettering on a project is not proportional, it distracts from the eye appeal of the project and often distracts the reader of the intended message.

Figure 1-58 shows disproportionate lettering and uniform, proportional lettering. After reviewing the lettering in the figure, you can see none of the disproportionate letters are the same; and they distract from the clarity of the lettering. The uniform, proportional letters are the same size, easy to read, and eye appealing.

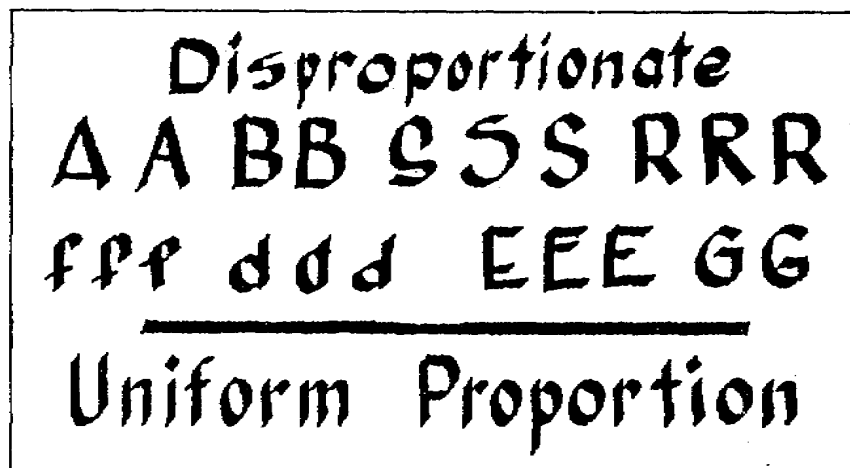


Figure 1-58. Example of lettering

c. Letter Stability. Stability makes lettering appear balanced. When applied correctly, most letters appear balanced (e.g., W, R, T, Y, H, M, and X). Unfortunately, some lettering



appears unstable, even when applied correctly (e.g., P, F, and J). You can compensate for this distracting effect by making these letters somewhat top heavy.

## 6. Applying Freehand Lettering.

You apply freehand lettering by hand, without any mechanical aids, using the basics strokes for each letter (figure 1-59). You can use pencils, pens, markers, or brushes to apply freehand lettering. Your lettering must present a sharp, clean, firm, and opaque appearance.

a. Pencil Lettering. Manufacturers make drawing pencils in different graphite densities, indicated by a letter and a number. The letter "B" denotes a soft, dark graphite; whereas the letter "H" indicates a hard, light graphite. The number used with the letters "B" and "H" show the degree of hardness or softness of the drawing pencil's graphite (figure 1-60).

For example, both 2B and 6B drawing pencils are soft pencils; however, of the two drawing pencils, the 2B is a harder drawing pencil. When using the 2B drawing pencil to apply lettering, the lettering is lighter than the lettering applied with a 6B drawing pencil. Remember, the softer the graphite, the darker the lettering.

Now consider a 4H and 8H drawing pencil. Which of the two drawing pencils do you believe would produce the lightest lettering? You would use the 8H drawing pencil for the lightest lettering. Though both the 4H and 8H drawing pencils are hard drawing pencils, the number "8" tells you the 8H drawing pencil is the hardest of the two, and the harder the graphite, the lighter the lettering.

(1) Choosing the correct pencil. To a large extent, choosing the correct graphite drawing pencil for the lettering project depends on the roughness (tooth) of the paper. The rougher the paper, the harder the pencil graphite required to produce quality lettering. You must choose a pencil hard enough to prevent excessive wearing down of the point, but soft enough to produce jet-black lettering. As an aid to selecting the proper pencil, try several different pencils until you find the one that best suits the needs of the project and paper.

The size of the lettering you apply to a project also affects the drawing pencil you use for lettering. When applying small lettering, you use a drawing pencil sharpened to either a conical or chisel point. If you are applying medium lettering, then you should use a thick, soft lead drawing pencil, sharpened to a chisel point (figure 1-61).



Figure 1-59. Basic lettering strokes

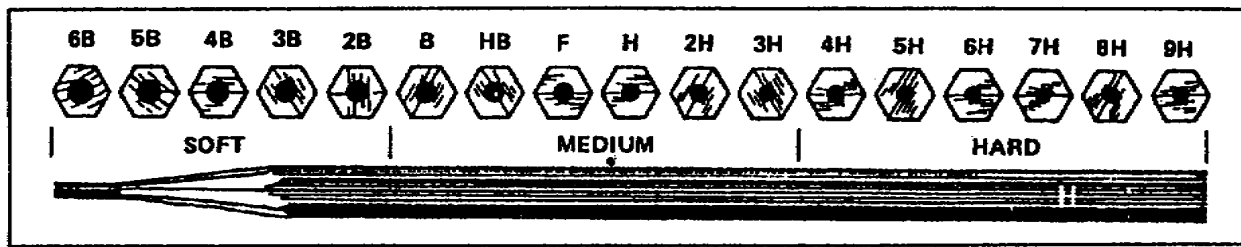


Figure 1-60. Grades of drawing pencils

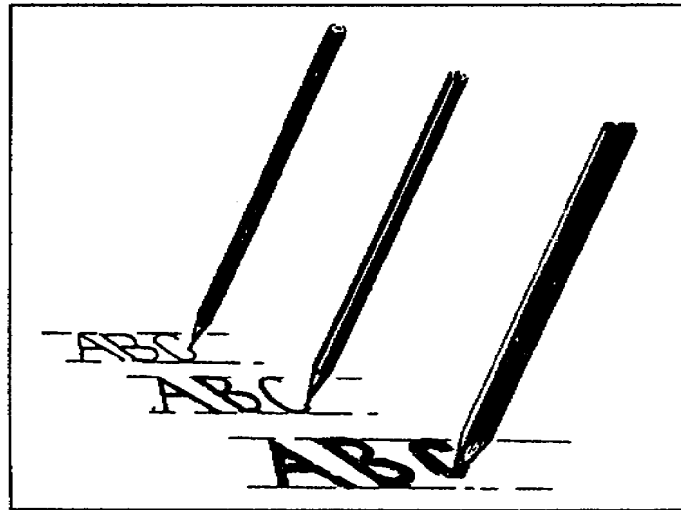


Figure 1-61. Lettering pencils

You should use a carpenter's or layout pencil for large lettering. Use a carpenter's pencil with a chisel point to apply different styles of lettering, such as text, Roman, or some script (figure 1-62).

(2) How to use the pencil. When applying lettering with a pencil, you must hold the pencil correctly and comfortably. Hold the pencil with the thumb, forefinger, and second finger in the normal writing position, or a position that is comfortable for you. Draw vertical, slanting, and curved lines with a steady, even finger movement. Horizontal lines require a similar motion; however, add a small pivot of the hand at the wrist. The pressure you use when lettering should be firm and uniform, but not so heavy as to cut or leave grooves in the paper.

b. Pen Lettering. Before the invention of the printing press, authors hand lettered all books using a broad, flat pen. Freehand lettering with a technical fountain pen, standard fountain pen, speedball lettering pen, or a flexible quill with



ink is still useful when lettering posters, signs, charts, and displays. The wide variety of inks presently available range from a high pigment, opaque India ink to low pigment writing ink to inks of many colors.

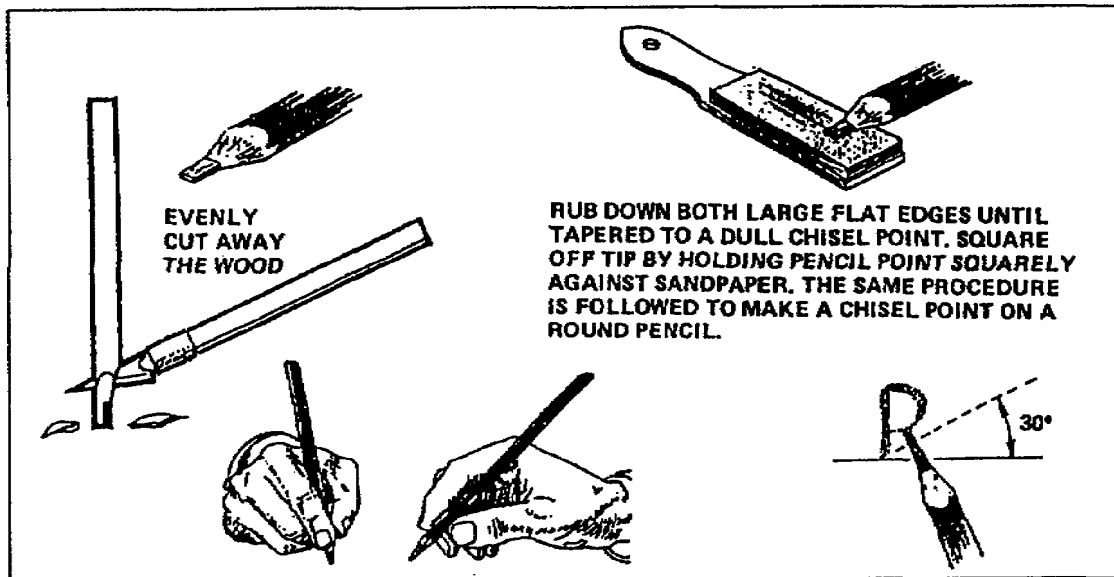


Figure 1-62. Sharpening and holding a carpenter's pencil

(1) Guidelines for pen and ink lettering. When using a pen to apply lettering, hold the pen as you would a drawing pencil. Do not hold the pen tightly because you lose the sense of feel required to construct the letters correctly. Always pull the pen in the direction it is leaning when you are holding it. If you try to push the pen, the tip digs into the paper and splatters ink over the project.

Once you have selected the style and the type of pen you will use, lightly draw the guidelines and letters. Do not forget to use direction lines if you must apply slanted lettering, usually  $67^{\circ}$  for italic lettering. Once you have the guidelines and lettering in place, you can rearrange the drawing surface to a comfortable position; however, ensure you position the project so you have a constant point of view. This assists in producing uniform lettering.

Begin applying the ink by dipping the tip of the pen into the ink bottle. Remove any excess ink from the tip by touching it to the side of the bottleneck. Each time you re-ink the pen and before applying ink to the project, you should make two or three trial strokes on a piece of scrap paper. This allows you to ensure the tip has the correct amount of ink in the nib. The trial strokes also allow you to check the quality of the lines,

and to ensure no foreign matter is lodged in the tip. Do not allow any foreign matter to collect in the nib; clean the nib as often as necessary. When you have completed lettering the project, thoroughly clean the pen with pen cleaner and pat the nib dry with a paper towel or lint-free cloth.

Even the best illustrators make mistakes. If you make a mistake while using ink, correct the error by lightly scraping the mistake with a steel eraser. You must then reburnish and re-ink the surface, or cover the error with whiteout and re-ink the surface.

(2) Speedball pens have four different points or nib styles, each designated by a letter and number, that produce different sizes and styles of lines. The letter indicates the style of the point, while the number, which ranges from 0 to 6, indicates the size of the point. The smaller the number, the larger the line. For example, a point designated with a 3 creates a larger line than a point designated with a 6.

The "A" style speedball pen point has a flat, square tip that creates a line of uniform width with square ends. You would use the "A" nib for square Gothic and block lettering (figure 1-63).

The "B" style nib has a round tip that produces uniform lines with round tips. You use the "B" nib for Gothic lettering and uniform lines (figure 1-63).

The "C" style nib has a chisel-shaped point that produces thick and thin strokes. Because the "C" nib produces thick and thin strokes, you would use it for lettering projects requiring Roman and old English text letters (figure 1-63).

The "D" style nib has an oval-shaped point that produces thick and medium lines. Because of the shape of the "D" nib, you would use it for lettering projects requiring bold Roman and italics lettering (figure 1-63).

c. Marker Lettering. More often than not, you find this form of lettering used to prepare flip charts because it is one of the quickest and easiest means of lettering. Normally you use a standard marker, known as magic marker, felt tip pens, etc., to letter projects (figure 1-64). However, there are also high quality artist markers available. Artist markers come in a wide variety of colors, sizes, and point shapes.

There are two different sizes of the standard marker: small and medium. The small marker has a fine tip; therefore, you would use it for 1/4- to 3/4-inch lettering projects and drawing small, fine lines. Medium markers usually have a tip cut at a



45° angle, which allows you to use it to produce larger letters (3/4 to 3 inches) and draw thicker lines.

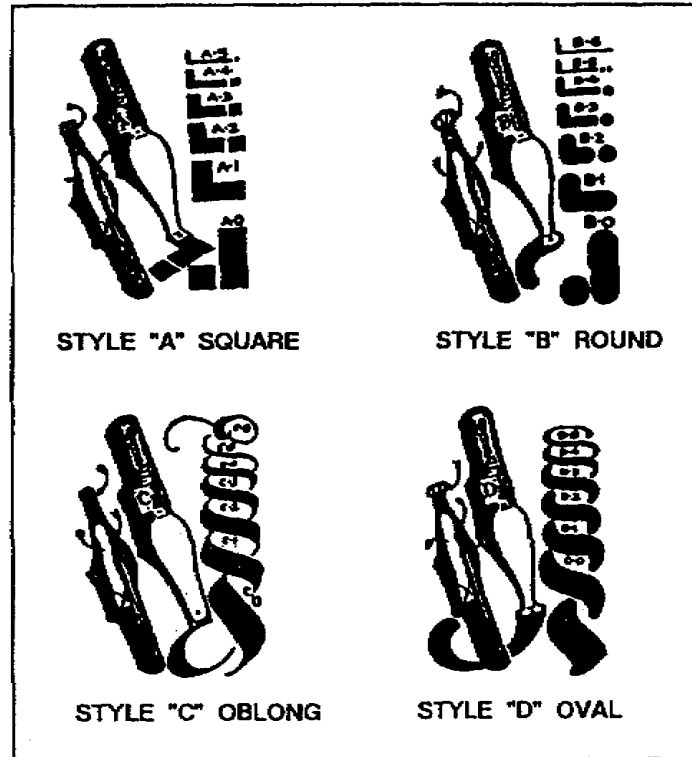


Figure 1-63. Speedball pen point

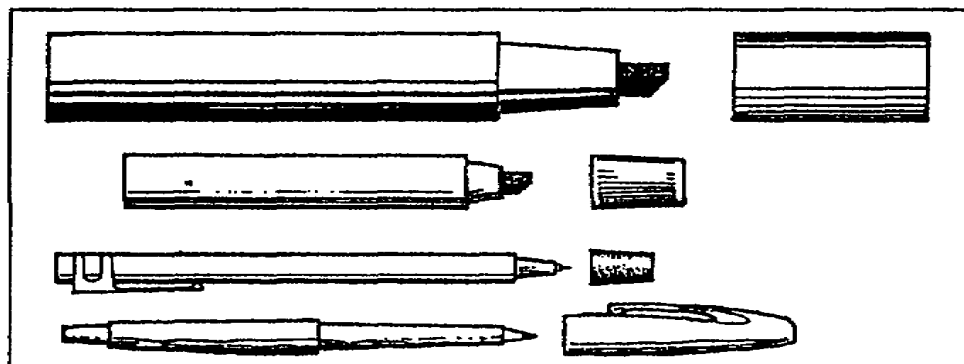


Figure 1-64. Markers for lettering

When lettering a project with a marker, draw the guidelines and text (the same process used for ink lettering). When you have completed the guidelines and text, check the text for correct spelling prior to lettering with a marker. However, if you do make a mistake while lettering with a marker, make the correction by covering the error with a typing label and relettering the area. This allows for neat corrections. Additionally, you must ensure the marker does not bleed through the drawing surface to the surface under the area you are lettering. If you





are preparing a flip chart, place a piece of scrap paper behind the area you are lettering to prevent the marker from bleeding through to the next page on the chart.

d. Brush Lettering. This is another flexible form of lettering that requires practice to obtain and maintain proficiency. As an illustrator, you can use brush lettering to produce letters ranging from 1/4-inch to 10 feet or more in size. All brushes have three major components: (1) hairs, (2) ferrule, and (3) handle. There are three different shaped brushes you use for lettering: (1) round, (2) bright, and (3) flat (figure 1-65).

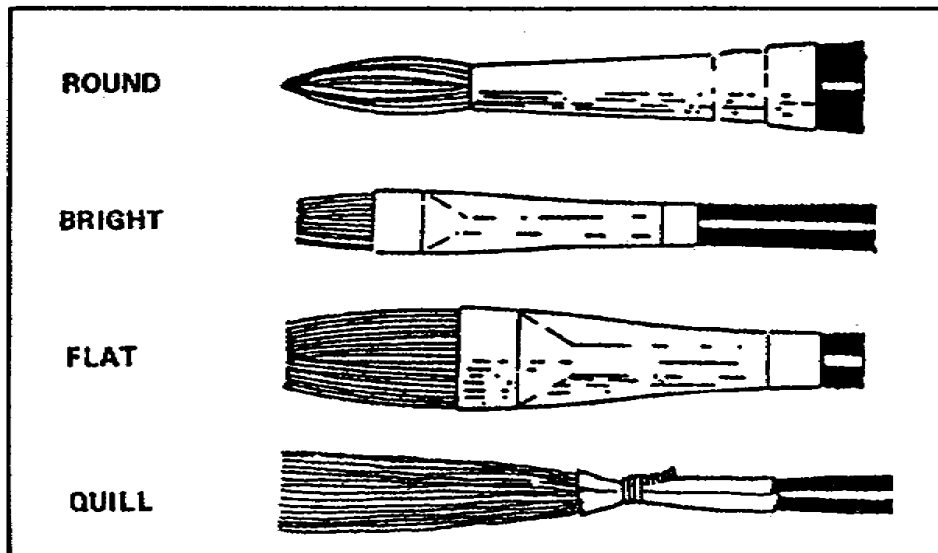


Figure 1-65. Lettering brushes

(1) Round brush. The hairs of this brush come to either a blunt or sharp point. The type of tip and the pressure exerted on the brush while applying the paint determines the different types of lettering for which you may use the brush. To use this brush to produce Gothic lettering, it must have a blunt, round point and you must apply even pressure while lettering. If this brush has a round tip, and you vary the pressure, you can create cursive lettering.

When using this brush to produce lettering, you can control the size of the line by controlling the amount of pressure applied on the brush. The more pressure you apply, the wider or broader the lines; conversely, the less pressure you apply, the finer the lines. A high quality round brush presents a fullness of the hairs when wet; whereas a poor quality brush looks concave at the sides and ragged.

(2) Bright brush. This brush has hairs that are 1 1/2 times longer than their width and flat with sharp corners. You would use this type of brush for lettering show cards, posters, and small signs.

(3) Flat brush. This brush has hairs 2 1/2 times longer than their width, square corners, and a flat ferrule. The long hairs of this brush allow for smoother application of the paint when making curves and long strokes. This brush also holds more paint than a bright brush; therefore, you can create more letters without resupplying the brush with paint.

(4) Quill brush. Illustrators consider a quill brush a specialized, flat lettering brush for signs. It has extra-long natural animal hairs, not stiff synthetic hairs, that hold large quantities of paint. Because of the length of the hairs, you normally use a maul stick for support and control when using this brush.

(5) Using the selected brush. To apply lettering with a brush, choose a brush with hairs equal to the size of the lettering (width of the stroke). After filling the brush with paint, use a scrap piece to work the tip of the brush into a chisel point that is the same size as the normal spread of the brush hairs. You then form each stroke of the letter with the tip of the brush, maintaining equal pressure with each stroke. Do not apply too much pressure to spread the hairs of the brush past their normal width. Excessive pressure causes uneven strokes and shortens the life of the brush.

(a) Brush grip choices. There are two different ways to grip the brush for lettering: pencil and two-finger. The pencil grip is the same grip used to hold a drawing pencil; use whichever grip you feel most comfortable with. No matter which grip you use, you must position the brush at a right angle (perpendicular) to the drawing surface so you finish each stroke with a clean-cut edge.

Most illustrators prefer the two-finger grip because it provides more maneuverability of the brush on curved strokes. To use this grip, hold the brush by its ferrule between your thumb and first finger. Keep the brush at a right angle to the drawing surface, and rest your other two fingers and the heel of your hand on the drawing surface. You make each stroke with a coordinated arm, wrist, and finger action. For vertical strokes, pull the brush toward you and make horizontal strokes from left to right. To draw a curve of uniform width, you roll the brush with your fingers in the direction of the stroke (figure 1-66).

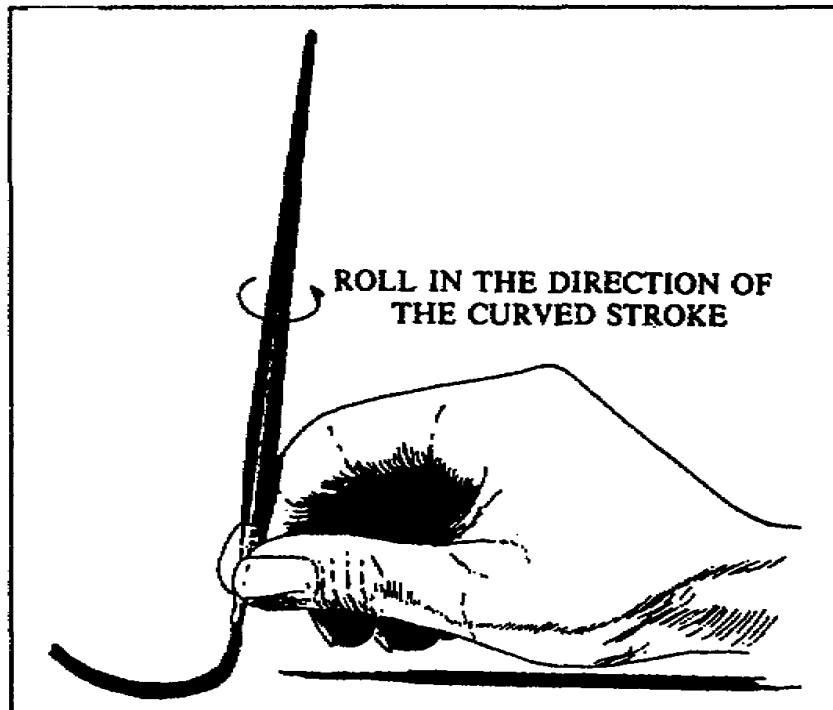


Figure 1-66. Two-finger brush grip

(b) How to do vertical and curved brush strokes. Figure 1-67 illustrates how to make vertical and curved brush strokes for the letters D and O. To form the D, your first stroke is a vertical stroke (step 1). After you have completed the vertical stroke, turn the brush sideways and square-off the top and bottom of the vertical stroke (step 2). You then make the left half of the curve holding the brush between the thumb and forefinger, twisting the brush in the direction of the stroke (step 3). The final step is to connect the curve as required to finish the letter (step 4). To draw the letter O, you start by creating two curves, and then turn the brush on its side to complete the letter.

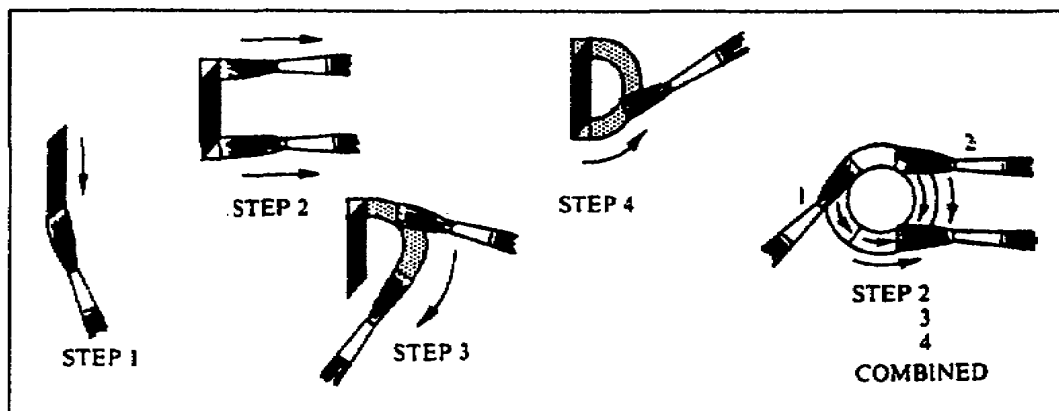


Figure 1-67. Sequence of vertical and curved brush strokes

(c) Caring for brushes. For the lettering brushes to perform properly and have a long life, you must clean and store them properly. All paints are not compatible with all thinners. Therefore, when you clean the lettering brush, you must ensure the thinner is compatible with the paint (figure 1-68). If you do not use the correct thinner to clean the brush, you could ruin the lettering brush.

	WATER	TURPENTINE	MINERAL SPIRITS	LACQUER THINNER
1 - USE FIRST 2 - USE SECOND				
WATER COLORS	✓			
LATEX	✓			
LATEX ENAMEL	✓			
ENAMEL		✓	✓	
LACQUER		2 ✓	2 ✓	1 ✓

Figure 1-68. Paint/thinner compatibility chart

Proper cleaning and storage of lettering brushes help prolong their life. After you have cleaned lettering brushes used in oil paints or lacquers, fill them with linseed oil, shape the hairs, and place them on their sides. Never rest brushes on their hairs.

An expedient way of storing a brush is to fill it with motor oil. The oil prevents the remaining paint from hardening, which causes the brushes to become useless. However, you must clean the brush and change the oil after a month of non-use.

A paint brush conditioner helps keep the larger brushes soft and pliable (figure 1-69). The container and thinner also softens dried oil-based paints in brushes. (The GSA supply catalogue details this container.)

## 7. Mechanical and Prepared Lettering.

You also can use mechanical lettering devices and prepared letters to letter graphic projects. Both mechanical and prepared letters have the advantage of producing uniform letters. Unfortunately, even the most experienced illustrator cannot letter a

graphics project as quickly using a mechanical lettering device as they can using freehand lettering.

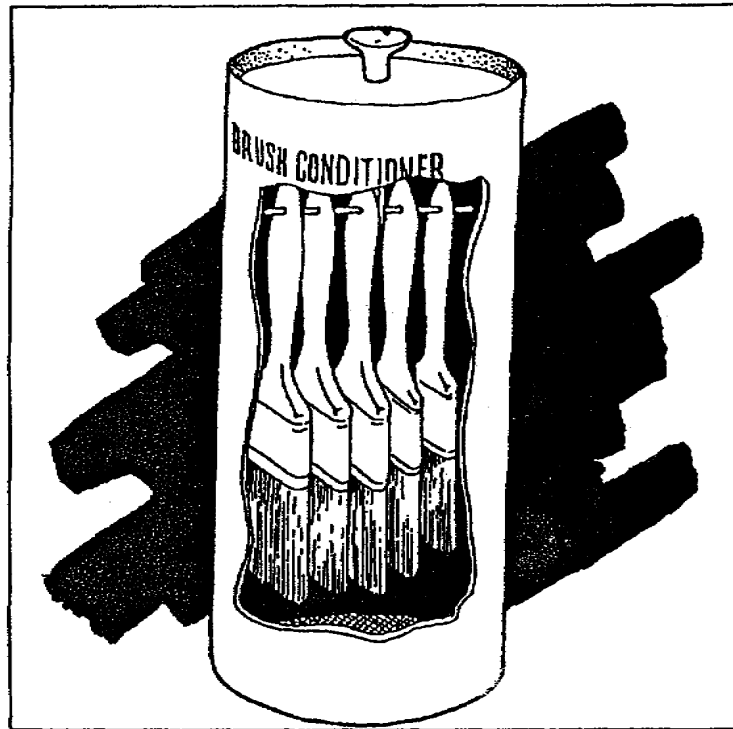


Figure 1-69. Brush conditioner

a. Mechanical Lettering. There are several different styles of commercial lettering sets that an illustrator could encounter, such as the Wilco, Varigraph, and Leroy. Each lettering set has the capability of producing a variety of neat, clean, uniform lettering styles and sizes, which range from 1/8 inch to 2 inches. With a small amount of practice, you can master the use of these lettering sets. Because of its popularity, the Leroy lettering set has become the industry standard for mechanical lettering (figure 1-70).

(1) Leroy lettering set. The Leroy lettering set has 12 templates or guides (60, 80, 100, 120, 140, 175, 200, 240, 290, 350, 425, and 500) with the height of the letters indicated in thousandths of an inch (e.g., 1/2 inch letters equal template 500), a three-legged, adjustable scribe, pens and pen holders, a special Leroy pen holding attachment, and a special pencil attachment for the scribe (figure 1-70). The templates and pens for lettering over 500 (1/2 inch) are not part of the standard set. The following templates and pens are available:

<u>Template</u>	<u>Pen Size</u>
700	8
1000	10
1350	12
2000	14

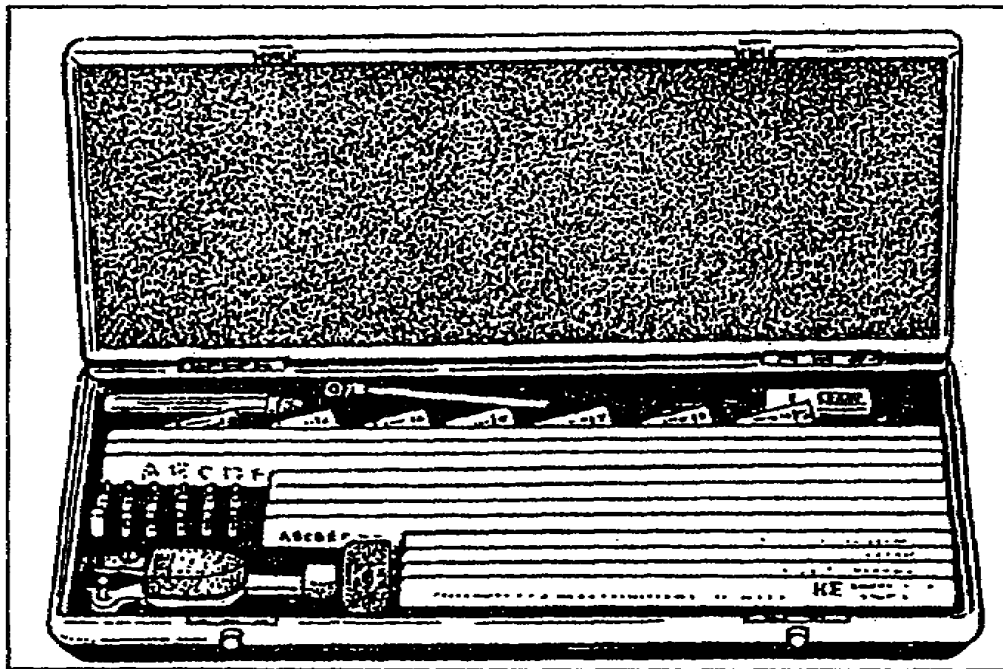


Figure 1-70. Leroy lettering set

One of the scribe's arms holds the pen or the pencil, and the other two arms have tracer points. The tail pin moves along the straight groove on the template, while the tracing pin moves in the engraved characters on template (figure 1-71). When you move the tracing pin around the contour of a character on the template, the entire scribe hinges on the tail pin in the groove on the template, and the pen or pencil duplicates the character you traced on the drawing surface.

The scribe has an adjusting screw next to the pen point (figure 1-71). The adjusting screw controls how much pressure or contact the pen point makes on the drawing surface. You set the adjusting screw so the tip of the cleaning pin just contacts the drawing surface. If the pen point exerts too much pressure on the drawing surface, the pen grooves the drawing surface and too much ink flows from the pen. The letters also have a tendency to run and smear. Additionally, you can adjust the slant of the characters up to  $22\frac{1}{2}^{\circ}$  by adjusting the scribe's tracer arm.





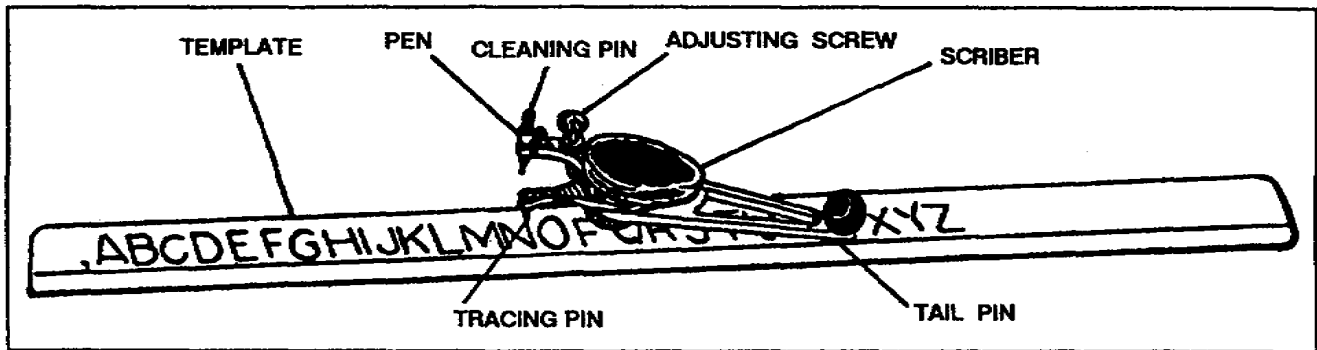


Figure 1-71. Leroy scriber and template

The pens used in the Leroy lettering set mount vertically in the scriber and have a steel wire cleaning pin that you use to keep ink from clogging the pen point. The newer models of this lettering set have reservoir pens that hold enough ink for several days of lettering without refilling the reservoir.

To produce quality letters for your graphics project, the size of the pen must correspond to the size of the letters. The larger the letters, the larger the pen used to produce the lettering (figure 1-72). For example, if you decide to use 1/2 inch (500) letters, you must use a number 6 pen to produce stable, uniform letters.

<b>TEMPLATE</b>	<b>60</b>	<b>80</b>	<b>100</b>	<b>120</b>	<b>140</b>	<b>175</b>	<b>200</b>	<b>240</b>	<b>290</b>	<b>350</b>	<b>425</b>	<b>500</b>
<b>PEN SIZE</b>	<b>000</b>	<b>00</b>	<b>00</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>6</b>
<b>PEN THICKNESS</b>												

Figure 1-72. Leroy pen table

(2) Using the Leroy lettering set. After you have determined the letter requirements and correctly fastened the graphics project to the drawing surface, you can letter the project with characters of uniform height, thickness of strokes, and slant using the Leroy lettering set by following a few simple steps:

(a) Draw the correct size guidelines for the lettering you have chosen for the project.

(b) Put the correct lettering template on the top edge of the T square and scriber (with the correct pen attached) in operating position on the template.

(c) Position the T square. Adjust the T square, template, pen, and scribe to the proper position for lettering on the guidelines. Once you have the T square properly positioned, a piece of tape at both ends of the T square helps prevent it from moving. Occasionally, moving the template along the T square causes smudges and streaks on the drawing surface. To prevent these marks from appearing on the project, place a piece of scrap paper between the drawing surface and the template.

(d) Letter the graphics project. If you make a mistake when lettering the graphics project, let the ink dry and remove the error with a steel eraser. Then reburnish the drawing surface and insert the correct lettering.

(3) Other lettering machines. Other mechanical means of producing lettering are the Kroy or Merlin pressure lettering machines. These machines produce characters through a pressure or dry carbon transfer process using a lettering font or wheel with various styles and sizes (8 to 36 point) of raised letters. The machine prints the characters on 1/2-inch paper or plastic strip that is clear or colored with an adhesive back with a protective, peel-off coating. These machines range from a simple, one character at a time process, to automatic with computer memory, editing functions, and a display screen (figure 1-73).

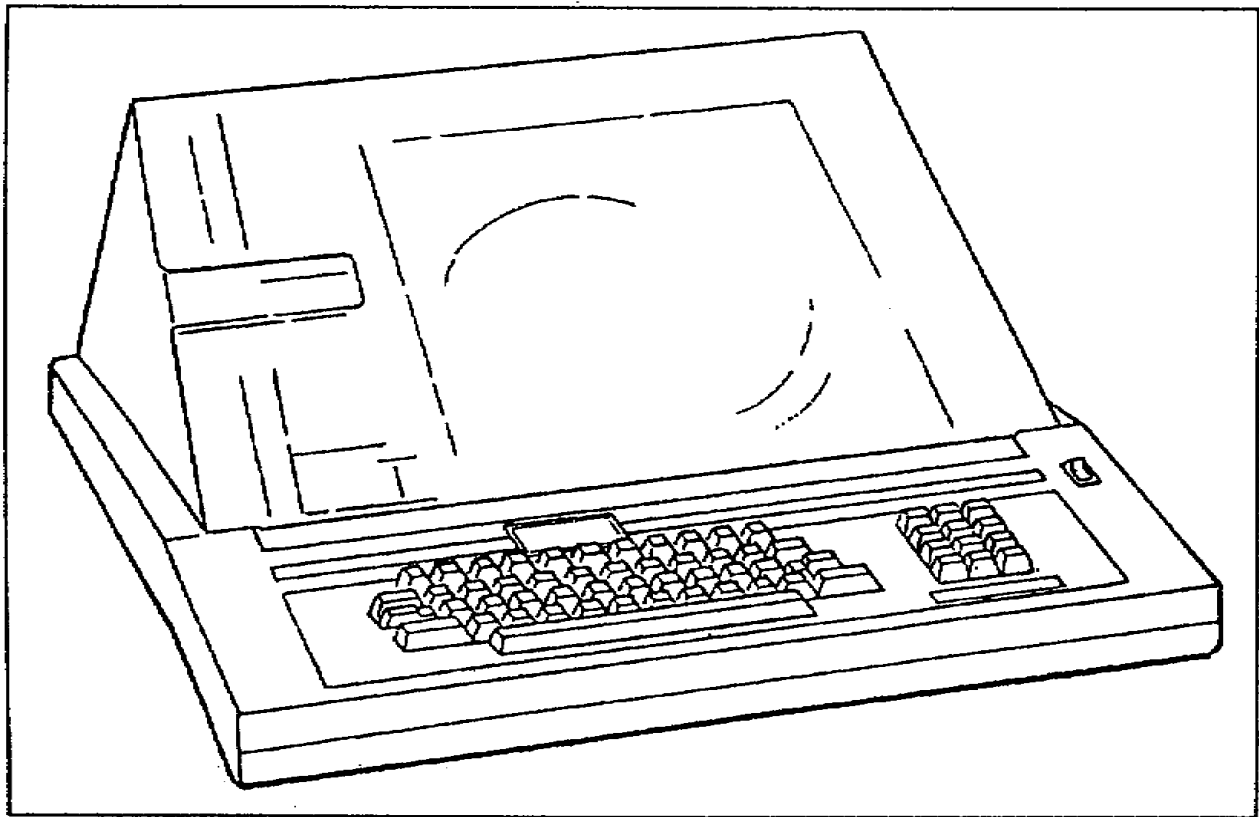


Figure 1-73. Pressure lettering machine



b. Prepared Lettering. As a graphics documentation specialist, you have a wide variety of sizes and styles of pressure-transfer lettering sheets to choose from when lettering a graphics project using this method.

(1) A lettering sheet. A lettering sheet has the letters of the alphabet printed on the back side of a waxed acetate sheet. Each lettering sheet has a protective backing sheet to protect the letters from sticking to another letter sheet during storage. For this reason, you must apply the backing sheet when not using the lettering sheet.

(2) Applying pressure-transfer letters. When applying pressure-transfer lettering, the only guideline you must use is the baseline. After you have determined the size and style of lettering for the graphics project, draw the guidelines (baselines) for the letters.

Then remove the protective backing from the lettering sheet, align one letter at a time with the guidelines, burnish the letter into place with a plastic burnishing tool, and lift the letter sheet (figure 1-74). If you do not have access to a plastic burnishing tool, you may use any rod-like object with a narrow, round end (e.g., the end of a comb). When burnishing a letter on the lettering sheet, ensure you burnish only the letter you must transfer to the graphics project. If you burnish two or more letters simultaneously, they may stick or not align correctly.

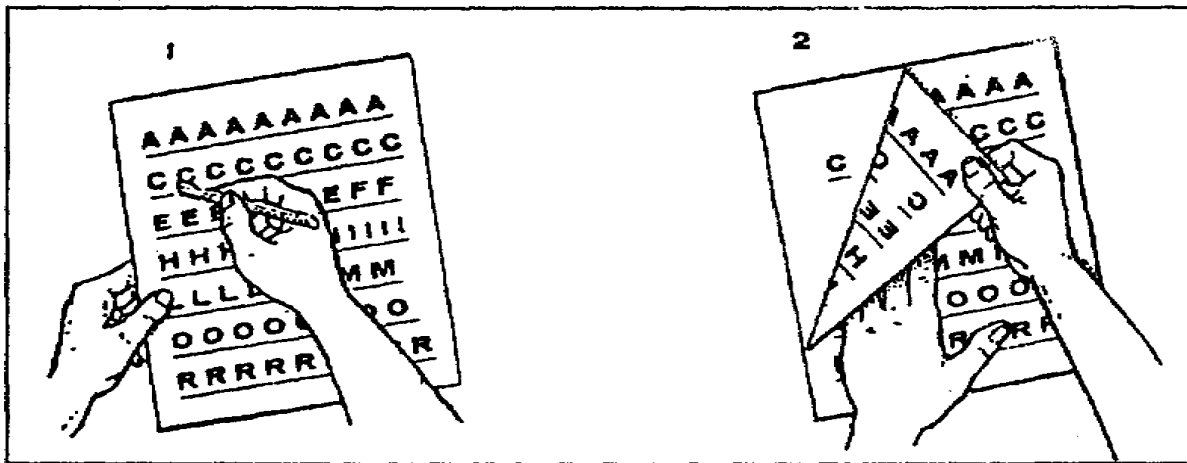


Figure 1-74. Burnishing a letter into place

(a) You should not use a pencil as a burnishing tool. A pencil leaves graphite on the lettering sheets that could transfer to the graphics project and ruin the project.

(b) If you apply the incorrect letter, you can remove it by applying masking tape over the incorrect letter and



carefully lifting it up with the masking tape. Then you insert the correct letter in the space.

(c) Pressure-transfer lettering sheets provide quality letters for indoor use. However, you should only use them for small jobs since they require much time to apply and have a limited number of each letter on a sheet.

(3) Centering letters. You are going to encounter many instances when a graphics project requires the lettering centered over graphics or within a certain space. No matter what lettering method (mechanical or pressure-transfer lettering sheets) you select, center the lettering using the same process.

First you find the center of the area or graphic on which you must center the lettering. Then find the letter that is in the center of the letters you must apply and place it on the center of the area or graphics. Then apply the remaining letters from the center out.

For example, you must center the letters "Army Training." over a box that is 2- x 2-inches. First, you must find the center of the box, which is one inch from either side. Next you count the number of letters, spaces, and punctuations marks in "Army Training.", which is 14. With 14 spaces used in the lettering, the letter in the seventh space is the center of the group, the letter "r" in training. Therefore, you place the letter "r" on the center of the box and apply the remaining letters from the center out. Figure 1-75 shows the completed lettering centered over the box. For a graphic presentation, you would not show the center line of the box; however, the figure shows it so you can see the phrase is centered over the box.

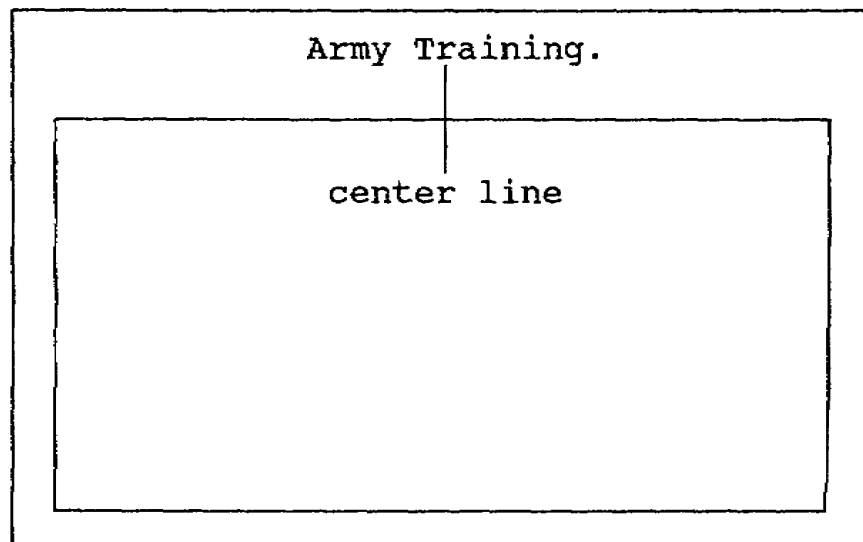


Figure 1-75. Center of lettering in a graphic

(4) Determining letter size. The key to legibility is the size of the lettering in the graphics project, not the overall size of the project. Just because the overall size of a project is relatively small, that alone does not dictate the use of small lettering in the project. The distance from which the viewer must see and understand the project does dictate the size of the lettering used in a graphics project. The closer the viewer is to the project, the smaller the lettering on the project; conversely, the farther away from the project the viewer is, the larger the letter you must use.

Figure 1-76 shows the minimum letter height required for a given distance. If the viewer is 10 feet from the project, the minimum size letter on a graphic project would be .350.

MINIMUM LETTER SIZES		
DISTANCE FROM DISPLAY TO FARTHEST VIEWER (FEET)	MINIMUM LETTER HEIGHT (INCHES) (POINTS)	
10 - 11	.350	25.2
11 - 12	.400	28.8
12 - 15	.425	30.6
15 - 18	.500	35
18 - 21	.600	43.2
21 - 23	.700	50.4
23 - 25	.750	54
30 - 35	1.000	72
35 - 40	1.250	90
45 - 50	1.500	108
55 - 60	1.500	108
60 - 70	2.000	144
70 - 85	2.500	180

Figure 1-76. Minimum lettering size chart

## PART C - COMPUTER IMAGING SYSTEMS

### 8. Terms and Definitions.

Before you can use any system or piece of equipment, you must understand the terms associated with the equipment. This part of the lesson begins with the definitions of the terms associated with computers.

a. Hardware Terms. The term hardware applies to all parts of the computer that you use to run the various programs. It

also includes the components inside as well as outside the case of the computer.

(1) Processor (microprocessor). The processor has two functions in the computer. The first function it performs is the actual mathematical calculations required for a computer to perform the tasks input to it. The second function it performs is controlling any processing that takes place as directed by a program resident in the memory.

(2) Memory. The space the computer uses to perform the tasks input, usually measured in kilobytes or megabytes. In a microcomputer, memory consists of chips attached to the microprocessor. Memory has the capability of being increased or decreased by simply removing or adding chips.

Most microcomputers have two types of memory: read only memory (ROM) and random access memory (RAM). ROM stores permanent data (i.e., setup instructions for the computer and current time and date). You do not lose the data stored in ROM when turning the computer off. You do not have the capability of changing data in the ROM or adding data to ROM.

RAM allows the processor to change the data that it holds. Therefore, this is the memory the computer uses to perform its work. However, for RAM to retain data input, the computer cannot be turned off. If the computer loses power or you turn it off, you lose all data in RAM.

(3) Central processing unit (CPU). This is a general computer term that describes the processor and any memory used in support of the processor. When referring to microcomputers, it includes the microprocessor chip and the small amount of RAM.

(4) Coprocessor. As indicated by its name, the coprocessor helps the processor perform tasks input to the computer. The most common coprocessor you encounter is a math coprocessor. When the program requires difficult math calculations, the processor may send it to the math coprocessor, which allows the processor to continue monitoring and performing other functions. This is one way of speeding up a computer that continuously performs complicated math functions (most graphic programs require many math computations). The coprocessor mounts in a socket adjacent to the processor.

(5) Peripherals. Peripherals are accessory devices that attach to the computer for data input and output. Do not confuse peripherals with optional equipment. Without peripherals, there is no way to input data to a computer or receive output data from a computer. The following are some common computer peripherals:



(a) Keyboard. The keyboard is one of the computer's input devices. It has the same basic arrangement as a typewriter keyboard, with the addition of more keys. The keyboard has 10 function keys labeled F1 through F10. These keys perform different functions as dictated by the program in memory.

Most keyboards have a numeric keypad. This part of the keyboard has the same layout as a business calculator. When activated, this part of the keyboard functions the same way as the keyboard of a calculator (figure 1-77).

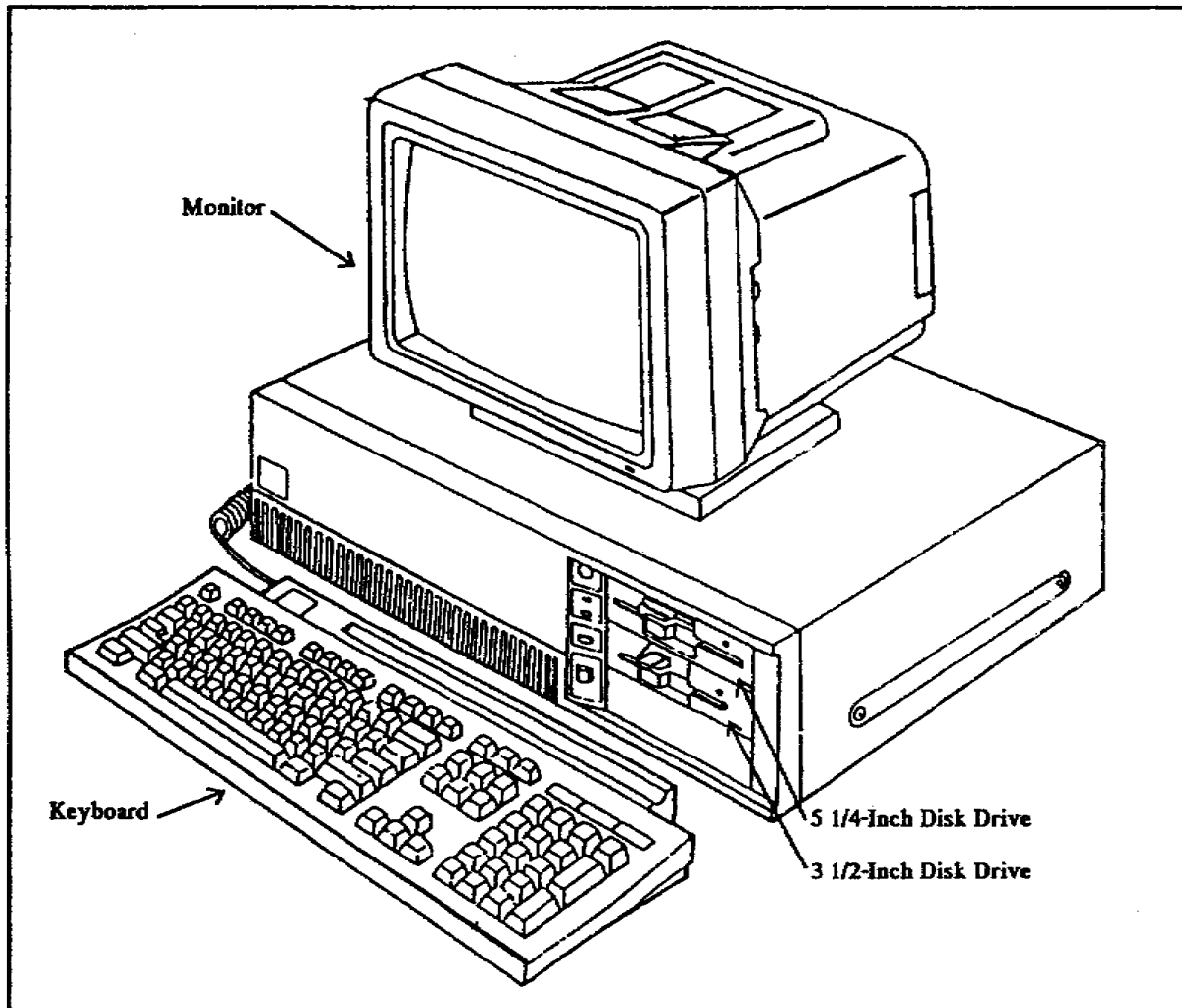


Figure 1-77. Typical computer

(b) Monitor. This is another computer output device. There are two types of monitors: color and monochrome. The monitor enables users to see the results of their input to the computer. The monitor also displays the cue or prompts the computer uses to ask for operator input (figure 1-77).

(c) Drives. There are three different types of drives: (1) hard disk, (2) floppy disk, and (3) tape. Both the hard disk and floppy drive are mass data storage devices for microcomputers and are input and output devices. Usually the hard disk drive mounts permanently in the computer and can store in excess of 105 megabytes of information.

Like the hard disk drive, the floppy disk drive usually mounts in the computer, but uses floppy disks (either 5 1/4- or 3 1/2-inch) to store information.

External drives, both hard disk and floppy, present a means of increase to the storage capacity of the computer without a major reconfiguration. External drives have a separate power supply and connect to the computer via cables.

Originally, only large computers used tape drives. However, advances in technology have developed them to the stage where occasionally you find them in use with the microcomputer. The cassette tapes come in a wide variety of storage capacities, 20 megabytes to 8 gigabytes.

(d) Printers. Printers are computer output devices. Printers provide a way of taking a permanent record of the computer output, known as a hard copy. The printers used with today's computers are more than just glorified type-writers. Most printers now have the ability to create graphics, such as charts, graphs, and pictures.

(6) The system. This term includes all the computer's components and peripherals. The system includes all the input and output devices, in many different forms. The system is all the components required to take the operator's input, process it to the desired form, and have a permanent record of the finished form, either a hard copy and/or stored on a hard or floppy disk.

b. Software. Software is the individual program that allows the computer operator to create the graphics presentation. There are many software programs available for an illustrator to use to create charts, slides, and line drawings.

c. Floppy Disk/Diskette. Floppy disks serve as a form of low-cost data storage. Currently there are two sizes of floppy disks in use, 5 1/4- and 3 1/2-inch. Depending on the size and characteristics of the floppy disk, it can hold anywhere from 360 kilobytes to 1.4 megabytes of data.

The 5 1/4-inch floppy disk is a thin, flexible magnetic disk stored in a thin, square, cardboard casing. To ensure you do not damage the floppy disk and lose the data on it, use the following safety precautions (figure 1-78):

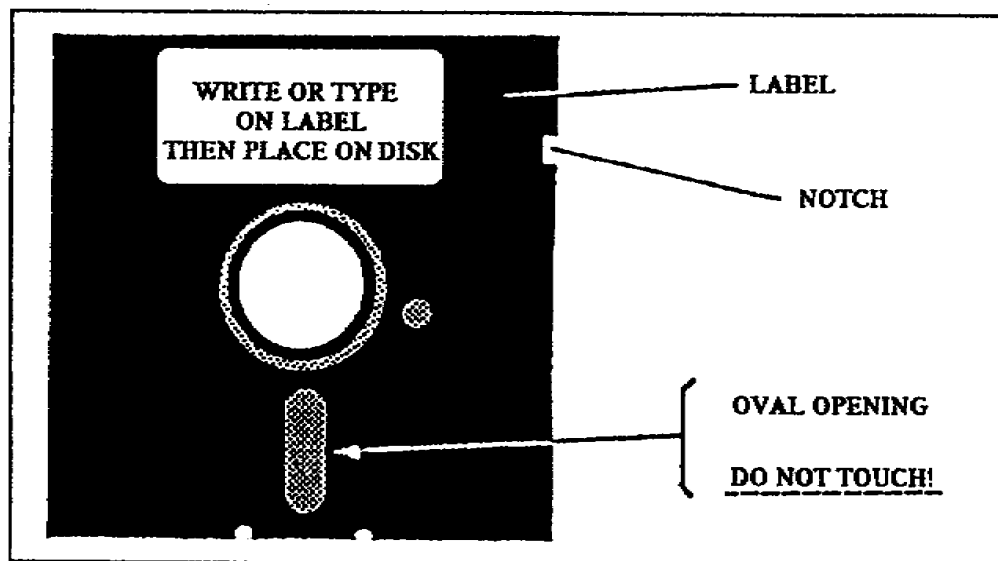


Figure 1-78. 5 1/4-inch floppy disk

(1) Handle the disk by its edges only. Never touch the disk through the read/write (oval) window.

(2) Keep the disk away from direct sunlight, magnets, and heat. You should never store the disks in metal cabinets.

(3) When preparing a label for the disk, complete the label prior to attaching it to the disk. Never write on a label already attached to the disk.

(4) Make a back-up copy in case of operator error or system/power malfunctions.

(5) Exercise caution when inserting the disk in the drive. Ensure that the notch is in the correct position, on the left when the drive mounts horizontally in the computer.

(6) If the disk contains classified information, store it in a place that is cleared for the level of security of the data on the disk.

d. Save. This term means transferring the data used to produce a graphic to a hard or floppy disk. Once you have saved the data, you can recall the data and make changes repeatedly. There is no limit to the number of times you can save and recall data to make changes. When creating large graphics, you should save your work frequently. This provides you with a back-up copy in case of operator error or a system malfunction.



NOTE: The portion of the lesson discussing a computer imaging system was developed using generic computer terminology that applies to most imagery systems. The order and some steps in the process could differ depending on the system you are using.

## 9. Computer Imaging Systems.

With the advancement of computer technology and graphic software programs, computer imaging systems are now another tool that an illustrator uses to produce graphics projects. An advantage of a computer imaging system is, no matter what the desired output, you can design all projects in the same manner and then use the software for the specific output (i.e., viewgraphs, 35mm slides, hard copy, etc.).

These systems are time-saving tools because once you have designed the graphics, you print a hard copy, and save the image to the hard disk or on floppy disk. If you are reviewing the graphic and you see the need to make changes, you simply recall the graphic to memory, make only the required changes, and repeat the process to print a hard copy and save the graphic. Most graphics software programs provide a means of changing many of the attributes of a graphic, such as, but not limited to, the size and style of lettering, line weights, and backgrounds.

a. Inputs and Outputs. A typical graphic imaging system has many different input and output peripherals that make up the system. The key to a system that operates well in all modes is compatibility of the software and peripherals. If the software cannot interface (communicate) with the input or output devices, the results are unrecognizable symbols and characters.

Figure 1-79 shows a typical graphics imagery workstation. The inputs for this work station are the keyboard, mouse, and scanner. The outputs of this workstation are the monitor, laser printer, plotter, and camera.

b. Creating a Graphic Using a Computer Imagery Workstation. Prior to turning on the computer, review the VI work order for the job requirements, and review the standing operating procedure (SOP) for any standard formats already developed. (The use of standardized formats saves time and adds to the VI facility's professional reputation.)

After you have reviewed the work order, turn on the computer and perform the necessary steps that the software requires to start the graphics program that you have selected to produce the graphics (i.e., pie or bar chart, text, illustrations, etc.). Then, you enter the data for the graphic from the thumbnail sketch provided with the work order, which may include:

- (1) Title.
- (2) Number of increments (slices, divisions, etc.).
- (3) Bulletized information or any text.
- (4) Legend information (patterns, colors, shapes, etc.).

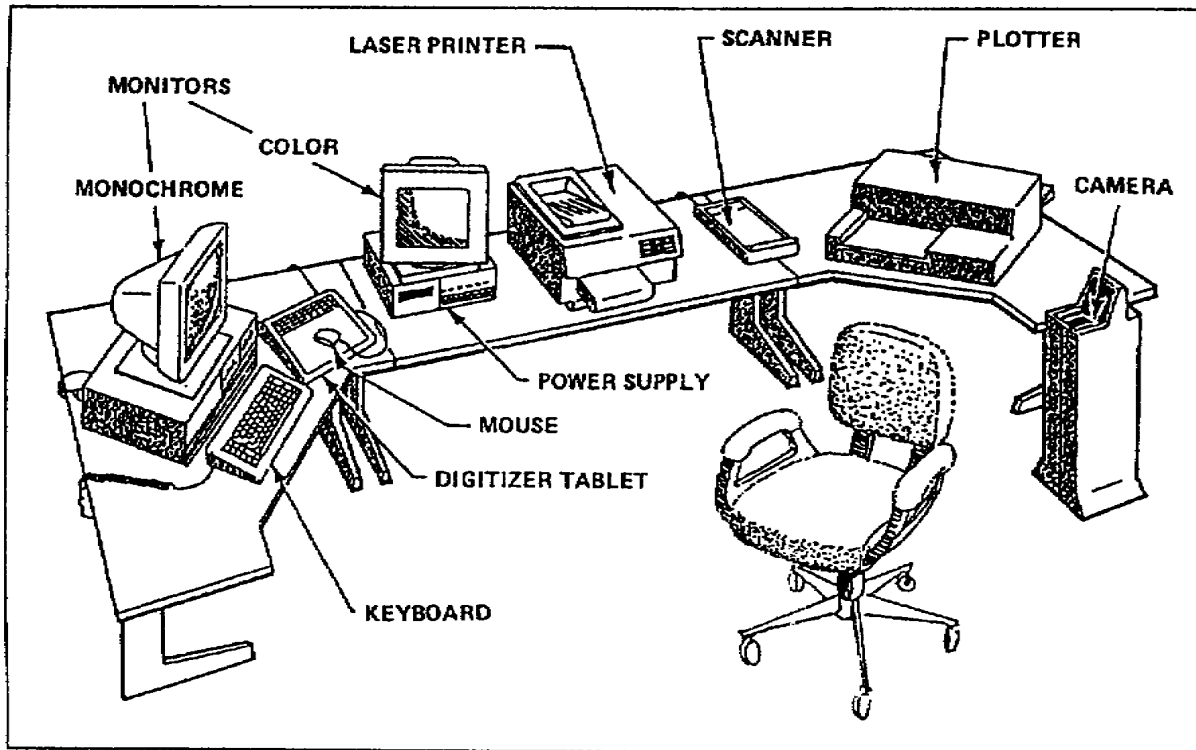


Figure 1-79. Typical graphics imagery workstation

Use the appropriate command (i.e., view, preview, draw, edit) to have the computer place the information in the graphic and display it on the monitor. The graphic the computer displays on the monitor has the data you input to the computer in a default image. (Default images use standards previously established relating to size, layout, line weight and size, and size and style of text.)

c. Reviewing Computer Image and Making Changes. After you have reviewed the image the computer presents on the monitor, you have the opportunity to make changes to the graphic by using the draw, edit, or enhancement function (whichever the software you are using requires).

(1) Making changes. The function allows the operator to make changes to almost any of the graphics attributes. For example, the operator can change the color of the background, borders, data, line weights in different portions of the graphic, lettering types, styles, or move portions of the graphic to different locations and resize them.

When you have completed the changes to the graphic, use the same function as before to view the graphic again. This time you see the graphic with all the changes you made. At this point, you can make additional changes or save the graphic. Remember to save your work frequently when creating graphics with large amounts of data.

(2) Naming the graphic. When saving the data used to create a graphic, the computer usually asks you to provide the name for the graphic. Use a name that allows you to figure out what the graphic is and to what project it belongs. Once you have provided the name, the computer lists the choices of actions you can take (i.e., save and continue editing, save and print, save and return to main menu, save and exit the system, etc.).

(3) Producing the graphic. When you are satisfied with the graphic, choose the appropriate output device (printer, plotter, 35mm camera system) for the format of the finished project. You then use the correct software to process the graphic and send it to the output device for production in the proper format. For example, use the plotter for printing on clear acetate to produce viewgraphs, and the laser printer to produce a hard copy (paper) of the graphic.

After you have checked the finished graphic, you still have the opportunity to make any changes you deem necessary. To make these changes, use the same process as before: recall the graphic, edit and make the changes, save the changes, produce the finished graphic.

When you are satisfied with the finished graphic, you can start another or log off the system.

(4) Time-saving feature. Most graphics software programs provide you with a time-saving feature. If another graphic you have already produced closely resembles the new graphic, you can call the completed graphic into memory. Then, make the necessary changes so it presents all the data required for the new graphic and save the graphic with a new (different) name. Not only do you have the new graphic you created, but the graphic you previously created with its original title is still available.

d. Computer-based Graphics Presentations. With the increased use of computers, you could be tasked to produce a computer-generated graphics presentation. This type of presentation is where the computer presents all the information on the monitor in one or a series of graphics. In addition to normal requirements for a graphic, there are simple requirements that you must consider and apply when preparing a computer-based graphics presentation.

(1) Use the appropriate display rate when the graphic consists of more than one screen. Because individuals reread or skim previously-read material to review it, you should display whole paragraphs or large blocks of text at the same time instead of one sentence or line. Once you have developed the display rate, keep it regular and predictable.

(2) Place the primary information at the upper-left hand corner of the screen as that is where the eye goes first.

(3) Limit the line length to 60 characters. Readers find text lines at an excess of 60 characters hard to read without losing their place.

(4) Left-justify text but do not right-justify it. When you right-justify text, the spaces interrupt eye movement and slows down the reading speed.

(5) Use different fonts to differentiate screen-components. Use bolder letters to designate higher-level priorities such as titles and headings.

(6) Emphasize important data with text attributes. You can use text attributes to add emphasis and aid comprehension, but use them with restraint. Use only two attributes on any screen to avoid a cluttered, busy look.

A specific example of a computer-based graphics presentation is the slide show capabilities found in the Harvard Graphics software. A slide show is a collection of either single or multiple charts, other slide show files, or bit-mapped files created in paint programs. The slide show feature in the software provides you with the capability of working with more than one chart at a time. Additionally, this software feature provides you with the capability of capturing the output of other software programs (e.g., dBASE, Lotus 1-2-3, etc.) and incorporating them into a slide show presentation.



With Harvard Graphics, you can preview the slide show on the computer screen, or send the output to a printer, plotter, or film recorder. This software also allows you to create practice cards for the user's notes or a menu so the user can make selections that control the slide show. Once you have created the slide show, the software provides you with the capability of adding, deleting, or rearranging the slides, as required.

This concludes lesson 1. Before continuing with lesson 2, complete the practice exercise following this lesson.



## LESSON 1

### PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. You must design and construct a chart that shows data accumulated over a specific period of time. Which of the following types of charts should you use for this requirement?
  - A. Bar
  - B. Pie
  - C. Line
  - D. Column
2. You are designing a table for a presentation. Which of the following describes the correct position to place the data the table emphasizes?
  - A. Upper-left side
  - B. Lower-left side
  - C. Upper-right side
  - D. Lower-right side
3. When you design a table for a graphics presentation, which of the following statements must you apply when determining the width of each boxhead?
  - A. Keep it as large and as wide as the largest caption.
  - B. Keep it as large and as wide as the caption placed in it.
  - C. Keep it two lines larger and two spaces wider than the largest caption.
  - D. Keep it two lines larger and two spaces wider than the caption that is placed in the it.
4. You must letter a graphic with lettering consisting of only upper-case, inclined letters. Which of the following describes the guidelines you would use for this lettering?
  - A. Cap, base, and waist
  - B. Cap, base, and direction
  - C. Cap, waist, and direction
  - D. Base, waist, and direction

5. You are lettering a graphic with a flat brush. To ensure you finish each stroke with a clean-cut edge, at which of the following angles should you hold the brush in relation to the drawing surface?
- A. 30°
  - B. 45°
  - C. 90°
  - D. 120°
6. Using a Leroy lettering set, you must letter a graphic with 1-inch letters. To ensure the letters are the correct width, which of the following size pen tips should you use?
- A. 8
  - B. 10
  - C. 12
  - D. 14.
7. When designing a computer-based graphics presentation, which of the following indicates the maximum number of characters you would place on each line of text?
- A. 60
  - B. 70
  - C. 80
  - D. 90

## LESSON 1

### PRACTICE EXERCISE

#### ANSWER KEY AND FEEDBACK

<u>Item</u>	<u>Correct Answer and Feedback</u>
-------------	------------------------------------

- |    |         |
|----|---------|
| 1. | C. Line |
|----|---------|

	Each type of chart presents data in different forms and time periods. A smooth line chart presents the cumulative (total) effective over a given time period. The smooth line chart is very useful in presenting the current trend of the plotted data, whereas a pie chart compares the individual parts that comprise the total to the total, and the bar and column charts show relationships between several items at or over a given time period (page 1-30, para 3b).
--	---

- |    |                    |
|----|--------------------|
| 2. | A. Upper-left side |
|----|--------------------|

	Since most people that will be reading the table read from left to right and top to bottom, the first place the viewer looks when reading a table is the upper-left side; therefore the upper-left corner is the appropriate place to present the data the table emphasizes (page 1-60, para 4b).
--	---

- |    |  |
|----|--|
| 3. | C. Keep it two lines larger and two spaces wider than the largest caption. |
|----|--|

	For the viewer to readily see and understand the captions in the boxheads and for the table to present an uncluttered appearance, you should size the boxheads two lines larger and two spaces wider than the largest caption. This means all the boxheads are the same size, with the lettering in the center (page 1-62, para 4b(2)(d)).
--	--

- |    |                             |
|----|-----------------------------|
| 4. | B. Cap, base, and direction |
|----|-----------------------------|

	When constructing guidelines for upper-case letters only, you use the base and cap lines; however, when the lettering is inclined you should also use direction lines as a reference so all letters have a uniform slant. So in this case, you should use the cap, base, and direction guidelines (pages 1-63 and 1-64, para 5a).
--	---



Item      Correct Answer and Feedback

5.            C.     90°

Whatever grip you use to hold the brush, you must hold the brush perpendicular (90°) to the drawing surface so each stroke ends with clean-cut edges (page 1-72, para 6d(5)(a)).

6.            B.     10

Using pen tip sizes 8, 12, and 14 to create 1-inch letters would produce letters with lines that are not proportional to the size of letters. (Size 8 would produce small lines, sizes 12 and 14 would produce large lines.) When using the Leroy lettering set, the size of the pen tip must correspond to the size of the letters so you can produce uniform, proportional, and balanced letters (page 1-75, para 7a(1)).

7.            A.     60

When you have more than 60 characters per line of text, the viewer often finds it difficult to read without losing his place, which may cause him to overlook the intended emphasis of the graphic. Therefore, you should always use 60 characters or less per line of text on a computer-based graphics presentation (page 1-89, para 9d(3)).





## LESSON 2

### PROJECTION MEANS AND METHODS

Critical Tasks: 113-579-2019, 113-579-2024  
113-579-2027, 113-579-5060  
113-579-8004

### OVERVIEW

#### LESSON DESCRIPTION:

In this lesson you will learn the different types of projection equipment used in conjunction with graphics and how to prepare projection graphics. You also will learn how to prepare overlays, the different printing processes, and the color separation process.

#### TERMINAL LEARNING OBJECTIVE:

- ACTIONS:
- a. Describe the various methods used to reproduce graphics for use in projection presentations.
  - b. Describe the operation of a diazo process machine.
  - c. Describe the operation of a photostatic camera.
  - d. Describe the operation of a thermofax machine.
  - e. Explain the methods used for projected graphic presentations.
  - f. Describe the requirements for effectively produced still graphics.
  - g. Explain the requirements for effectively produced television graphics.
  - h. Explain the various methods used for printing.
  - i. Describe the color separation process.
  - j. Explain the various types and uses of overlays.
- CONDITION: You will be given information from DA Pam 325-10 and STP 11-25M13-SM-TG.
- STANDARD: Describe the methods of reproducing and projecting graphics, printing processes, and preparing overlays in accordance with DA Pam 325-10 and STP 11-25M13-SM-TG.

REFERENCES: The materials contained in this lesson were derived from the following publications: DA Pam 325-10 and STP 11-25M13-SM-TG.

## INTRODUCTION

As an Army graphics documentation specialist, part of your responsibilities include preparing overlays for graphics and maps, graphics for various types of direct projection, and television graphics. This lesson presents some of the methods available to perform these tasks.

### PART A - METHODS OF REPRODUCING

#### 1. The Diazo Process.

This reproduction process provides you with the capability of producing standard paper copies or viewgraph slides of original graphics. However, this process allows only a one-to-one reproduction ratio from the master. No reductions or enlargements are allowed.

a. Diazo Process Materials. This process uses specially treated film and paper and a diazo machine to develop these materials. The film, or foils, and paper have a special coating of diazo salt and an azo dyestuff. The diazo salt used to treat the foil or paper is light sensitive, especially to ultraviolet light.

(1) Chemical change. When you expose the coated foils or paper to an ultraviolet light, a chemical change takes place that will not allow an image to form. By not exposing the coating to the ultraviolet light and developing it in an alkaline medium, such as the vapors of commercial ammonia (ammonium hydroxide), the diazo salts combine with the dye to form a colored image, as determined by the type of dyestuff on the foil (figure 2-1).

(2) Methods to develop diazo foils. There are two different methods used to develop the diazo foils: dry developing and ammonia developing (figure 2-2). The dry method has both the diazo and the coupler included in the sensitizing formula, stabilized by a mild acid to prevent premature coupling. The ammonia method has the developer on the paper and the coupler is in the developing solution.

The diazo process has three basic steps: (1) preparing the master, (2) exposing and developing the diazo foils, and (3) mounting the foil.

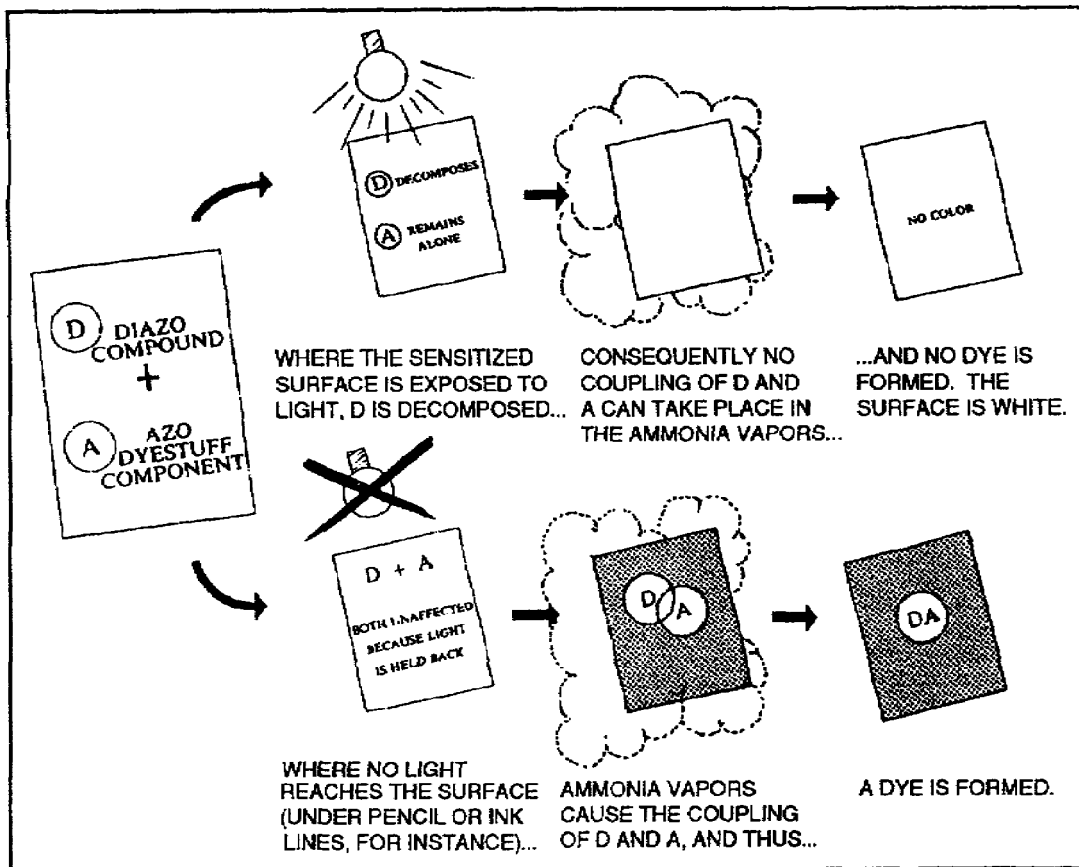


Figure 2-1. Simplified diazo process

b. Preparing the Master Copy. The drawing and base materials used to prepare the master are a key element affecting the quality of the diazo reproduction. For this process to function correctly, the paper used to prepare the master copy must allow ultraviolet light to pass through the areas not covered by the graphic, while the graphic must not allow the ultraviolet light to pass through or penetrate to the diazo film.

(1) Select correct diazo master. Therefore, you must use a transparent film or translucent paper as the base material for a diazo master. Usually, the use of a high grade of tracing paper for the master results in excellent reproductions. Select a grade of tracing paper with a fine fiber texture. Additionally, using the same grade of paper for all masters eliminates changing the exposure time, which decreases wasted film by



eliminating the constant need to find the correct exposure setting.

The graphic on the master must not allow the ultraviolet light to pass through or penetrate to the diazo film. Therefore, you must ensure the entire image is opaque (will not allow light to pass through). To ensure the graphic is opaque, use a good quality India ink when inking the graphic. You cannot use regular pencils, transparent inks, or typewriter ribbon to create opaque graphics or lettering on a diazo master.

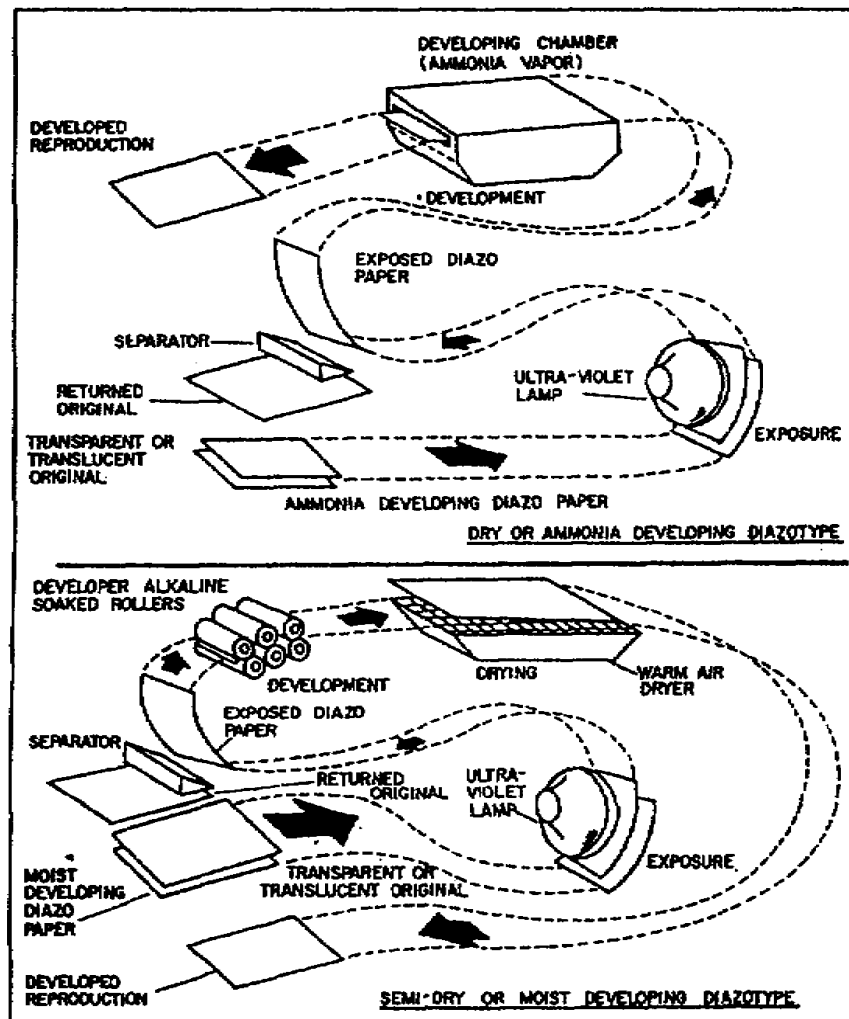


Figure 2-2. Diazo developing methods

(2) Lettering height. If you are preparing a master for a viewgraph, ensure the lettering is the correct size for the viewgraph's intended use. The distance the farthest viewer and the projector are from the screen dictates the minimum size of the lettering used on the viewgraph. If you were to calculate this mathematically, you would have to consider the enlargement of the viewgraph on the screen, the average vision of the audience (20/20), and perform a complicated math operation.



(a) Fortunately, a chart exists that you can use to determine the minimum size of the lettering, based on the two distances (figure 2-3). This chart has three scales: (1) projector distance in feet, (2) farthest viewer from the screen distance in feet, and (3) minimum height of the lettering in inches, indicated in fractions as well as decimals.

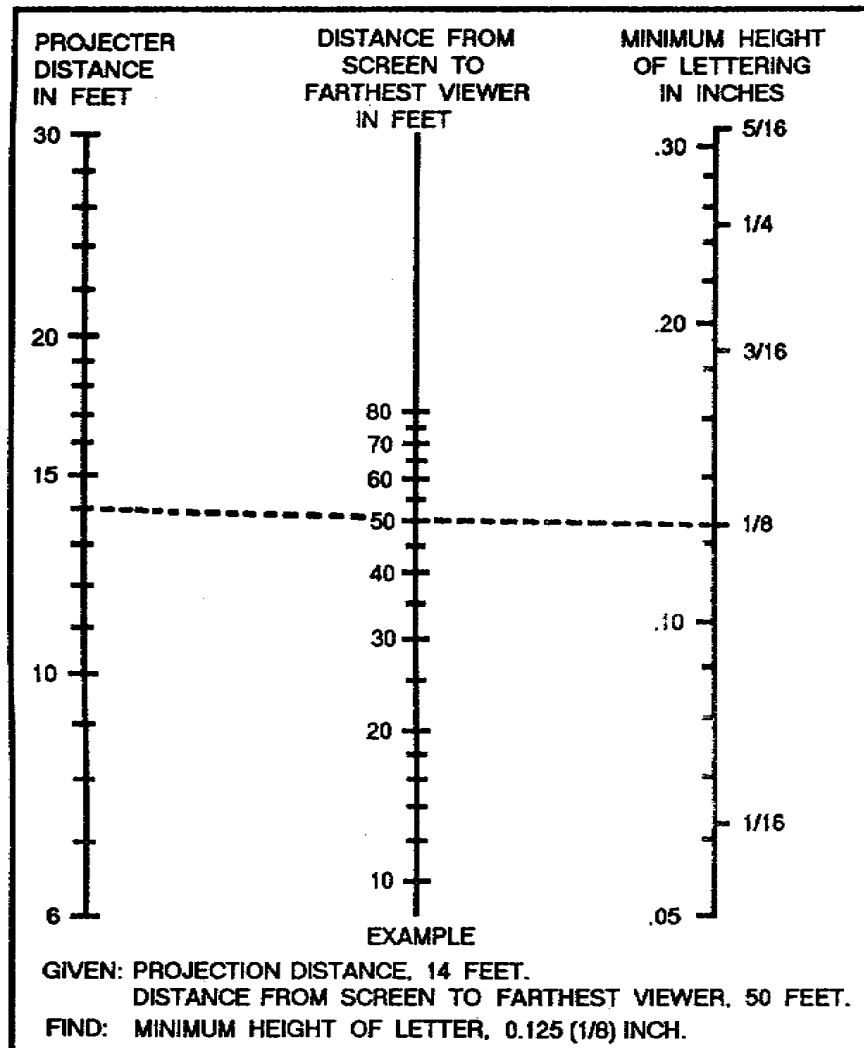


Figure 2-3. Minimum lettering height chart

(b) The only information you need to use this chart is the distance the projector and the farthest viewer are from the screen. To use this chart, place a straight edge at the point on the left scale (projector distance in feet) that represents the distance the projector is from the screen and align it with the point on the middle scale (distance from the screen to farthest viewer in feet) that presents the distance the farthest viewer is from the screen. When you have the straight edge aligned with these two points, the point where it crosses the right scale (minimum height of letter in inches)

represents the minimum height of the lettering you can use for a viewgraph which the viewer can read from the distance stated.

For example, you must find the minimum height of the lettering for a viewgraph when the projector is 14 feet from the screen and the farthest viewer is 50 feet from the screen. The dotted line on the chart in figure 2-1 shows how you align the straight edge. First you place the straight edge at the 14-foot mark on the left scale, and then align it with the 50-foot mark on the center scale. As you see, the point where it crosses the right scale is the 1/8-inch mark. That is the minimum height of the lettering you could use for the viewgraph to meet both distance requirements.

Now find the minimum height of the lettering for a viewgraph where the projector is 30 feet from the screen and the farthest viewer is 60 feet from the screen. You should find the minimum height of the lettering is 1/16 of an inch for a viewgraph used for these distance requirements. If you did not find this answer, try again ensuring you align the straight edge correctly.

(3) Aperture opening. The aperture opening on the viewgraph frame is the 7 1/2- by 9 1/2-inch cutout portion. When preparing the master for a viewgraph, you must ensure all the lettering and graphics stay within the aperture area of a viewgraph slide mount. One method to ensure your work stays centered in the aperture is marking the center and outer edges of an aperture opening on graph paper, and attach the graph paper to the drawing surface. Then place the tracing paper over the graph paper attached to the drawing surface and attach it to the drawing surface. Since the tracing paper is transparent, you can see the graph paper through the tracing paper, which allows you to remain aware of the limits of the aperture opening.

Even the best illustrators make mistakes. If you should make a mistake when preparing the master, you do not have to make a new master. You correct the mistake by cutting out the mistake and removing it, and then inserting a section of tracing paper, using translucent mending tape. Then all you must do is redraw the area where the mistake was.

c. The Diazo Machine (figure 2-4). The diazo machine has four sections: (1) printing, (2) developing, (3) cooling, and (4) exhaust.

(1) Printing section (figure 2-5). This section of the machine has four units: (1) light source, (2) reflector assembly, (3) printing cylinder, and (4) feedbelt. At the start of the reproduction process, you feed the original and a diazo foil or paper into the machine.



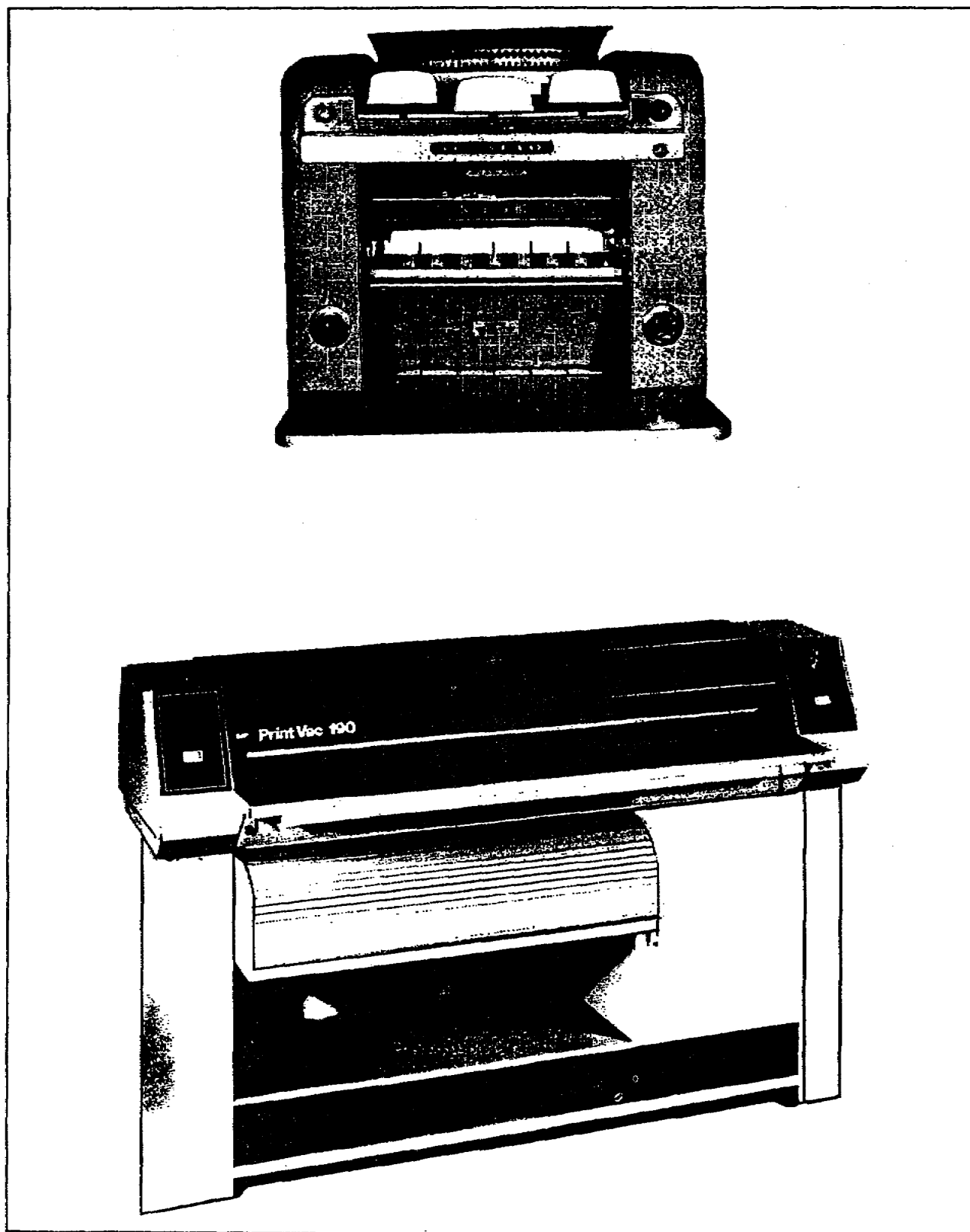


Figure 2-4. Types of diazo machines

The feedbelts move the master and diazo material around the revolving print cylinder where they are exposed to the ultraviolet light. After the machine has exposed them, the pick-up assembly directs them toward the developing section. After the pick-up assembly has directed the original and diazo material toward the developer section, a guide roller directs them between a printer and tracing separator belt. The tracing separator belt delivers the print and the original to two separator tank assemblies where the original and print separate from each other. From this point, the original leaves the machine and the print continues to the developing section. However, if you want the print removed before entering the developing section, you can accomplish this by simply operating a lever.

(2) Developing section (figure 2-5). This section has a perforated, stainless steel developing tank and ammonia feed system. Using a gravity feed system, the tank is continuously supplied with ammonia from the ammonia supply tank.

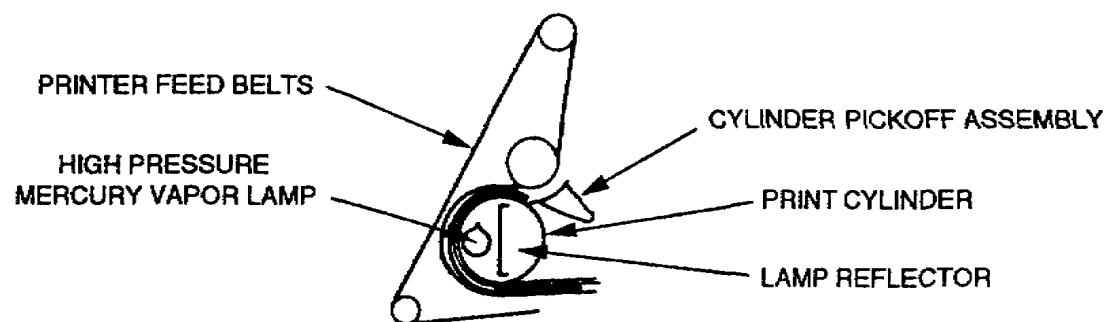
Next, the ammonia is directed to the evaporating drip trays suspended in the developer tank. These trays have electric heaters attached to speed-up the formation of ammonia vapors. The ammonia vapors leave through holes in the upper part of the developing tank and activates the image on the diazo material.

Most machines have an automatic shut-off valve in the ammonia feed line that protects the machine from flooding with ammonia when shutting off the machine. This valve closes automatically when you shut off the machine, and opens automatically when turning on the machine.

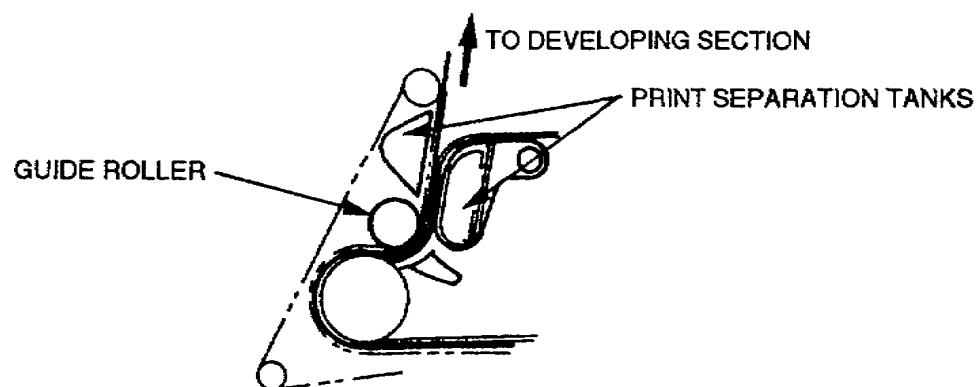
(3) Cooling and exhaust sections. The cooling and exhaust sections prevent excessive amounts of heat and ammonia vapors from reacting the area surrounding the machine. These systems use a motor-driven blower to remove fumes and hot air from the machine's enclosure and vents them to the outside atmosphere. The blower creates a partial vacuum in the machine's enclosure that causes air to flow into the machine's enclosure continuously.

(4) Timer switch. A separate timer switch controls the blower. This switch allows the blower to run after shutting off the machine to ensure no ammonia vapors or heat build up in the machine enclosure while the machine cools down.

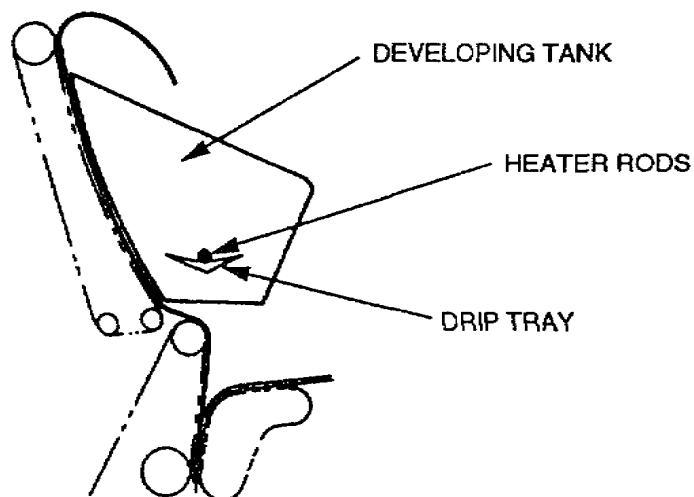
d. Diazo Materials. You find diazo materials available in a standard paper weight and a clear cellulose film.



1. PRINTING SECTION



2. SEPARATION PROCESS



3. DEVELOPING SECTION

Figure 2-5. Diazo machine operating sections

(1) Diazo paper. Standard weight diazo paper produces a black or blue image on a white background. Manufacturers produce diazo paper in a wide variety, ranging in sheet size from 8 by 10 to 34 by 44 inches and in rolls that range in width from 11 to 42 inches with lengths of 50 to 100 yards. Additionally, manufacturers also make diazo paper using a colored stock, which provides a blue or black image on the colored stock, and plastic-coated paper that produces a slightly glossy print with better density than standard paper.

When you must produce many copies, the original you prepare tends to fade and wear out after repeated exposure to the ultraviolet light. To overcome this problem, produce a sepia line intermediate that serves as a duplicate original. A sepia intermediate has greater density than an original; therefore, it produces a darker image than the original and withstands repeated exposure to ultraviolet light. You also can make corrections to a sepia intermediate.

(2) Diazo foils. Diazochrome foils have a transparent-colored dye image on a clear cellulose-acetate film. Manufacturers make diazo foil in a standard weight (.004 in. thickness) and two densities: (1) K-series, maximum density foils, and (2) P-series, pastel densities.

You find the K-series foils available in the following colors:

- KGN - green image
- KMG - magenta image
- KOR - orange image
- KRD - red image
- KBK - black image (8 1/2 inches by 11 inches)
- KBKP - black image (11 by 14 inches)
- KBKD - emulsion, both sides
- KBK-FP - black image, fast processing speed
- KBL - blue image
- KBR - brown image
- K-MAX II - high opacity image
- KCY - cyan image
- KSP - sepia image
- KVT - violet image
- KYL - yellow image

You find the pastel foils available in the following colors:

- PBL - pastel blue image
- PBR - pastel brown image
- PCY - pastel cyan image
- PMG - pastel magenta image
- POR - pastel orange image

PRD - pastel red image  
PYL - pastel yellow image

Films with a matte surface on the reverse side have the suffix M. For example, sepia (KSPM), blue (KBLM), or black (KBLM) have a matte surface. The matte surface accepts either pencil or ink for additions or corrections to the foil.

Diazo foils do not have a long shelf life. You should keep the unopened packages refrigerated until ready for use; however, you must allow time for the foils to reach ambient temperature prior to using them.

e. Exposing and Developing the Diazo Foils. Before you can expose and develop the film you must start and adjust the machine. Ensure the ammonia storage tank is filled to capacity, insert the drain tube into the residue bottle, and if the ammonia feed is not an automatic function of the machine, turn on the feed switch. Then turn on the machine and adjust the ammonia system to feed 50 to 60 drops per minute. Allow the machine a warm-up period until the temperature of the chemicals reaches 180° to 210°. If bubbles appear in the ammonia during operation, the machine has heated the ammonia too much. You can correct the temperature of the ammonia by adding 1/8 to 1/2 cup of cold water.

(1) Positioning the master and foil. Remove the diazo foil from its lightproof package (the foils have a nick in one corner). Then place the master on top of the emulsion side of the foil, face up, ensuring you have the nicked edge of the foil in the top left-hand corner when facing the foil. Having the nick in this position ensures the emulsion side of the foil is properly positioned against the backside of the master. Place the foil and master on the slip sheet that came with the foil (figure 2-6):

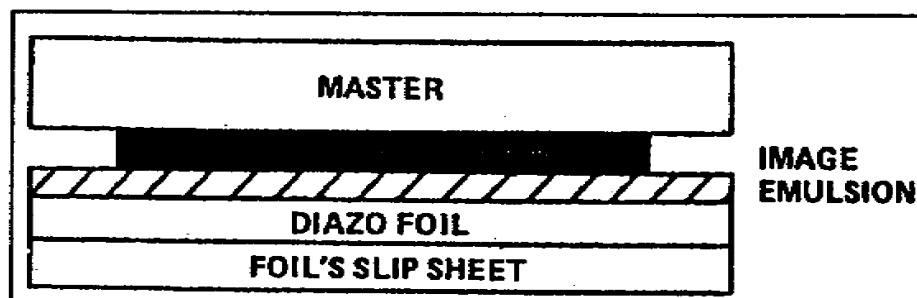


Figure 2-6. Slip sheet, foil, and master ready for exposure

Feed the slip sheet, diazo foil, and master into the printing section of the machine. The speed at which the trio (slip sheet, foil, and master) travel varies, depending on the color of the foil. Unfortunately, you have to use a trial and error

method to find the correct exposure time for the various colors. Once you find the time for the various colors, note the time for future reference.

The heat produced by the light source causes some expansion or shrinkage of the image. To minimize these effects, always run diazo foils in the same direction in the machine. When the machine has finished exposing the foil, it may eject the foil and the master or just the master, depending on the type of machine you have. If the machine ejects only the master, the print automatically continues to the developing section.

(2) Developing the foil. After you have exposed the foil and the master, and the machine ejects the master and foil, feed only the diazo foil into the developing section of the machine, emulsion side up. The key to the success of the process is remembering that exposure time in the printing section is critical and time in the developing section is not. You must leave the foil in the developing section long enough to obtain maximum density and full color. You can remove it from the ammonia vapors any time after reaching that point.

f. Mounting the Diazo Foils. Mounting the foil adds durability and ease in handling the viewgraph. You can use commercially-manufactured cardboard or plastic frames or make your own. If you decide to construct the frames, use an opaque material such as heavy cardboard, heavy paper, or even a file folder, and cut the aperture to size (7 1/2 by 9 1/2 inches).

Whether you use a commercial or locally-constructed frame, you mount the foil using the same technique. Center the image on the foil in the aperture opening on the back side of the frame, and use masking or plastic tape on all four sides of the foil to secure it to the frame. You cannot use cellophane tape to secure the foil because it dries up and becomes brittle with age. Mounting and taping the foil to the back of the frame produces a professional-looking viewgraph, assures a flat projection area, and leaves the front of the frame free for any overlays or notations.

NOTE: The following discussion of a photostatic camera uses a Visual Graphics POS 1 system, model 320.

## 2. The Photostatic Camera (figure 2-7).

You can use this camera to produce enlarged or reduced copies of camera-ready and tone illustrations.

a. Preparing the Camera. When preparing to make copies with this camera, you must ensure the chemicals in the developing section are at the required level and usable.

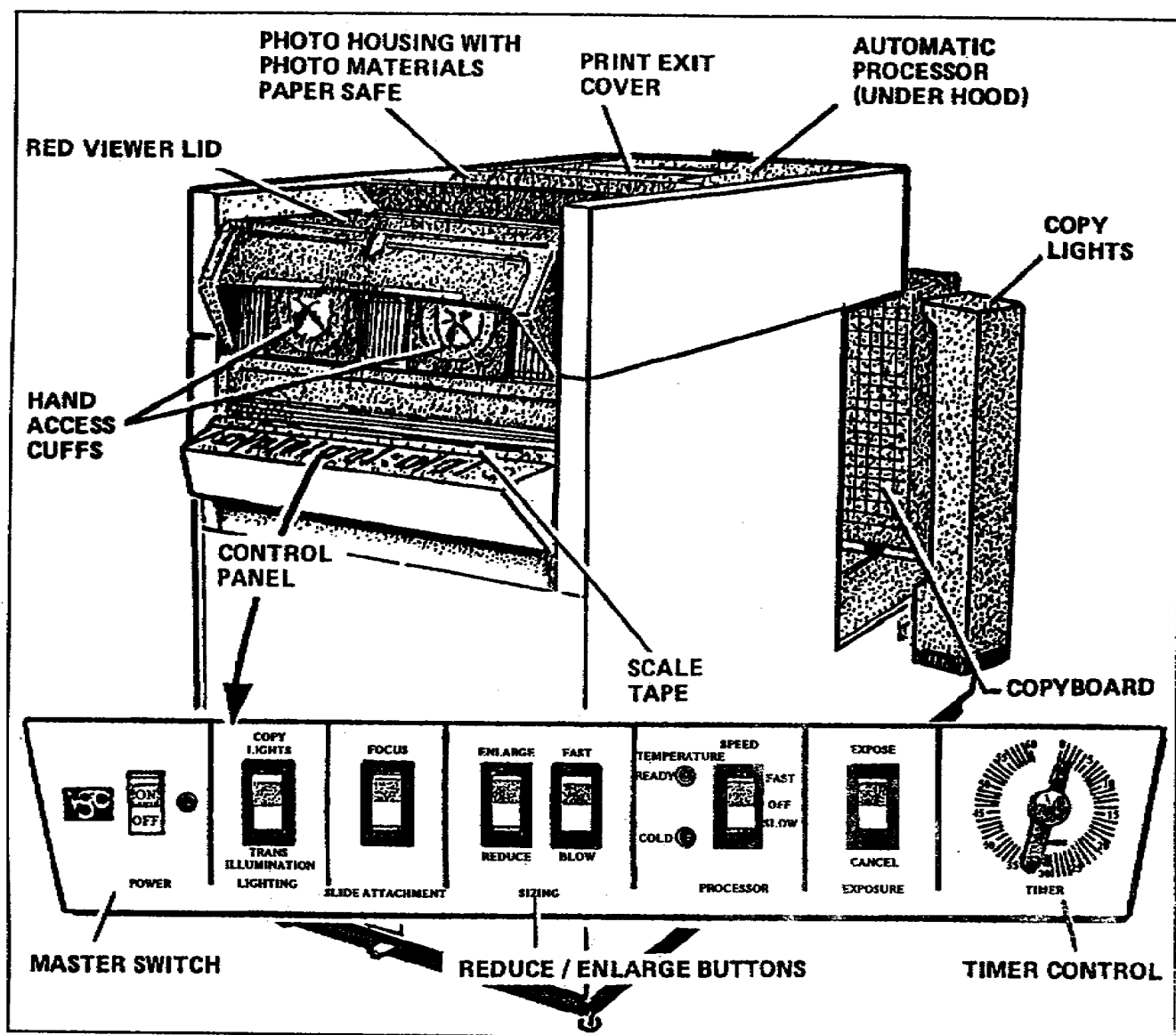


Figure 2-7. Photostatic camera (POS 1)

(1) Each chemical used in the camera gives a different indication when you must replace it. You replace the developer when it turns dark brown, the fixer when it turns yellow, and the rinse when it is cloudy. If any of the chemical tanks have dry, thick, brown residue, you drain the chemical and soak and clean the tank. Follow the manufacturer's instructions when draining old chemicals, cleaning the tanks, mixing new chemicals, and refilling the tanks.

(2) Next you must check the copy lights to ensure each light operates after turning on the master switch (figure 2-8). If any of the bulbs do not light, you must replace them. To replace any of the copy light bulbs, turn the camera off.

Remove the burned out bulb and replace it with a new one, using a cloth or paper towel to handle-the bulb.

**CAUTION**

Never touch a copy light bulb with your bare fingers. The body oils on the fingers cause a blemish on the bulb that results in a hot spot burning out the bulb or causing it to break.

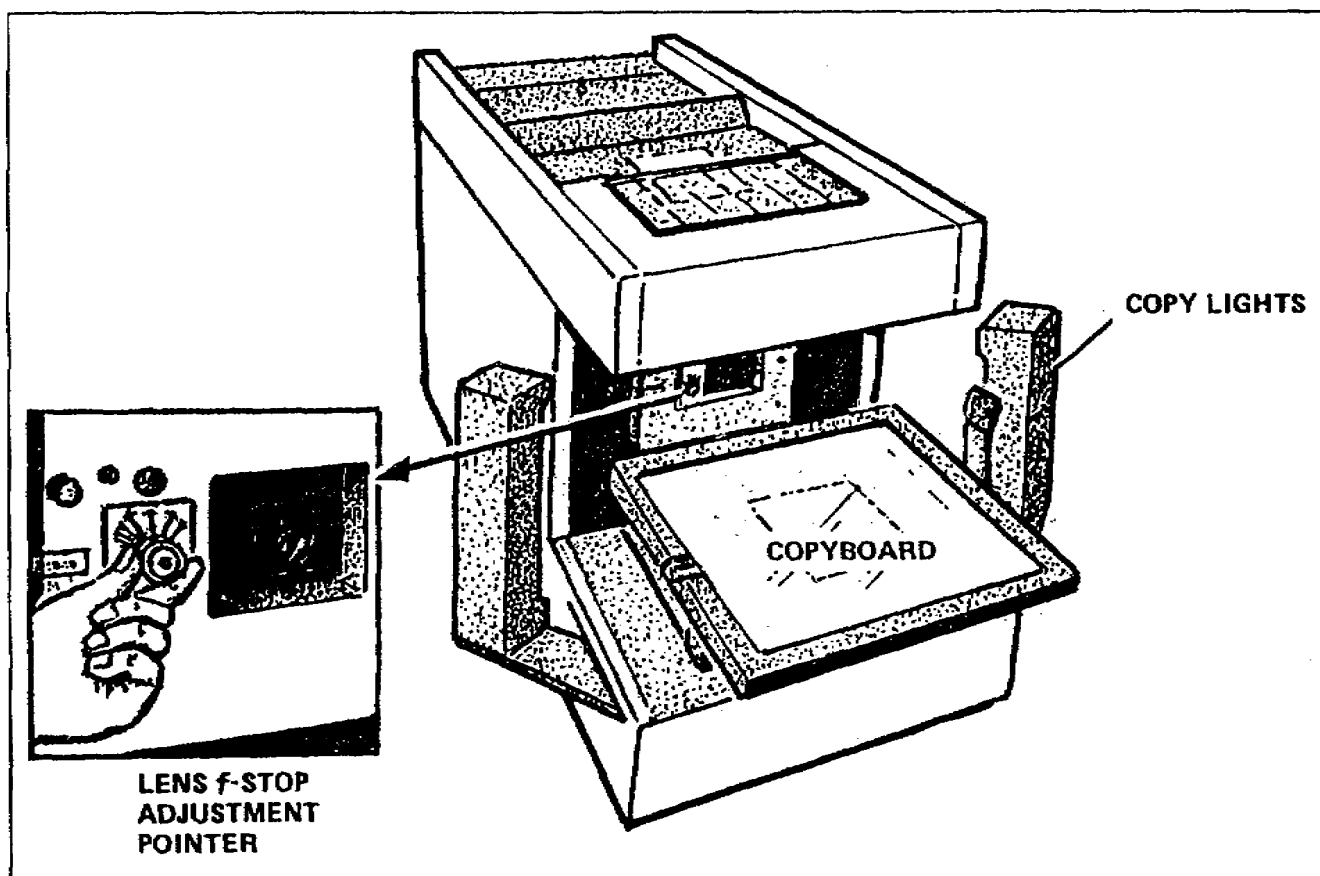


Figure 2-8. Copyboard and lights

(3) The last area you check before turning on the camera is the viewing area. Make sure the copyboard, split platen, and lower glass are clean. Any spots or marks caused by dirt or grime in the viewing area can show up as a spot on the finished print.

b. Making the Copy. To ready the camera to make copies, turn it on and allow it to warm approximately 20 minutes. When the chemicals in the camera reach operating temperature, the "ready" light comes on (figure 2-7).



(1) Positioning the copy. After the "ready" light has come on, move the copyboard back until it rests in a horizontal position (figure 2-8). Open the copyboard by squeezing the latch together and lifting the copyboard glass until it rests against the copyboard rest pad. Then center the copy with the appropriate guide markings. You then close the copyboard glass, ensuring the latches lock into position over the copyboard frame, and move the copyboard to its vertical position.

(2) Setting the enlargement or reduction. With the copy in place, you must set the camera for any reduction or enlargement.

(a) You can use a proportion rule (scaling wheel) to determine the correct scale setting for the reproduction size required (figure 2-9). A scaling wheel has two independent scales mounted at a common center. You can use this scale to determine the reduction or enlargement of a copy in either a percentage or linear (inches, feet, etc.) measure.

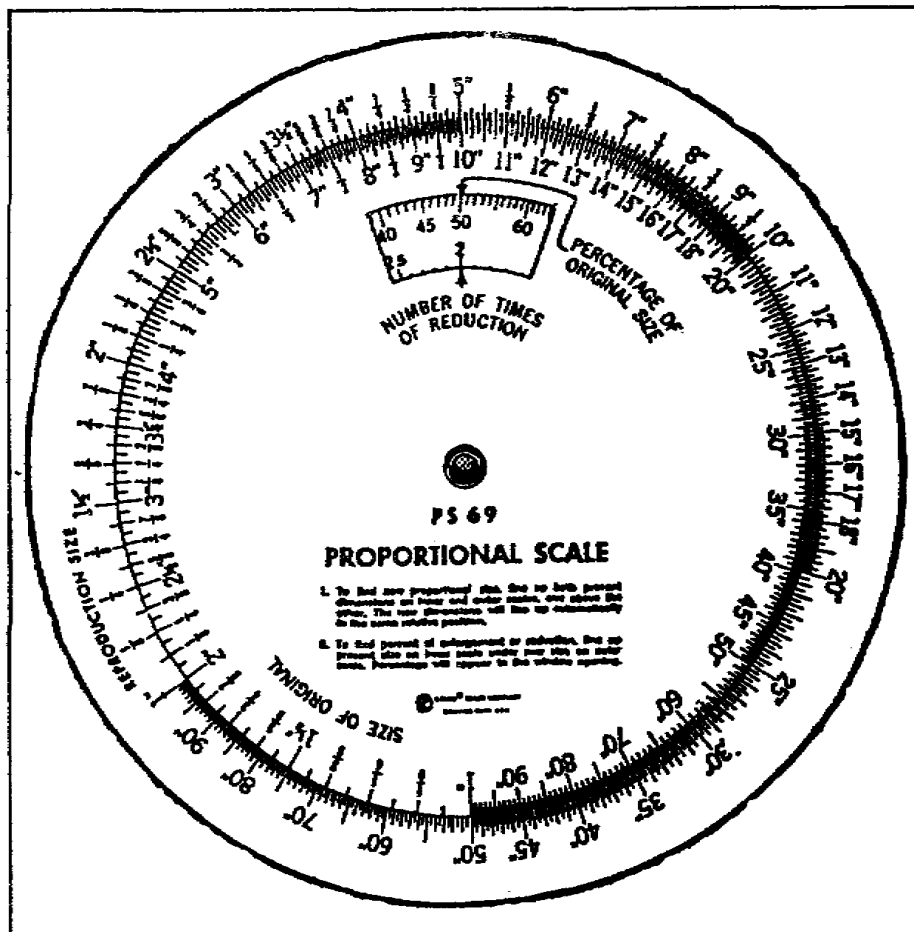


Figure 2-9. Proportional scale (scaling wheel)

(b) The proportional scale has a range from 25 to 300 percent. To determine the change in a percentage, align the



current size of the copy on the inner scale with the required size of the print on the outer scale. The percent of change then appears in the percentage of original size window of the scaling wheel (figure 2-9). This is the setting used for the camera. For example, the size of the copy is 8 by 12 inches, and the print must fill an area 10 by 15 inches. After you have aligned the two scales, the percentage window reads 125 (enlargement).

(c) To adjust the camera to the reduction or enlargement, set the slow-fast switch in the sizing section of the control panel to the fast position. Then press the enlarge or reduce switch until the scale's pointer aligns with the required reproduction size (figure 2-7). To make fine adjustments, set the slow-fast switch to the slow position, and press the enlarge or reduce switch until reaching the desired setting.

(3) Positioning split platen. After you set the correct reduction or enlargement, lift the red viewer lid and ensure the light selector is in the main light position. Then fold down the split platen so it covers the image area (figure 2-11). Now press the view button and check the image, ensuring it centers correctly on the split platen marks. If the copy is not correctly centered, you must recenter it on the copyboard. After you have the copy centered on the split platen, unfold the split platen and close the red viewing lid.

(4) Setting the f-stop and timer. Using the exposure chart attached to the camera, find the f-stop setting for the print material you selected (figure 2-10). Then check the lens f-stop-setting (figure 2-8) and set it to the required setting for the print material you selected.

To set the timer, again refer to the exposure chart attached to the camera and find the required exposure time and processor speed for the print material you have selected. Then set the timer to the required time and the processor to the required speed (figure 2-7).

(5) Positioning the print material. Insert your hands through the access cuffs (figure 2-7), raise the cover of the photo material storage compartment (figure 2-11), remove the selected photo material, and trim it to size. Place any remaining photo material back in the storage compartment and close the lid. Remember, the smallest size photo material the camera accommodates without jamming is 2 1/2 by 7 inches. When using any type of film or exposing paper for more than 45 seconds, you must use a black cardboard backup card, cut to the same size as the selected material.



BASIC EXPOSURE CHART		If positive prints are too light, decrease exposure. If positive prints are too dark, increase exposure.					
MATERIAL	LENS	PROCESSOR	SCALE SETTING IN SECONDS				
			50%	75%	100%	150%	200%
pos film <sup>405</sup>	F-16	FAST	8	9	12	12	10
pos tone paper <sup>201</sup>	F-16	FAST	40	40	40	40	35
pos paper <sup>205</sup>	F-16	SLOW	17	16	23	18	20

BASIC EXPOSURE CHART		If negative prints are too light, increase exposure. If negative prints are too dark, decrease exposure.					
MATERIAL	LENS	PROCESSOR	SCALE SETTING IN SECONDS				
			50%	75%	100%	150%	200%
neg paper <sup>205</sup>	F-32	SLOW	6	7	9	9	9
neg film <sup>405</sup>	F-22	SLOW	10	12	15	12	12

Figure 2-10. Sample exposure charts

When you have sized the selected material and cardboard backup, you can slide the photo material, emulsion side down, with the cardboard backup on top, between the clear glass and the folded platen (figure 2-11). It is helpful to remember that manufacturers package paper and film emulsion side down in the magazines. When you have aligned the photo material on the positioning marks, fold the split platen down over the photo material and cardboard backup.

(6) Exposing the print material. You can now press the exposure button on the control panel and start the exposure process. When the camera has completed the process, the lights go off, and the timer resets to the original setting.

(a) You then lift the split platen slightly and slide the exposed print forward from under the glass. Do not touch the emulsion on the print material. This could result in your fingerprints on the developed print. Next feed the exposed print material squarely into the process feed chute (figure 2-11). When the processor takes the edge of the print, release

the print. The paper automatically feeds through the processor and exits fully processed. When the print exits the processor, leave it under the clear print exit cover for at least 15 seconds which allows for complete drying.

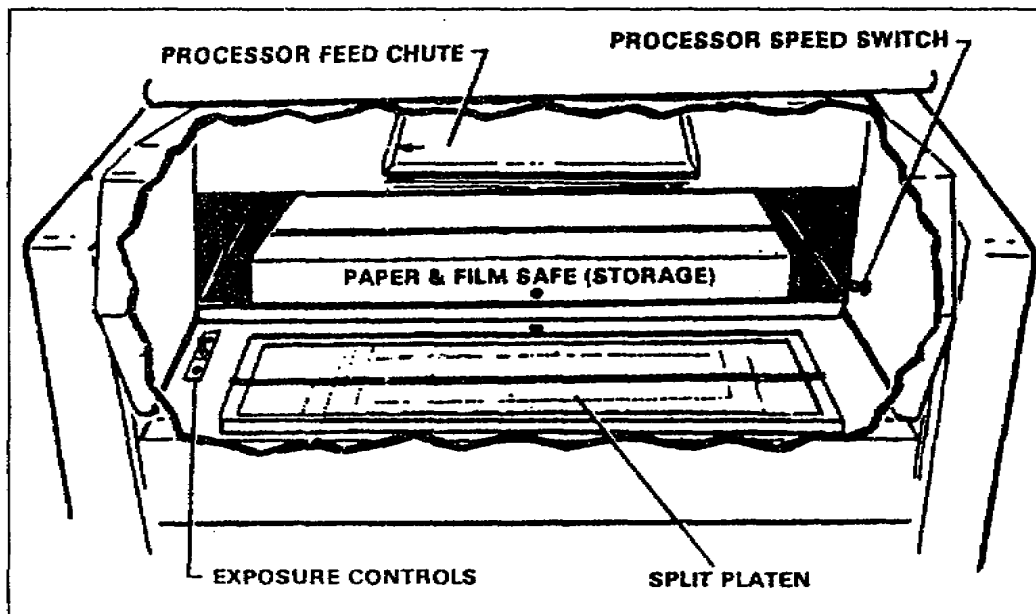


Figure 2-11. Viewer and processing station

(b) To make a halftone print from a continuous tone photo or drawing, you must use a halftone screen, dots up with the photo paper on top (emulsion side down), between the split platen and copyboard, and adjust the f-stop and film exposure time to manufacturer's recommendations. A halftone screen reproduces a continuous tone photograph or drawing by translating the tone image (dot pattern) into a line image. You find different quality halftone screens used in the different printing systems. The more detail required of the finished print, the finer the lines of the halftone screen. Once you have placed the screen, you continue the copy process as before.

### 3. The Thermofax Machine.

You can use this process as an alternative to the diazo process to produce viewgraphs. Although this process does not produce the same quality viewgraph as the diazo process, its main advantage is flexibility. You can produce viewgraphs using almost any printed material. This process also produces spirit masters, gummed labels, laminates, and paper copies. The film for this process comes in a variety of colors and preframed (frame attached) or plain film.

Since this machine is easy to operate and efficient, many times you find it in the self-help area of a VI facility, or used to produce low-priority, short-suspense requirements. This process requires only four steps to produce a viewgraph (figure 2-12).

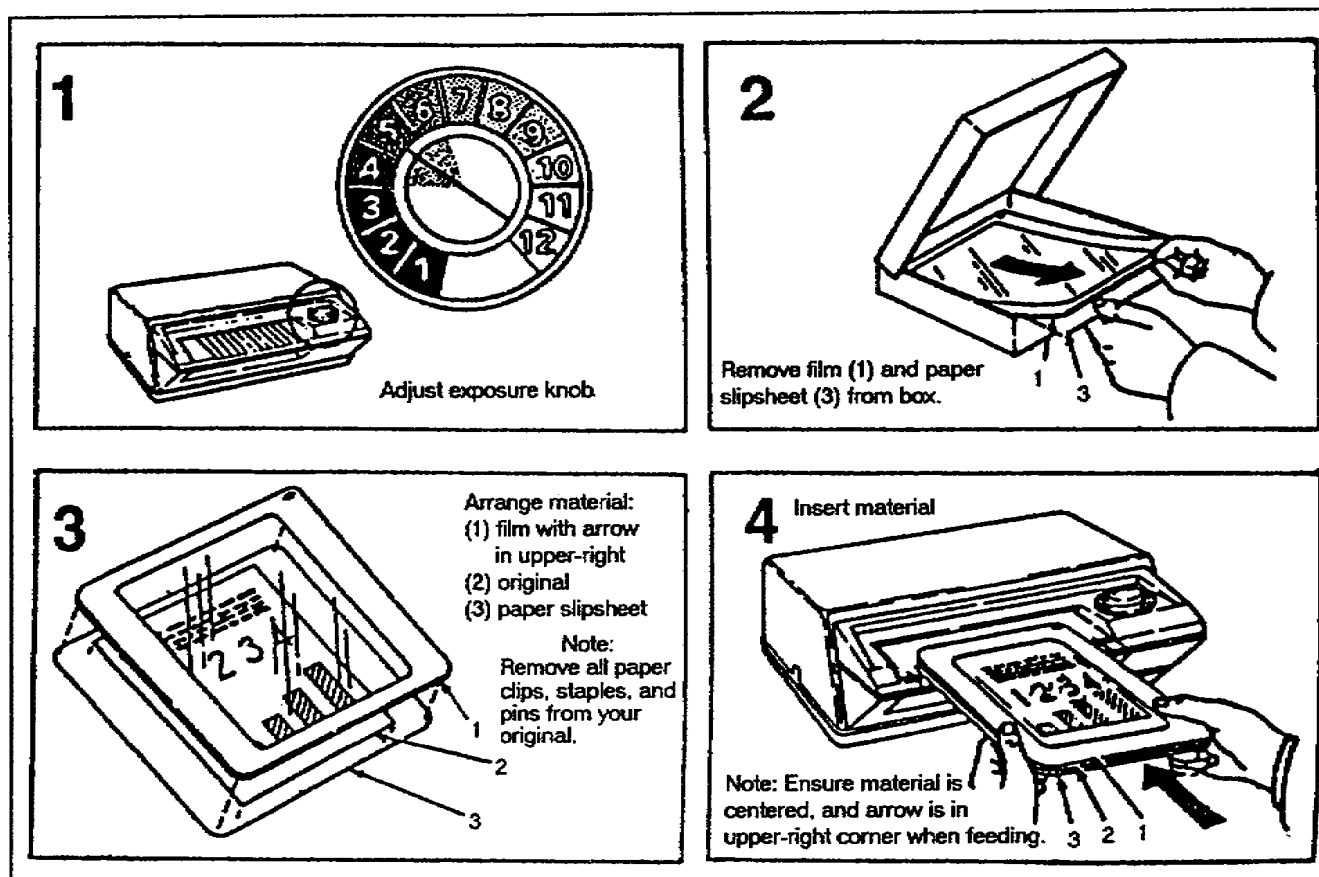


Figure 2-12. Thermofax production steps

a. Adjust the Exposure. The exposure knob has numbers ranging from 1 to 12, with 1 being the lightest setting. The setting of the control determines the density of the viewgraph. Experience serves as the best teacher for learning the exposure setting required to produce a quality viewgraph. When you have this experience, you can look at the density and quality of the original and determine the correct exposure setting.

b. Position the Film. To produce a quality viewgraph, you must have the slipsheet, film, and original in the proper order. Starting from the bottom up, the slipsheet is first, followed by the original laying face up, and then the film with the notched corner or arrow in the upper right-hand corner.

c. Inserting the Film. Center the materials (slipsheet, original, and film) as a group and insert them into the

machine. Once you feel the machine take hold of the material, release the material and let the machine process it.

d. Mount the Viewgraph. If you did not use preframed film, you would mount the viewgraph using the same process used to mount viewgraphs produced using the diazo method.

#### 4. 35mm Slides.

As an illustrator, you also design transparencies in the 35mm slide format. Like viewgraphs, the 35mm slide format also uses a 2 to 3 height to width ratio.

a. Advantages. This format has many advantages, the greatest one being its size. Since a slide only measures 2 1/4 by 2 1/4 inches, you can store and transport them easily. 35mm slides also adapt to a wide variety of visual effects, such as color, 3D, and drop-shading, to mention a few.

b. Disadvantages. The 35mm slide format also has its disadvantages. After considering the time required to produce the artwork, photograph the artwork, and mount the slides, the most critical is the production time. Additionally, it is often difficult and time consuming to make corrections. Sometimes it is necessary to redo the entire graphic; therefore, you must have an exact editing of the slide by quality control or editing personnel.

c. Production Guidelines. The photo lab uses direct photography to produce 35mm slides. Because of the production process there is a simple realism you must keep in mind when developing slides: "What you see is what you get." If you keep the realism and following guidelines in mind when developing the slides, you can produce a quality finished product.

(1) Use the correct ratio. The 35mm slide format uses a 2 to 3 ratio. Always create the graphics with a 2 to 3 ratio in mind.

(2) Consult the photo lab. They can provide advice relating to any system limitations, different lighting effects, which colors photograph true, etc.

(3) Register overlays correctly. When using overlays to produce the finished slides, ensure you use the required registration marks. (We discuss overlays later in the lesson.)

(4) Allow adequate bleed area. Allow a sufficient amount of bleed area around the image aperture for variances in camera alignment and slide mounting. When developing graphics for the 35mm format, determine the aperture area and draw it on





a piece of tracing paper large enough to cover the workpiece. Attach the tracing paper to the workpiece with hinge tape so the photographer can lift it from the graphic after focusing the camera on the aperture opening. The tracing paper with the aperture drawn on it serves three purposes: (1) allows you to ensure the area you want on the slide is well within the aperture opening, (2) shows the photographer what to focus on, and (3) protects the graphic from dirt and mishandling damage.

(5) Check your work objectively and critically. Not only can you save yourself embarrassment and frustration, but you can save time and money by finding and correcting mistakes before sending the graphics to the photo lab.

(6) Provide the photo lab clear instructions. When you turn over the completed graphics to the photo lab, meet with them and explain how you feel they should photograph the graphics. However, keep an open mind and draw on the photo lab's experience when reaching the final decision.

(7) Handle the graphics carefully. Anything you see on the graphics the camera photographs, and anything the camera records, the projector enlarges. The possibility exists that you will have a requirement where you can use the graphics again. Therefore, you should store them properly.

## PART B - COPY LAYOUT AND PROJECTION EQUIPMENT

### 5. Copy Layout.

When working in a VI facility, one job you could perform is laying out an article, or copy layout. Copy layout and design resembles arranging furniture. Only in copy layout, you move the design parts, copy, titles, pictures, and border areas, instead of furniture to achieve the effect desired for the article. The finished layout is an article that is eye pleasing, balanced, and easy to read. To start the layout process, you receive at least two sets of copy (printed text for the article), the photographs and sketches for the article, and general instructions pertaining to the desired emphasis of the article and layout instructions.

a. Types of Copy. You receive two different types of copy; galley and slick. Galley copy is printed on cheap, coarse paper. You would use this copy to proofread, edit, and complete the rough layout of the article.

Slick copy comes printed on good quality paper stock with a smooth surface. Slick copy is high quality copy and photographs well. Because slick copy photographs so well, use this copy to paste up your final layout.



b. Standard Format. Most publications use double-page size cardstock sheets marked with non-reproducible blue lines to show column layout, borders, center gutters, page information, cut lines, and bleed areas as a standard format.

c. The Layout Process. You start the layout process by reading the copy, reviewing the graphic for the article and general instructions sent, and formulating an idea of what the article presents. If you have any doubts about the article or your opinion varies from the authors, meet with the author and review the article. With the author's expertise on the subject and your expertise as an illustrator, you can present a quality article.

Once you understand the emphasis of the article, draw a series of thumbnail sketches. Attach tracing paper to the layout board (figure 2-13) so you can see the layout lines and develop a rough draft of the best two or three thumbnail sketches on tracing paper. When preparing these rough drafts, place all the text, titles, graphics, etc., in their desired location. You then use the rough drafts to choose the final version of the layout for the article.

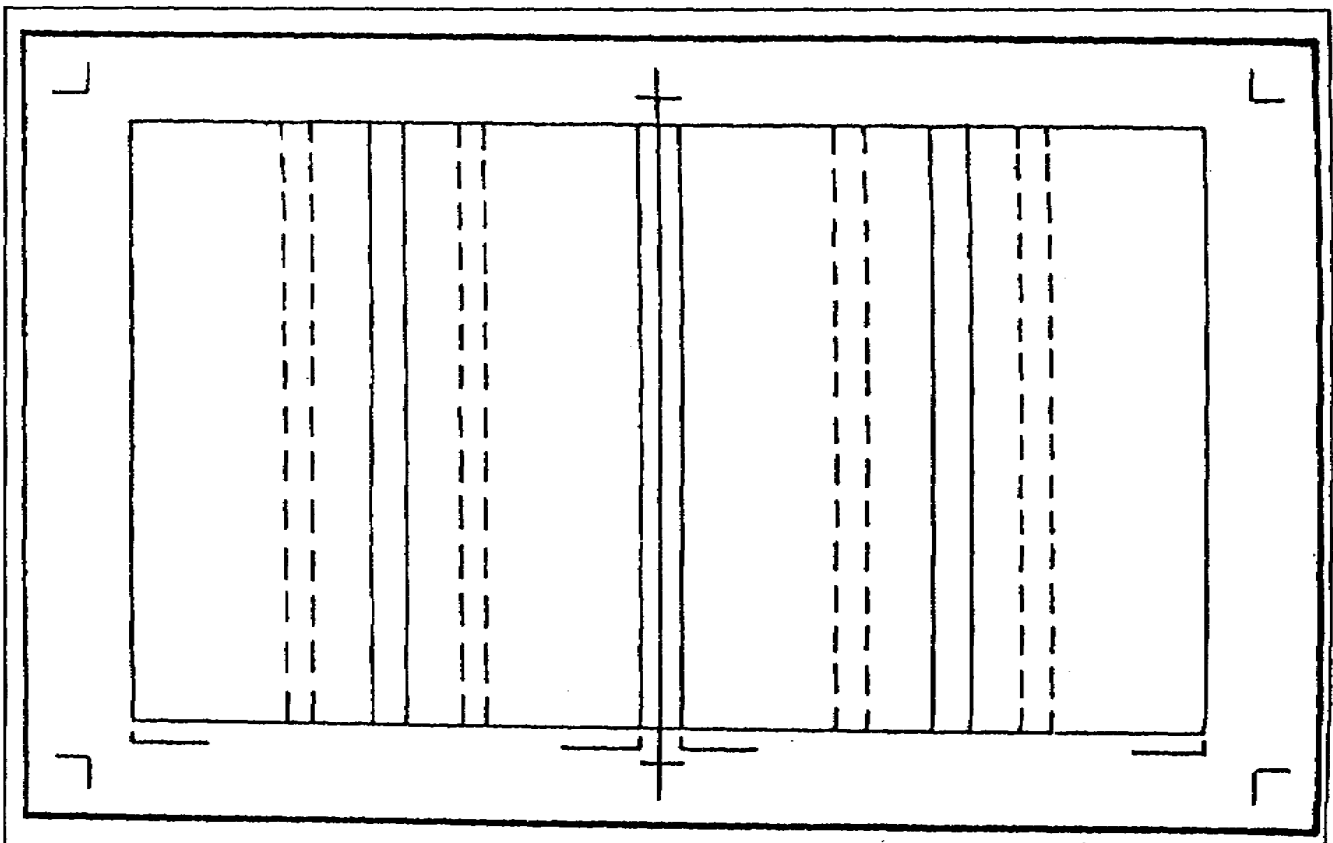


Figure 2-13. Layout board

(1) Comprehensive draft. Attach a clean sheet of tracing paper to the layout board and make a comprehensive version of the rough draft you selected as the final layout. Using the rough draft you selected, measure the copy area, cut the galley copy, fit the copy into the area you roughed out for the copy, and tape it down. You now have the opportunity to move the copy so it fits evenly in the column areas or make any other changes you feel necessary. When you have finished moving the copy and are satisfied with its placement, mark off the windows for the graphics in the article.

(2) Final layout. When the comprehensive draft meets your approval, start the final layout process. Using the comprehensive layout as a guide, cut the slick copy and apply it to the format sheet on the layboard with a light coating of adhesive or adhesive wax. When you have the copy in place, block out the graphic window areas with "ruby-lith," para-opaque, or by blackening out the area with ink or black paper. When the lithographer photographs your layout, the negative shows the graphic window areas as clear windows. When the article includes photographs, he then screens them as halftone negative and "strips" them in the windows.

(3) Cropping and scaling. You prepare the graphic or photographs for inclusion in the article by cropping, scaling, and annotating the graphics or photos so the printer knows exactly what you want him to do. The majority of the time, the graphics and photos are not particularly suited for the layout because they are the wrong size or contain too much unwanted image area. You correct this problem by careful cropping.

There are two different methods available for you to use when cropping a picture: (1) tissue-overlay and (2) white opaquing fluid. Each method accomplishes the same thing; however, the tissue-overlay does not destroy the graphic or photograph. When cropping a graphic or picture, remember to maintain the same height-to-weight ratio as the graphic's window you created in the layout.

(a) Tissue-overlay cropping method. Most illustrators use the tissue-overlay method when cropping graphics or photographs. For this method, you place a piece of tracing paper over the entire graphic or photograph and use a colored marker to enclose the area you photographed. (Remember to maintain the same ratio as the window on the layout.)

After you have marked the area of the graphic or photo you want photographed, you must size it for placement in the window in the layout. First you add dimension lines outside the box and



write in the desired height and width of the cropped area. Then use a proportional scale (discussed previously in paragraph 2b(2)(a) of this lesson), find the percentage of enlargement or reduction required to get the graphic or photo to the desired size, and write it on the tracing paper or the back of the graphic or photograph (figure 2-14).

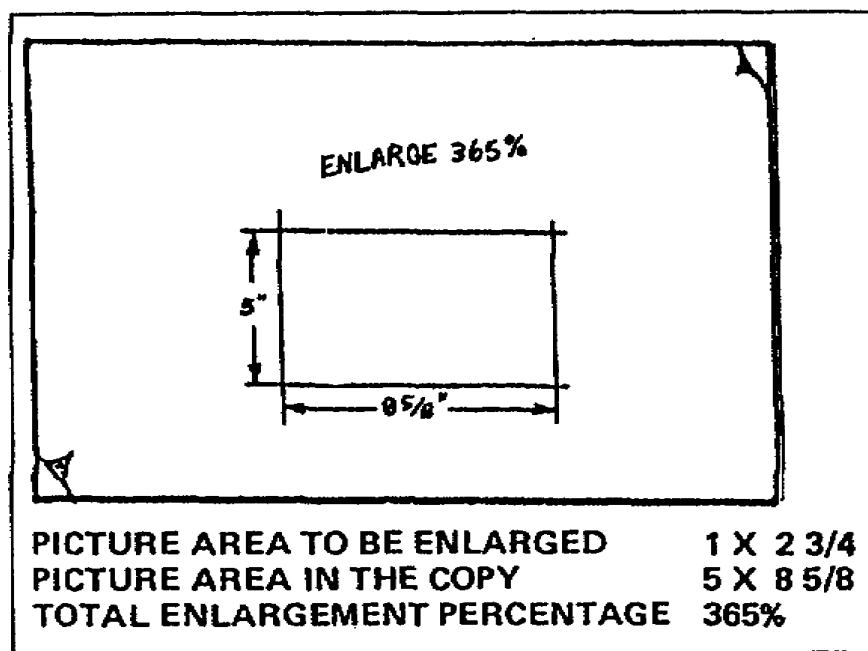


Figure 2-14. Photo notes

(b) Opaque method of cropping. The second method of cropping uses white opaque fluids. This method is just as effective as the tissue-overlay method; however, it destroys the graphic or photo. Once you have selected the area you want photographed, lightly outline it in ink. Then use white opaquing fluid and paint a box around the area you outlined. Next you add the dimension lines, size the area, and make the required annotations like you did when using the tissue-overlay method of cropping.

(4) Matching the graphics or photos to the layout windows. No matter which method you choose to crop and size the graphics or photos, you must ensure the photographer knows where to place each graphic or photo in the layout. To accomplish this, you identify each graphic or photo window on a page with a letter, and number each graphic or photo. Then add a note on the back of the graphic detailing its number, the page number, and the letter designation of the window where you want it placed. For example, insert graphic 2, page 4, window B. This note eliminates any misunderstanding or doubt in the printer's mind where each graphic or photo belongs.

This completes the layout process. You can now send your layout to the printer.

## 6. Television Graphics.

This communication medium appeals to two of the human senses; sight and sound. As an illustrator, your involvement in this medium is preparing the graphics presented through this medium. You must remember that graphics prepared for television must replicate the shape of the screen that displays the graphic.

a. Aspect Ratio. When preparing graphics for television, you must use a 3 to 4 (height to width) aspect ratio so the viewer sees all graphics on the screen. The television screen shown on the left-hand side of figure 2-15 shows the effect of using the wrong aspect ratio. The frame added illustrates the area cut off. You also should notice the unbalanced effect the graphic presents on the screen. The right-hand side of figure 2-15 shows the same graphic presented using the correct aspect ratio. The entire graphic is on the screen, no material is cut off, and it presents an eye-pleasing, balanced appearance.

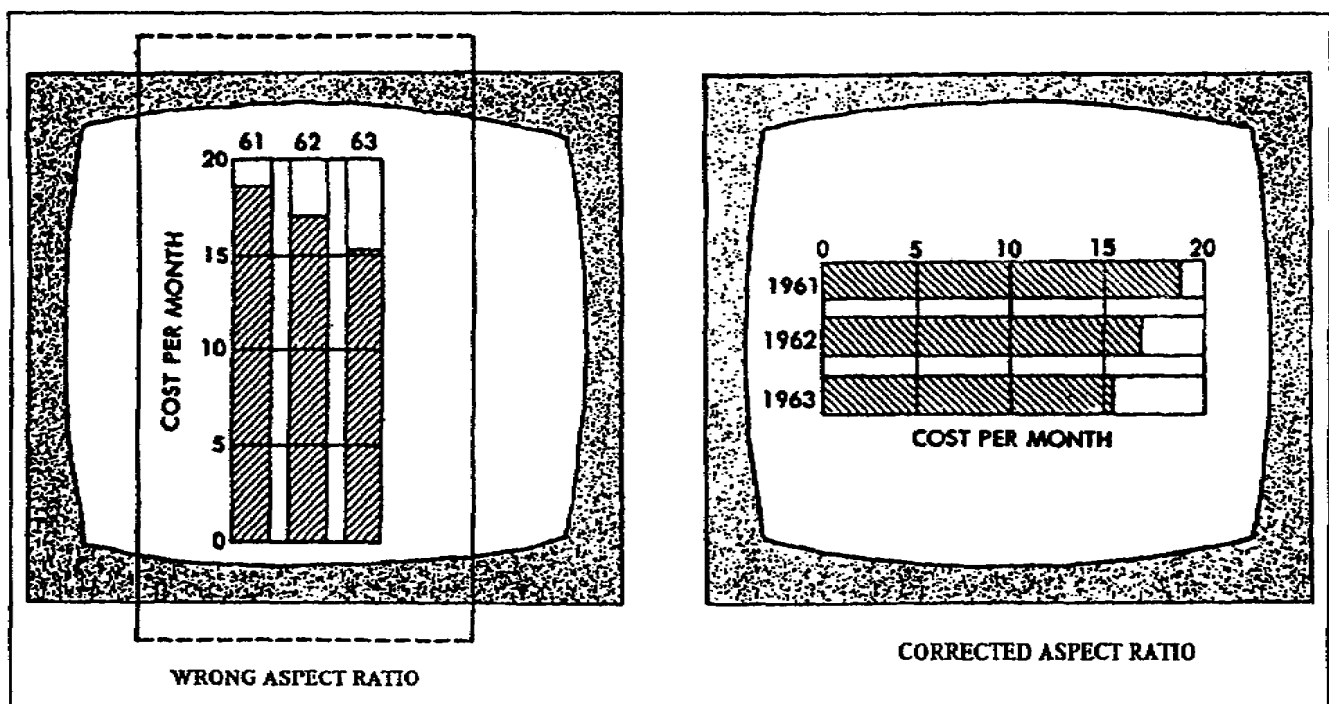


Figure 2-15. Television aspect ratio

Television uses a 3 to 4 aspect ratio for many different reasons. The primary reason is the motion picture industry uses



it. Additionally, research has proven this aspect ratio artistically sound because it duplicates the dimensions of normal human vision, horizontal range one-third greater than the vertical range. Therefore, when you design graphics for a television production using this ratio, it allows for maximum use of the picture area and correct framing by the camera operator.

b. One-sixth Rule. When creating graphics for television productions, you must consider the edge loss television cameras have. With slides, film, and graphics presented using an opaque projector, the projector crops the graphic image and shows the cropped image on the screen. The television camera crops the image as it picks up the image, and the monitor or television crops it again before you see it. In other words, the television system crops the image twice. To overcome this loss, you must build in a safety field using the one-sixth rule.

(1) Applying the one-sixth rule. To apply this rule, you divide the camera field (the total area of the picture) into six equal parts, vertically and horizontally. The area comprised of the 16 center rectangles make up the safe area (figure 2-16). This is the area where you place the important features of the graphic (figure 2-17).

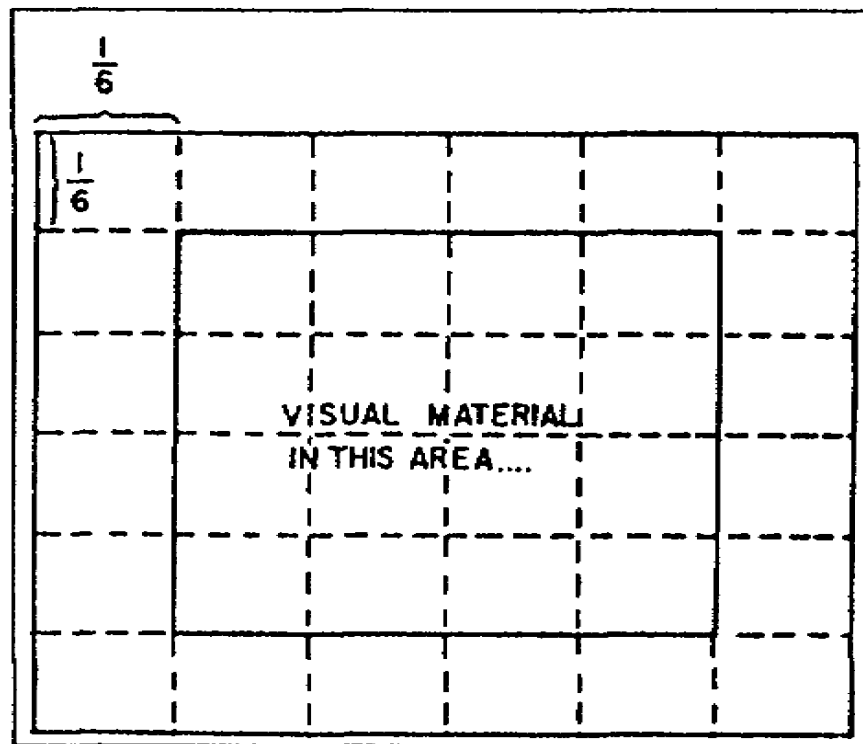


Figure 2-16. Safety field (one-sixth rule)

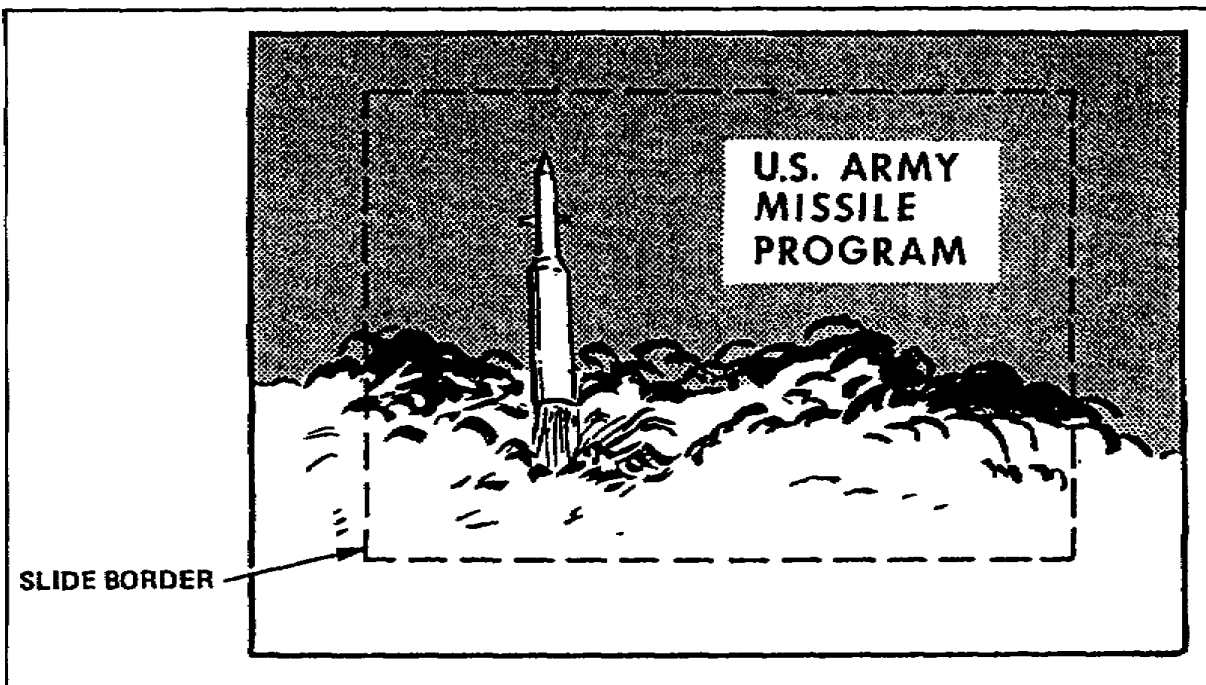


Figure 2-17. One-sixth rule applied

(2) Rule provide safety margin. As you see, the one-sixth rule provides a substantial safety margin. When the television studio uses a camera equipped with an image orthicon tube, the safety margin has significant importance. A camera with an orthicon tube causes the picture to rotate slowly and imperceptibly to prevent the image from being semipermanently imprinted on the tube. Though the average viewer cannot detect this rotation (1 to 2 times per minute), the camera shifts the framing of the picture on the camera for 20 to 30 seconds. If the original graphic does not have an adequate safety margin, the camera would have the picture correctly framed when it first appears and the image would appear misframed after the orbiter shifts it.

c. Designing Television Graphics. You, the camera operator, and director must have a thorough understanding of the intended use of graphics designed for television. There are times when the graphics remain confined and are seen in its entirety on the screen, and at other times the graphics bleed off and out of the picture area.

When designing graphics for television, an agreement between yourself, the camera operator, and producer about the framing arrangement used for graphics helps eliminate any doubt about the intended viewing area and important content area. Once you have reached this agreement, you develop a mask for the agreed format. When the camera operator places the mask over a graphic and correctly frames the display area, he can move the camera toward or away from the graphic and the camera maintains the



correct framing throughout the movement. You can use the mask while developing the graphic to ensure the completed graphic meets the requirements of a television graphic.

(1) Line thickness. The thickness of the lines or line weight is another important factor you must take into consideration when designing television graphics. You should draw ordinary lines of a graphic with a minimum thickness of  $1/75$  the width of the graphic layout area. The type of graphic and the importance of each line within the graphic also is a factor when determining the weight of the lines.

(2) Actual size of a graphic. You can design a graphic to any workable size as long as you maintain the 3 to 4 aspect ratio used for television graphics. Theoretically, you could design a graphic 3 by 4 inches, or 30 by 40 inches, or 9 by 12 feet, since all maintain the 3 to 4 aspect ratio. However, each of these sizes presents problems when designing the graphic. The problem that you face when designing a television graphic is providing a graphic with the correct aspect ratio, in a workable size, and which presents a clear picture when displayed on the monitor.

(a) Selecting the illustration board. When determining the actual size of a graphic, you must consider the standard stock size of the illustration board, file and storage space requirements, and the complexity of the graphic. Common sense tells you to use a size that is comfortable to work with. Television gray board comes in a standard size of 30 by 40 inches, which maintains the required 3 to 4 aspect ratio. You should use this board in its standard size for a graphic. Do not let the size of the board give the impression that a television monitor will show your finished graphic clearly. The camera must reduce the graphics on the large gray board so it fills the monitor. When it reduces the size of the graphic it has the tendency to lose some of its clarity.

Consider the difficulty working with an extremely small piece of stock, say 3 by 4 inches. Not only would you find it difficult to draw the graphic, but the camera would have to enlarge the graphic. When a camera enlarges small graphics to fill the screen, it also enlarges any minor mistakes and trembles that distract the reader's attention away from the intended message of the graphic.

(b) Advantages of 10- by 13-inch size. Experienced television illustrators cut the standard gray board into nine pieces, each 10 by 13 inches. You find gray board cut to this size is comfortable to work with, you can store it in a standard file, and it is a convenient size for the television



production people to handle. You must keep in mind that this is the size of the stock and the viewing area is smaller after applying the one-sixth rule. When designing a series of graphics for a single television production, make every possible effort to keep them the same size. This helps to eliminate the need for the camera operator to constantly refocus the camera.

(3) Checking the clarity of the graphic. When you design a graphic, it is approximately 20 inches from your eyes; therefore, it appears to have excellent clarity. However, you must determine if it maintains that clarity when a television viewer sees it.

At what distance must you view the graphic to have the perspective as a television viewer? For this discussion, the basic graphic's height is 10 inches, it has a border of 1 1/2 inches at the top and bottom, the viewer has a 14 inch monitor and is 9 feet away from it. To find the distance you must view the graphic from, you must first determine the height of the graphic itself by taking away the top and bottom borders ( $10 - 3 = 7$ ), which leaves the graphic's height, 7 inches. Since the height of the graphic equals half the height of the monitor, you must view it at half the distance the viewer is away from the monitor ( $9 \div 2 = 4 \frac{1}{2}$ ), 4 1/2 feet. When you look at the graphic from 4 1/2 feet, you have the same perspective as the viewer. You apply this theory to any size graphic, monitor, and viewing distance to check the clarity of a graphic. The point of the entire discussion and illustration is to point out that the clarity you see at the working distance is not the same clarity the viewer may see. To ensure your finished graphic presents its message clearly, constantly check your work for clarity.

d. Lettering Television Graphics. The legibility standard used for television requires a picture, including the lettering, being legible at 20 feet when displayed on a 21-inch monitor. There are no hard and fast rules for lettering television graphics. You apply the lettering techniques as discussed in lesson 1 of this subcourse when applying lettering and combine those techniques with your experience, the broadcasting station's capabilities, and local standing operating procedures.

(1) Lettering television graphics criteria. The criteria for lettering television graphics is when the viewer can read and understand the lettering on the monitor, you have selected lettering of adequate size and style. On the other hand, if the viewer cannot read and understand the lettering on the monitor, the size and style lettering you selected was not adequate.

For the best visibility of lettering on television graphics, use a simple style of lettering, with each character constructed consistently and clearly. Do not use complicated or ornate lettering styles such as Old English because viewers have a hard time reading them at a glance. Additionally, you should not use extremely thin letters because there is a chance of losing part of them during the transmission.

(2) Determining letter size. There is a simple rule to apply to determine the minimum size of lettering that provides maximum visibility: The height of the lettering equals at least  $\frac{1}{15}$  the height of the graphic. For example, when a graphic has a vertical height of 15 inches, it should have lettering at least 1 inch high (figure 2-18).

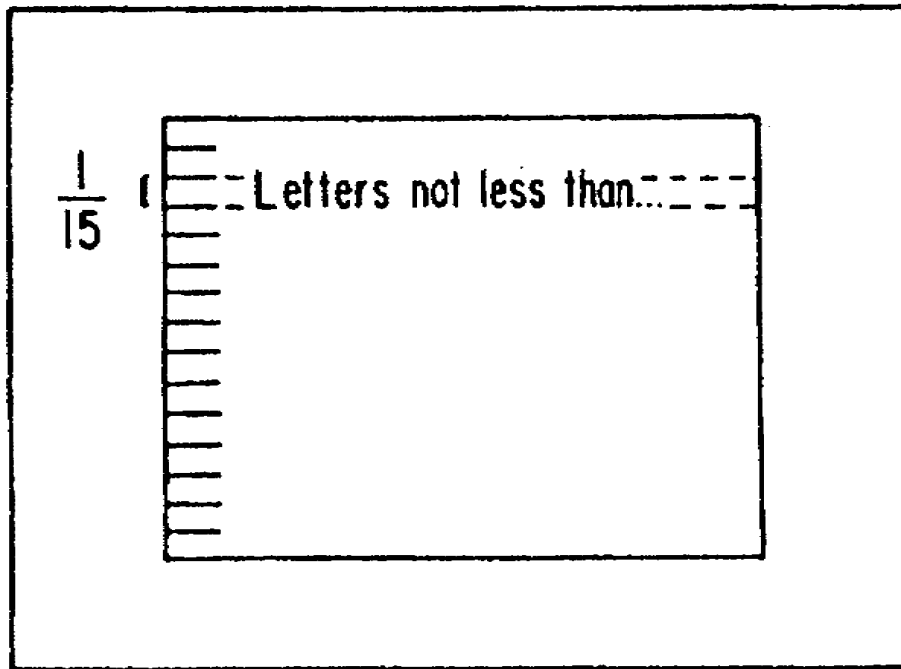


Figure 2-18. Minimum lettering height

When lettering a television graphic, you deviate slightly from the standard rules for spacing because the television camera tends to cause the lettering to appear closer together than it is. Therefore, the spacing used is wider than normal. For these types of graphics, never use a space less than half the thickness or larger of the two letters it separates.

To produce television graphics with quality lettering, you should use minimum lettering only when necessary to present a large amount of information in a limited space. Keep the minimum to a minimum, do not let it become the standard for your lettering.

e. Black and White Graphics. When you consider a graphic, your initial reaction is the colors black and white suit almost all forms of graphics, especially if the graphic presents a mathematical function or formula that would benefit from the extreme contrast between black and white. However, this does not apply to graphics for television.

(1) When there is too much contrast (when the two extremes are next to each other), it could cause halos and horizontal streaking. The best way to present this graphic is with three different tones.

As an illustrator you might consider it inappropriate, but you must use some black and white in graphics. The video engineer sets the video levels on a black-white basis. Therefore, he must have black and white present in the graphic to establish his basic video setup.

(2) After properly adjusting a black-and-white television, there are approximately eight different shades of gray, besides black and white. Unfortunately, transmission restrictions limit the number of these shades available for use, and you must use the shades carefully. You cannot place two slightly different shades of gray side by side because they probably will appear the same. You should limit your black and white graphic to no more than three different shades for gray, besides black and white. When using only three different shades of gray, you can use every other shade of gray.

f. Color Graphics for Black-and-White Television. When preparing color graphics for black-and-white television, you must select the colors cautiously, and only use them in their gray scale equivalents. You must remember that two colors may present a considerable contrast to the eye, but when seen on television, they appear as the same shade of gray. If you have any doubt about whether the colors are presenting a contrast on television, check them on the camera prior to designing the graphic. Do not fall into the trap of believing that somehow colors enhance this type of graphic, since they may not.

If for some reason you do use colors for a graphic black-and-white television, you should prepare and use a gray response chart. When designing and constructing the graphic, use the gray response chart as a reference to determine the contrast each color will present when seen on television. To construct a gray chart, lay out the gray scale and then make on-camera comparisons of the colors you intend to use. You may not find an exact shade of gray to match the hue of the color you chose for the graphic.



g. Television Resolution. Resolution is the ability a system has to reproduce fine lines. Video engineers assign a resolution number to a system by noting the maximum ability of the monitor to distinguish between the line of a resolution target (figure 2-19). As an illustrator, you should know the resolution of the system that the graphics you prepare will be shown. You must always visualize how the system presents the graphics you prepared. Additionally, you must keep the resolution rating in mind when deciding how much detail to present in a graphic for television. When preparing graphics for television, remember these words to help overcome resolution problems: big, bold, and simple.

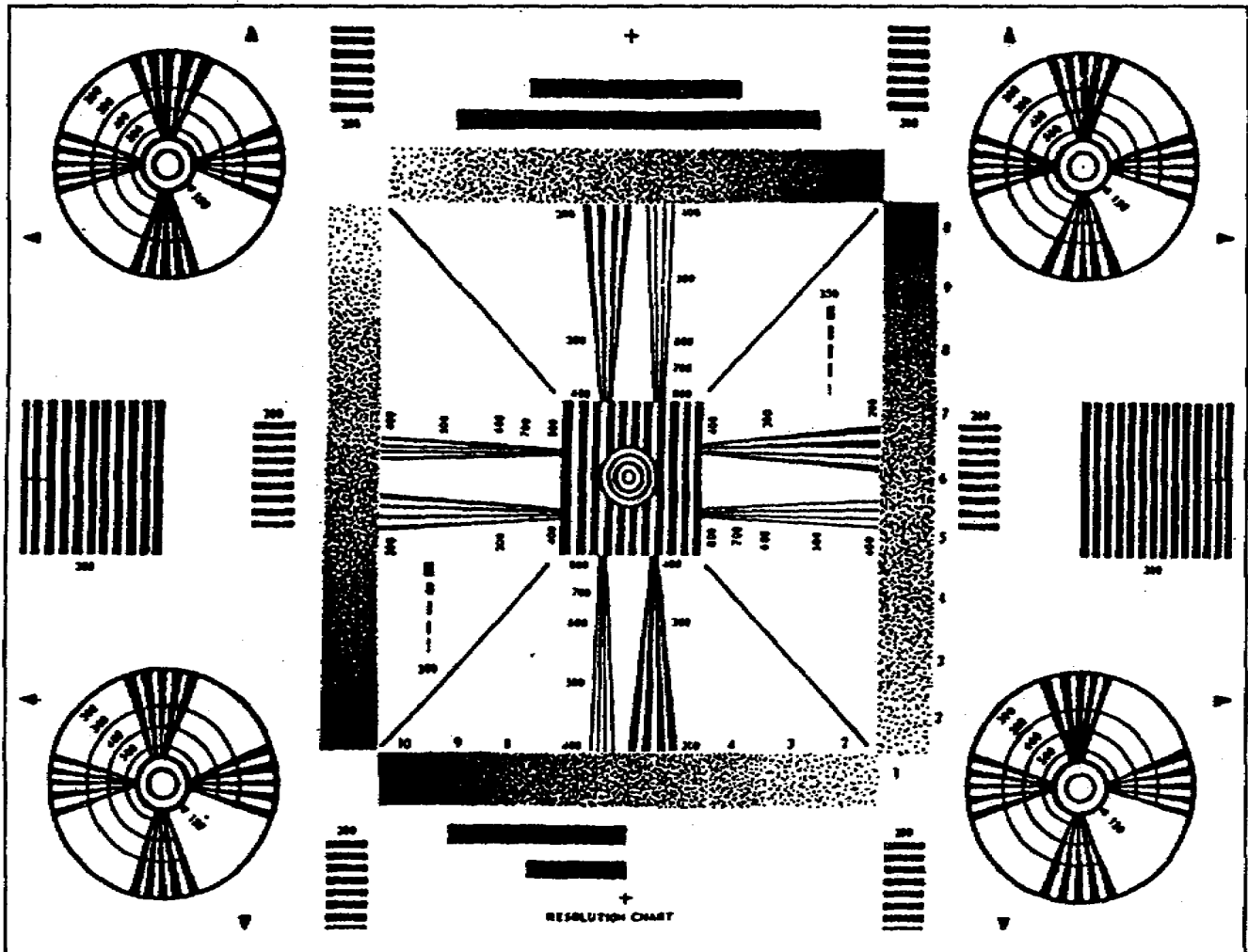


Figure 2-19. Resolution target

h. Types of Television Graphics. A television production uses many different types of graphics. Some of the prominent types of graphics are studio cards, rear projections, slides, phantoms, and animation.

(1) Studio cards. Studio cards are stationary graphics on small cards placed on an easel, mounted on pegboard, or stuck on the wall with tape, and shot with the studio camera. It is the most common form of graphics used in a television production. Since studio cards do not move, the narrator can point to and discuss the different parts and emphasize the information presented on them.

When preparing studio cards you could use tempera, retouch grays, airbrush, grease pencil, pencil, pen and ink, felt point pens, and pastels on matte-finish sheets or matte-finish tapes. Nonglossy photographs mounted on cardboard backing make excellent studio cards.

When presenting more than one main idea on a studio card, you would use a tracing paper overlay to conceal the information not yet presented. As the program develops the information on the studio card, you can modify the tracing paper or remove it completely from the studio card. An advantage of studio cards is that they are in the studio under the control of a narrator, cameraman, director, etc.

(2) Transparencies. When used in television productions, projectors show the transparency on the backside of a translucent screen (rear projection), and a studio camera shoots it. Television transparencies usually measure 2- by 2-inches or 4- by 5-inches. Television productions use rear projection for several different reasons: the projector and its necessary cable do not clutter the studio and hamper camera movement; the studio lighting system does not deteriorate the clarity of the graphic as it would with front projection; and the narrator or performer can work near the projection image without worrying about blocking the light from the projector.

When designing and producing graphics used as transparencies for television, you apply the information presented earlier in this lesson, paying particular attention to clarity and aspect ratio. When you have the graphic reduced to the correct size, mount the film in a frame. You can use a photographic negative or positive as a transparency for television.

Another form of rear projection uses no screen. This form of rear projection uses a large transparency, like the ones used with an overhead projector, placed on a transparent box that is lit from behind. The camera then shoots the rear-lighted transparency.

(3) Slides. Slides prepared for television are either in a positive or negative form. When used in the positive form, a slide functions the same as a studio card; however, the narrators cannot point to or touch the slide because they would interfere with the projection of the slide. When presented in the negative form, the director can superimpose the slide image over a live scene and present the live scene and the slide image as one image.

(4) Phantoms. The fundamental principle for this type of television graphic is color values. When you design and prepare this type of television graphic, draw the image on a medium gray background using a colored media, usually pencil. The color used to draw the image must have the same value on the gray scale as the background material. Usually you find the phantom and the narrator shown at the same time; therefore, the phantom is usually large, 15 by 20 inches or larger as the situation dictates.

Because the image and the background have the same gray scale, a television camera will not show the image, but the image is visible to the narrator. Therefore, when the narrator uses a grease pencil or felt tipped pen of a different gray scale value than the background to trace the image, it appears to the camera that they are creating the image on the background, when in fact they are just tracing the fully developed image.

For example, television uses this effect to develop complicated graphics or drawings or to present mathematical problems without errors. Another reason television uses this type of graphic is as a slowdown device (i.e., develop a graphic in steps that would otherwise be as a finished form). A slowdown allows the narrator to present information at a rate the viewer can easily comprehend and absorb.

(5) Animation. Animation is a special presentation technique used to create and hold the viewer's interest. Because moving objects attract, hold, and lead the eye, movement or animation is very effective as an aid to learning. Full animation techniques are complex, require a large amount of time to develop, and are expensive.

Animations created for television require 30 frames or pictures for every second of the presentation. Since animations are expensive to produce at a frame rate higher than 30, the excepted standard of animation for television is a limited form of animation with jerky motions and abrupt movements.

(a) Slide cards. This a simple form of animation for television. You can develop them to show such things as a line on a graph, expose a waveshape, or progressively show lines of lettering. A slide card usually has three layers. The top and bottom layers do not move, but the center layer moves. The bottom layer has the information displayed as the animation develops, and the center layer covers the bottom layer. The top layer has the cutout from which the viewers see the information, as the center layer moves to uncover the information on the bottom layer.

For economical and practical reasons, the best use for television animation is step-by-step development of specific graphics by the "pop-in" technique. For this technique, you shoot the incomplete graphic to a specific point, make the required changes or additions, reshoot the complete graphic, and edit the first shooting to the second. The editing gives the viewer the impression the additional items in the graphic just "popped-in" to the basic graphic. Television uses this system successfully to develop 5- or 6-segment graphics built up in steps by "pop-in."

(b) Technamation principle. Another method to create limited animations is technamation. This principle uses pressure-sensitive polarized materials and polarized light to create motion or a blinking effect. For example, weather broadcasts use technamation graphics when showing the movement of the wind or weather front on the weather map.

When a polarized light strikes a graphic with polarized materials, it reflects an unpolarized light from all areas, except the area covered by polarized materials, and enters the camera lens with no visual effect. However, if you slowly rotate a transparent disk, the reflected (or transmitted) light from the technamation material selectively goes from matched polarization to cross polarization. At cross polarization, no light enters the camera lens. Then gradually as the disk reaches the position where polarization matches, more light enters the camera lens. This principle gives the area covered with the technamation material a blinking effect. The rest of the graphic does not blink because it does not reflect polarized light. This effect is successful in cases where action is repetitive. Whether you use this principle for a band motion, circle expansion, flashing, etc., it cycles according to the rate you turn the polarizing disk.

You can use either front or rear lighting for this principle. When using rear lighting, you must cut the graphic in the areas containing the technamation materials so light passes through.

Depending on the application, you can place the polarizing disk on the light (when using a single light source) or directly in front of the camera lens. You also can apply the technamation principle to fade-ins, fade-outs, color changes, and other effects through manual operation of the disk.

(c) Crawl device. A crawl device shows large amounts of information progressively without losing continuity. This device makes information crawl or move either vertically or horizontally across the screen. Television uses vertical crawl devices more than horizontal crawl devices.

A drum crawl is a large cylinder (approximately 48 inches in circumference) with information attached that mounts on a rod. As you turn the drum, the information moves and comes into view at the bottom of the monitor screen and disappears at the top of the screen. The curvature of the drum gives the information the illusion of rolling in and out. The center of the information is clear and distinct while the lines above and below the center appear foreshortened and slightly out of focus.

A roller crawl has two rollers approximately 36 inches apart. One end of a roll of paper attaches to the top roller and the other end attaches to the bottom roller. With a roller crawl in the upright position, the information on the paper moves from the bottom to the top of the screen. If you lay a roller crawl on its side, the information moves from the right to the left side of the screen or vice-versa.

(d) A "gobo." A gobo is a two-dimensional part of the graphic with a cutout area mounted on the front of a crawl device. The cutout area of the gobo registers or aligns with the information on the crawl. As the crawl information moves, it appears in the cutout window. An excellent example of a crawl and gobo combination is a cartoon character holding a picture frame with information passing through the frame.

## 7. Types of Projectors.

Different types of graphics require different projectors to present the images on the screen. Usually you think of using a projector to show the images for viewing only. But projectors enlarge or in some cases reduce the image; therefore, after you have enlarged or reduced the picture to the required size, you could trace the image instead of redraw it to size.

NOTE: Use figure 2-20 to follow the discussion of an overhead projector.

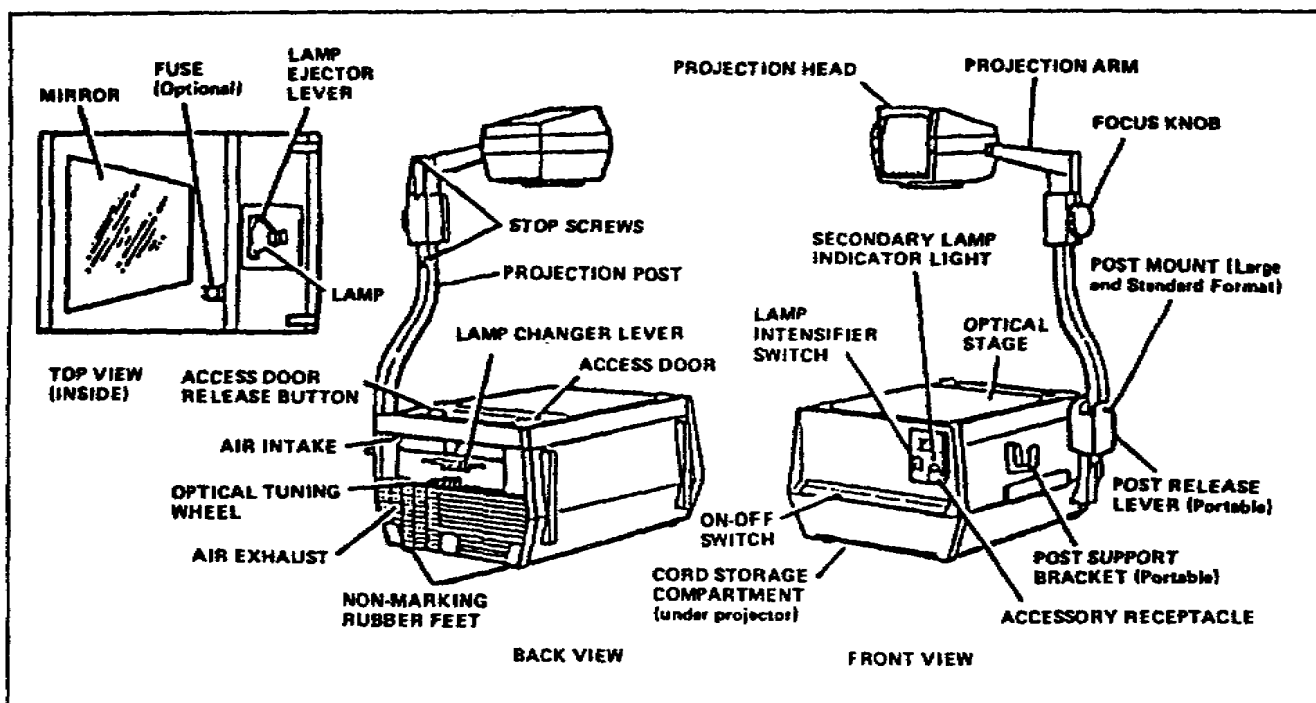


Figure 2-20. Overhead projector

a. Overhead Projector. You would use an overhead projector to project colored or opaque images from a transparency or viewgraph. An advantage of the overhead projector is you can use it in a room without turning off all the lights (when shielding the screen from direct light sources). Because of the relatively large size of the viewgraph, the speaker has the capability of working directly on the viewgraph while talking. You can use this type of projector for front and rear projection.

(1) Parts of an overhead projector. An overhead projector weighs about 26 pounds, has a 12-inch triplet lens system with a front surface mirror, and a 10 1/2 inch aperture.

(a) The older projectors have a three-position switch that controls the operation of the blower and lamp. In the first position, the switch only provides power to the blower for cooling the lamp after operation. If you do not properly cool the lamp after operation, the excess heat damages the lamp. In the second position, the switch provides power to both the lamp and the blower.

(b) The newer projectors have an on-off switch and a thermostatic switch that controls the blower operation. In the ON position, the switch provides power to the lamp. As long you have the projector connected to an electrical outlet, the thermostatic switch controls the blower operation. When the heat around the lamp reaches a predetermined point, the

thermostatic switch turns on the blower until the temperature drops to a preset point and then shuts off the blower. When turning off this type of overhead projector, leave it connected to the electrical outlet until the blower has stopped.

(2) Projector lamps. Overhead projectors have two lamps. When the primary lamp fails, turn off the projector and change lamps by sliding the lamp change lever to the secondary lamp position. Replace the primary lamp as soon as possible. The projector has a lamp indicator light that lights when using the secondary lamp.

When using this projector to show special viewgraphs or using it with a screen that has a problem with the ambient light, you can increase the light output by 10% by placing the lamp intensifier switch to the high position. You must realize that placing the lamp intensifier switch in the high position reduces the life of the lamp by approximately one half.

Occasionally, you find the image on the screen has red or blue corners. To eliminate this undesirable effect, use the optical tuning wheel to decrease the aperture opening of the projector. You also can use this control to adjust the projector to different size screens.

(3) Removing and replacing a lamp. These projectors use an ENX lamp with a life of about 170 hours at high intensity or 370 hours at low intensity. When a lamp has failed, allow the projector to cool before replacing the lamp and disconnect it from the power source. When the projector has cooled, rotate the optical tuning wheel counterclockwise until it stops turning. Then push the button to release the access door and open the door. Next you pull the lamp ejector lever toward the rear of the projector to release the burned out lamp from its holder and lift it out. Insert the new lamp in the holder, ensuring you wipe off any fingerprints. The body oils on your fingers stain the lamp and cause hot spots that cause the lamp to burn out or break.

Once you have installed the new lamp, plug in the projector and turn it on. With the lamp lit, eliminate any red or blue corners on the screen by adjusting the optical tuning wheel until the image on the screen is white.

(4) Cleaning the projector. To ensure the best possible image on the screen, clean the outside lenses of the projector head and the top surface of the optical stage. Use a mild detergent solution and a clean, soft, lint free cotton cloth, and rinse and dry the surfaces. You cannot use a paper towel to clean these surfaces because paper towels are abrasive and will scratch.





Do not clean the mirrors in the body and certain projection heads because they are front-surface mirrors. Front surface mirrors have their reflective surface on the front of the glass. These mirrors do not reduce the image intensity or clarity as do conventional mirrors. Remove any surface dirt in these mirrors with a camel's hair brush.

NOTE: Use figure 2-21 to follow the discussion of an opaque projector.

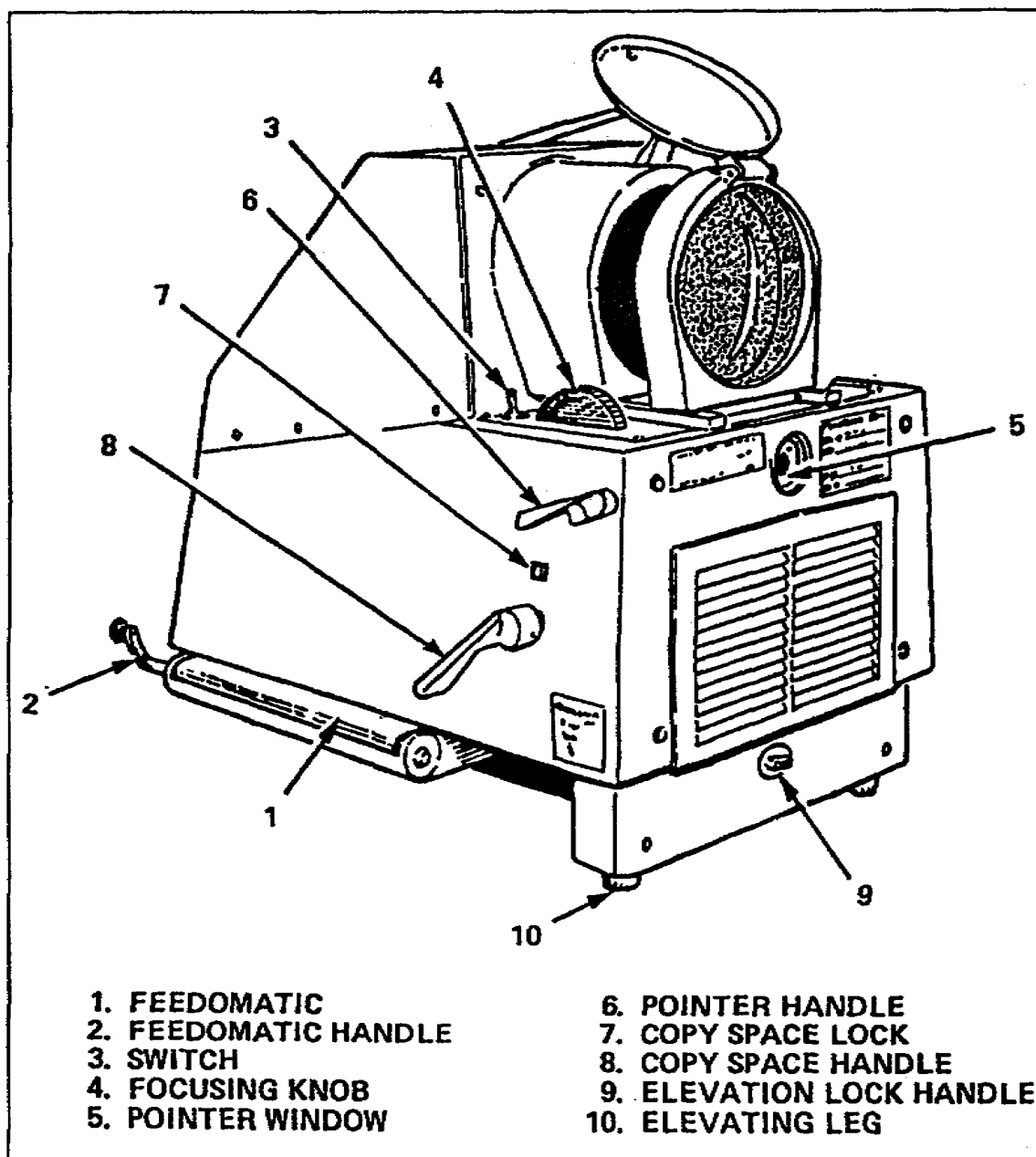


Figure 2-21. Opaque projector

b. Opaque Projector. Unlike the overhead projector, an opaque projector reflects light from the surface of an opaque object rather than passing through it. You would use this type of projector to display the pages of a magazine or book, photographs, charts, etc., up to 10 inches in size. It also can project any relatively small, flat objects such as cams, gears, and coins without prior preparation. Most opaque projectors use a 1000-watt lamp.

(1) Using the opaque projector. This projector has three positions that function the same as the older overhead projectors, with the first position from off (middle position) controlling the operation of the blower. An opaque projector has a feedbelt that feeds material into the projector smoothly. Place the copy on the feedbelt, turn the feedbelt handle, and center the image on the screen. If you have a thick copy, insert it into the projector by unlocking the carriage, moving it down with the copy space handle, and inserting the copy. Once you have the image on the screen, use the focusing knob to adjust the clarity of the picture.

(a) Advantages of the opaque projector. To protect the copy from the heat generated by the lamp, this projector has a heat filter. Additionally, the carriage has a glass pressure plate to help keep photos and books flat for projection.

(b) An advantage of this projector is the pointer window and handle. This window projects a small arrow on the screen that you use to emphasize points on the screen. Moving the pointer handle up and down moves the arrow vertically on the screen, and moving the pointer handle left and right moves the arrow horizontally on screen.

(c) You also have the capability of increasing or decreasing the magnification with this projector. To increase the magnification, loosen the lens screw and move the lens back in its mount. To decrease the magnification, pull the lens out, but no more than one inch.

(2) Cleaning an opaque projector. To ensure an opaque projector also presents the image clearly, you must clean the optical element's external surfaces with a lint-free cloth or lens tissue occasionally. (The manufacturer seals the lens; therefore there are no internal surfaces for the operator to clean.) To gain access to the rear surface lens, secondary mirrors, and parabolic reflector, open the rear of the projector.

The most important and delicate optical surface you must clean is the front surface mirror. Do not touch the mirror, leave

fingerprints, or other marks. Use a camel's hair brush to remove any dust, unless you find the mirror badly soiled. To remove any heavy soiling, use a clean, lint-free cloth or lens tissue. However, this is a last resort cleaning because it scratches the surface of the mirror and creates more damage.

(3) Removing and replacing a lamp. When the projection lamp burns out, replace it through the rear door after unplugging the projector and allowing it to cool. Remove the old lamp by gently pushing down on the lamp, turning it counterclockwise one-half turn, and removing it from the socket. Install the new lamp by aligning the socket ears with the matching slots in the lamp socket, gently pushing it down, and turning it clockwise to lock it in place.

(4) Maintaining the motor. The projector's motor has impregnated bronze bearings that require lubrication with light oil every six months. Remove the front grille of the projector for access to the bearings.

## PART C - PRINT PROCESSES AND PREPARING OVERLAYS

### 8. Printing Processes.

Regardless of the method used, printing transfers an image to a surface. As an illustrator, you give ideas in an intelligible graphic form. In many cases, printing is the last step in the process. It puts your ideas in the final form that presents the idea. There are three different methods of printing: (1) letterpress or relief, (2) intaglio, and (3) lithographic or planographic (figure 2-22).

a. The Letterpress or Relief Printing Process (figure 2-23). This form of printing is the oldest form and is still widely used. Relief started as the art of wood carving in which the printer gouged out the area of the wood not meant to be printed. This causes a design or letter that stands in relief.

A relief printing surface always produces a letterpress copy. Whether the printing surface is a single printing plate or a combination of one or more plates, they are usually metal with the relief created by a photoengraving process. However, occasionally the type is still hand set by the printer.

b. The Intaglio Printing Process (figure 2-24). The intaglio printing process uses a plate that has the letters or graphics etched below the surface. After inking the plate, a roller wipes it clean. However, the ink remains in the etched letters or graphic. Therefore, when forcing paper against the surface, only the ink-filled areas reproduce. Printers use this process to print engraved stationary, paper money, and postage stamps.



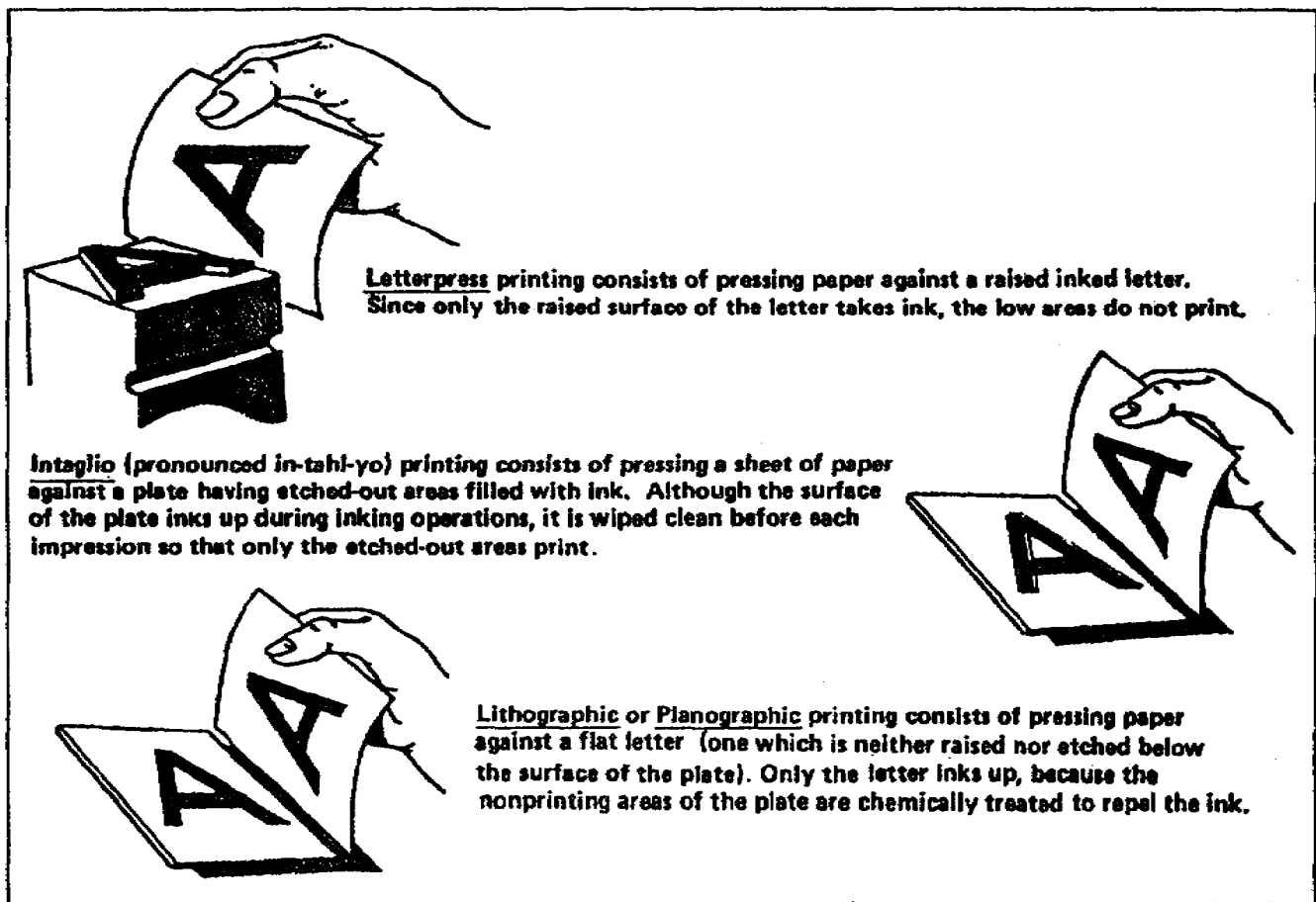


Figure 2-22. The printing processes

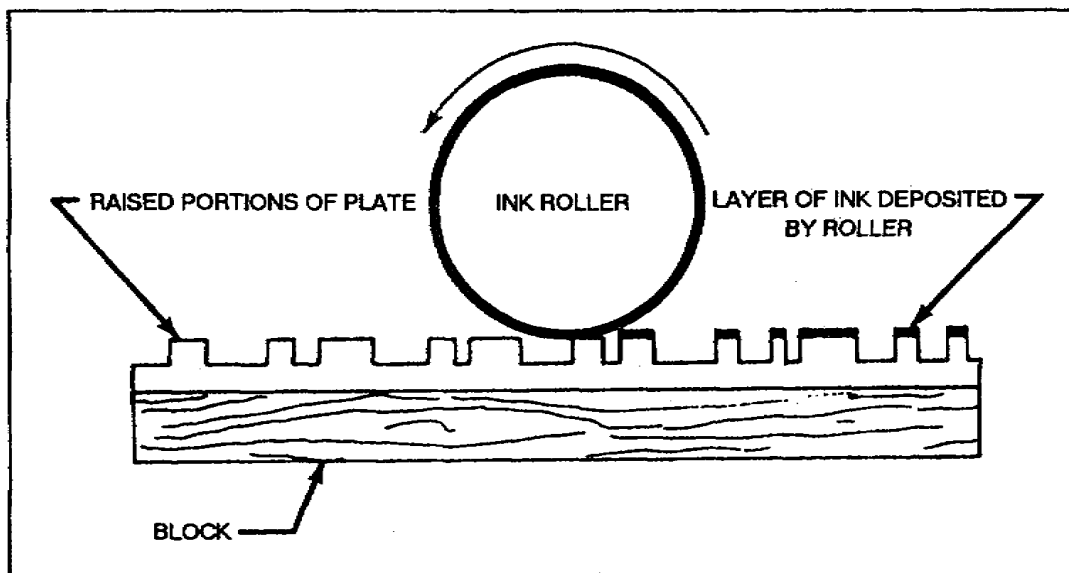


Figure 2-23. A simplified drawing of letterpress printing

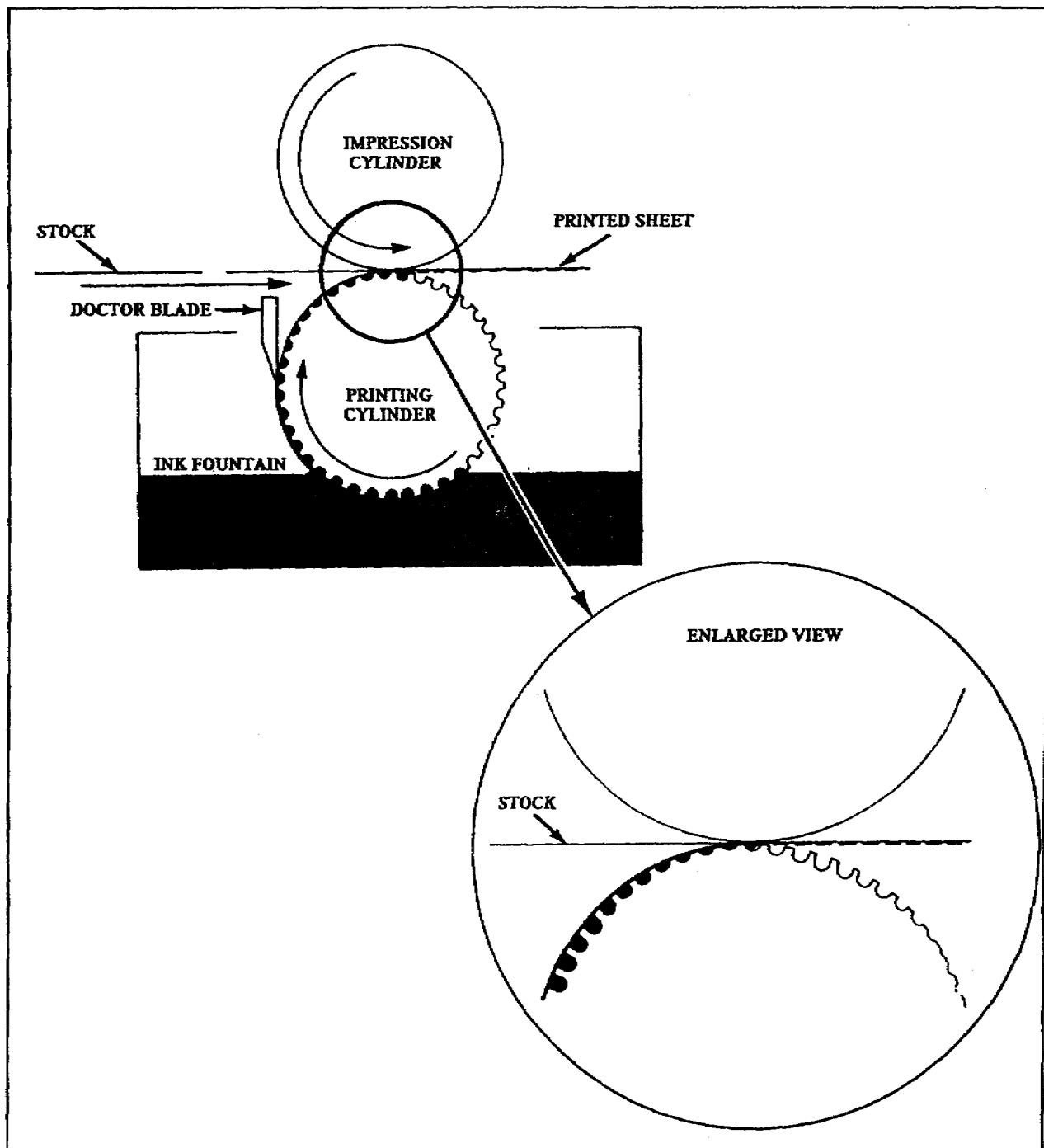


Figure 2-24. A simplified drawing of the intaglio printing process

c. The Lithograph or Planographic Printing Process. This printing process uses the principle that water and oil do not mix. This is the best known and most widely used printing process because it is economical, suited for both short and long

press runs, and produces a superior grade of printing. The process started as hand drawings on a flat limestone with greasy crayons. The area covered by the greasy crayon rejected the water when flushed, and retained only the oily ink. Pressing the paper against the inked surface created the printed copy. You can still identify modern lithography by its characteristic flat plane with the image on the surface of the plane.

From drawings on stone, this process has moved to photoprinting on sensitized metal. A lithographic plate is a thin, flat, chemically-treated zinc or aluminum metal surface. Because its surface has a photosensitive grease chemical treatment, the image remains in a chemical form on the plate, after photographically exposing a negative to the plate. The chemical areas exposed to the light (the clear areas of the negative) remain after developing and washing. The chemical areas not exposed to the light (the black areas of the negative) wash away exposing the bare metal surface. As the principle of lithography states, the photosensitive chemical image repels the water and accepts the ink. The bare metal surface accepts the water and repels the ink (figure 2-25).

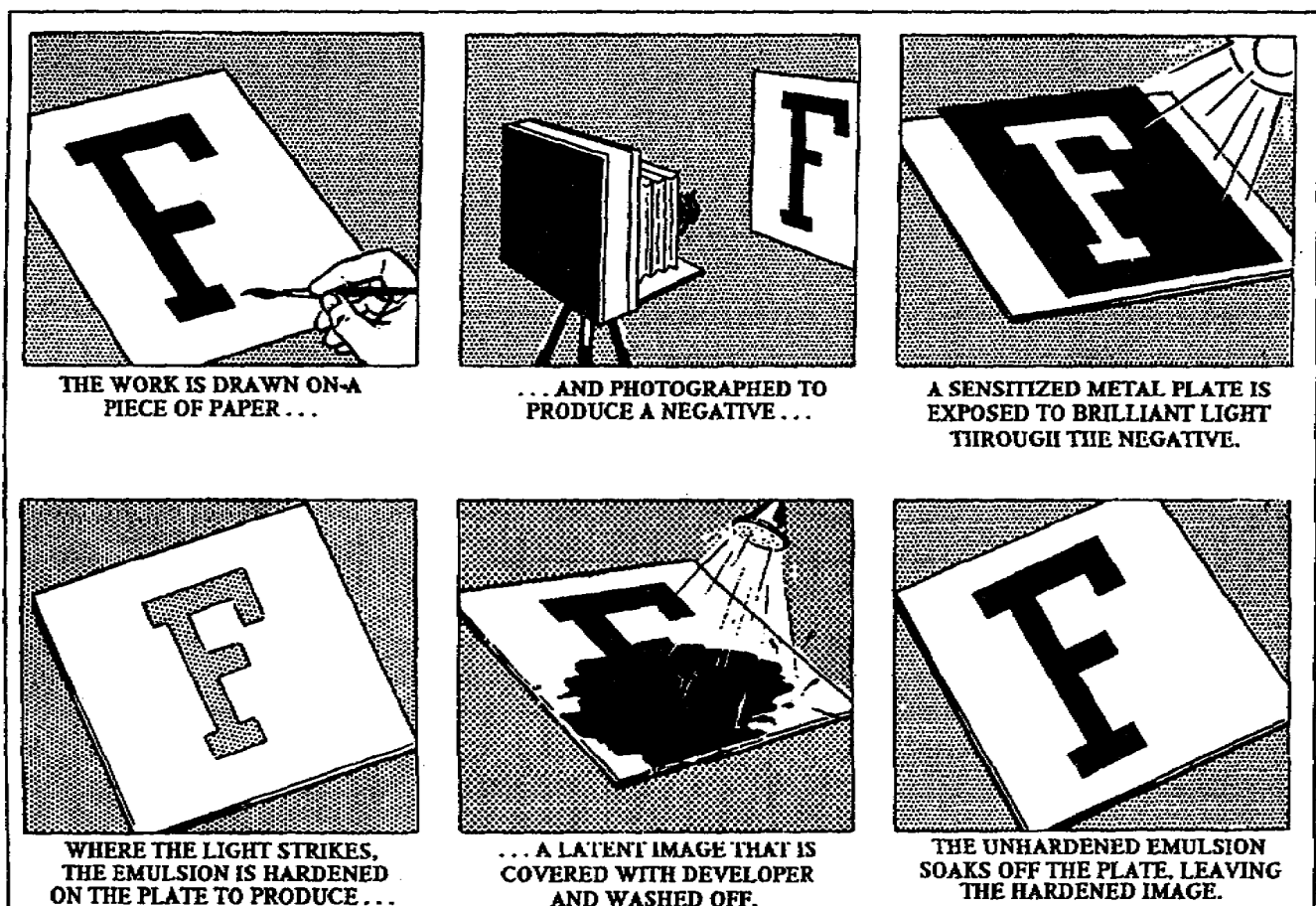


Figure 2-25. Producing a photolithographic printing plate





Today's lithography is photo-offset lithography, an indirect printing method. The process transfers ink from the plate to an intermediate rubber-blanketed cylinder that offsets the ink to the paper.

Figure 2-26 shows this process. Notice how the figure shows the plate cylinder contacting the offset cylinder, then rotate to contact the dampening rollers before the surface of the printing plate contacts the inking rollers. This ensures the nonprinting surfaces are damp and reject the ink, the lithography principle.

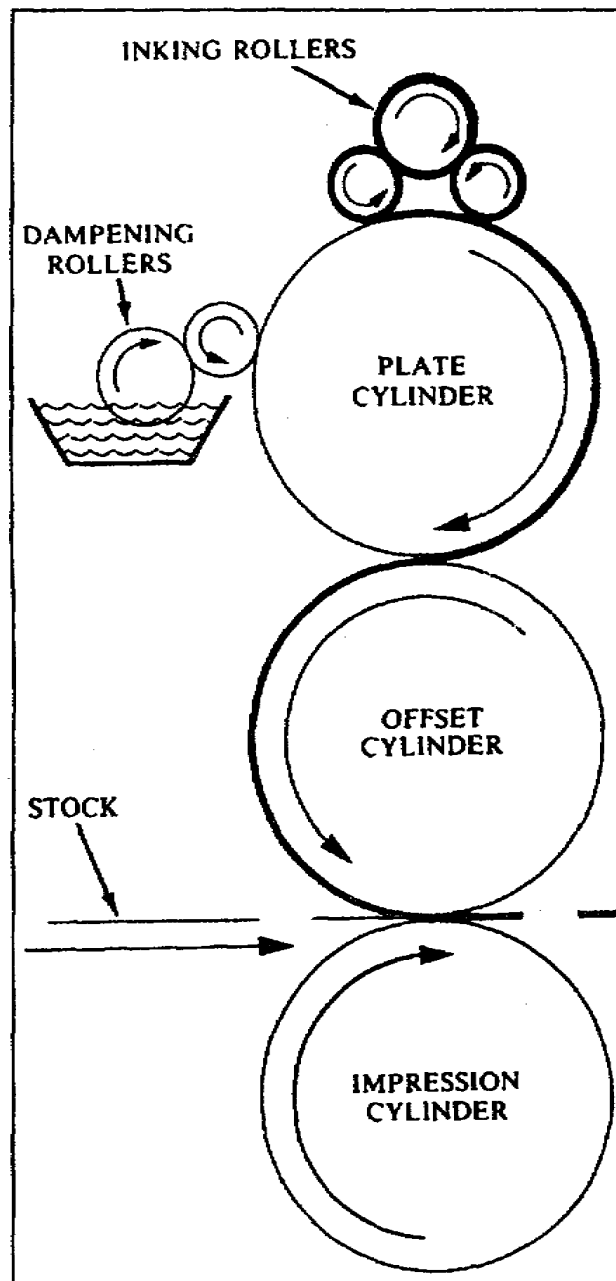


Figure 2-26. The basic offset lithography principle

## 9. Color Separation.

When reproducing a full graphic, you must produce four separate printing plates, a plate of each of the four basic colors. This is known as color separation. The photoengraver filters the sensitized emulsions to eliminate the three colors not desired on the negative. For example, when reproducing an image with green in it, the photoengraver uses a filter that allows the desired amounts of yellow and blue (the basic color that make green) through to the negative and holds the amount of red and black in the green area to a minimum. There are two methods used for color separation: indirect and direct.

a. Indirect Method of Color Separation. When using this color separation method, you produce continuous tone-separation negatives and then produce contact positives from these negatives. You retouch the contact positives and rephotograph them as halftones. You can use this method for difficult copies having very dense areas that the finisher would have problems opening if furnished as an ordinary set of prints.

b. Direct Method of Color Separation. You would use this method when you make a halftone color separation negative directly from the copy using filters. You then print the screen negatives on the metal and the color etcher not only etches the picture into the metal but also color-corrects by etching, to create a reproduction of the image.

Color separation is a subtractive process that uses filters that compliment the colors used for printing. When the photographer produces the yellow printer negative, he use uses a blue-violet filter. When producing the blue printer negative, he uses a red filter, and when producing the red printer negative, he uses a green filter. When the photographer produces the black printer negative, he uses a combination of red, green, and blue filters or no filter.

c. Indicating Color Separations. As an illustrator, often you assist the photographer or lithographer by making color separation drawings they can refer to when making the printing plates. The drawings range from using simple instructions when separating the colors, to in-depth drawings that do the job of separating the colors the filters do automatically.

(1) Tissue color separation overlays. This is the easiest method used to indicate color separation. You start this process by laying a sheet of tracing paper over the graphic and blocking out each color area with a crayon or pencil. The lithographer then uses the overlay when shooting each printer.

(2) Multiple drawings. When using this method, you create separate drawings for each color. When preparing the drawing, you must consider the value of the primary colors so when combined they produce the correct shade of the secondary colors. For example, you must consider the value on the red drawing and the blue drawing so the correct shade of violet prints on the finished copy.

(a) Before you can draw the color separation drawings, ensure you have two or more registration marks and crop marks on the original. Then place an acetate sheet over the original, frosted side up. Then add the registration and crop marks over the marks on the original. Next you outline the areas containing the color for this plate, and fill them in with India ink. To achieve lap register, the design of each plate is slightly larger than the original to ensure a slight overlap. The elements to appear in the lighter color should overlap into the darker color. You would use this process for all three primary colors and the black plate.

(b) Figure 2-27 shows an example of this process. The plate in the upper left-hand corner represents the color illustration the photographer must reproduce. You also should send this plate as a reference the photographer can use for the finished print. As you can see, this plate has three registration marks, crop marks, and dimension instructions. The example this figure shows also includes a 30% halftone plate that adds gray to some color areas. The photographer combines the halftone plate with the black when making the black printing plate.

## 10. Overlays.

Graphic overlays provide a means of presenting a series of ideas or construction theory one step at a time. A map overlay presents the current situation for a given area on a map.

a. Graphic Overlays. The use of overlays is an effective feature of overhead projectors. By preparing separate transparencies, you can divide problems, processes, and other types of information into logical elements and show them progressively.

(1) Preparing overlays for viewgraphs. When preparing viewgraphs using the overlay method, you must first make a sketch of the total viewgraph. Then you must decide which elements you will place on the base viewgraph and each overlay. Once you have determined the placement of the elements, use the original to prepare the foils for the base viewgraph and each overlay by copying the appropriate elements to each.



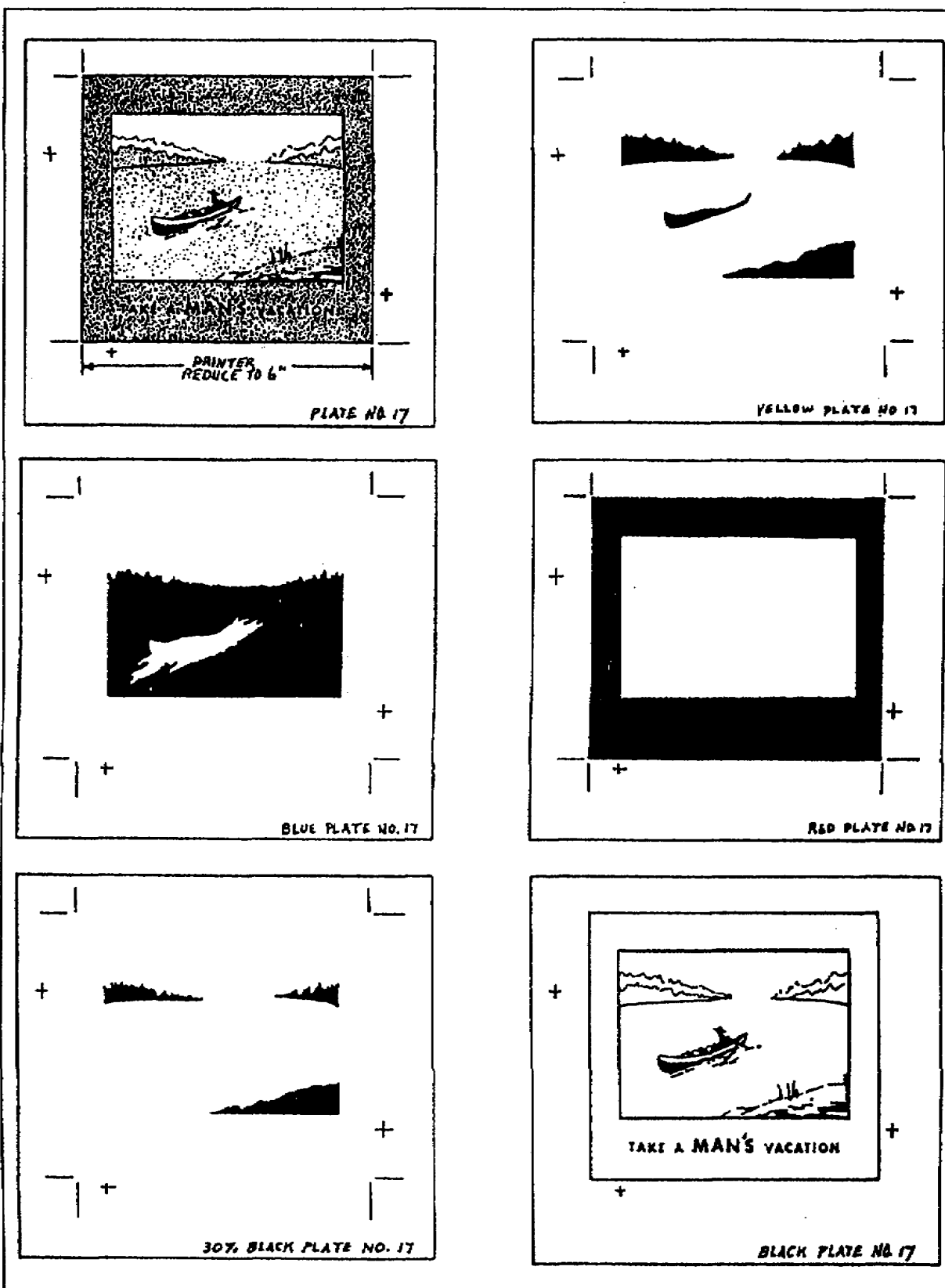


Figure 2-27. Color separation

(2) Mounting the overlays. As you learned in lesson 1, a viewgraph (in this case the base) film mounts to the back of the frame. Each overlay mounts on the front of the frame. When you must present the elements of the overlay in a specific order, mount each overlay on the same side of the frame. This also allows you to position them while on the overhead projector. If you do not have to present the overlays in a specific order, mount them on alternating sides of the frame. This way you can still position them while on the overhead projector. Then trim the overlays so they all fall into place easily.

You also can attach small tabs of masking tape or adhesive-back labels on the loose upper corner of each overlay. You can grasp the tabs easily when placing the overlays in place over the base element.

(3) Using overlays. Figure 2-28 shows the use of graphic overlays. Since the overlays mount on each side of the frame, that indicates you do not have to present them in a prescribed order. In this figure, the base element is the star with no shading in any points. As you position each overlay, you add shading to each point.

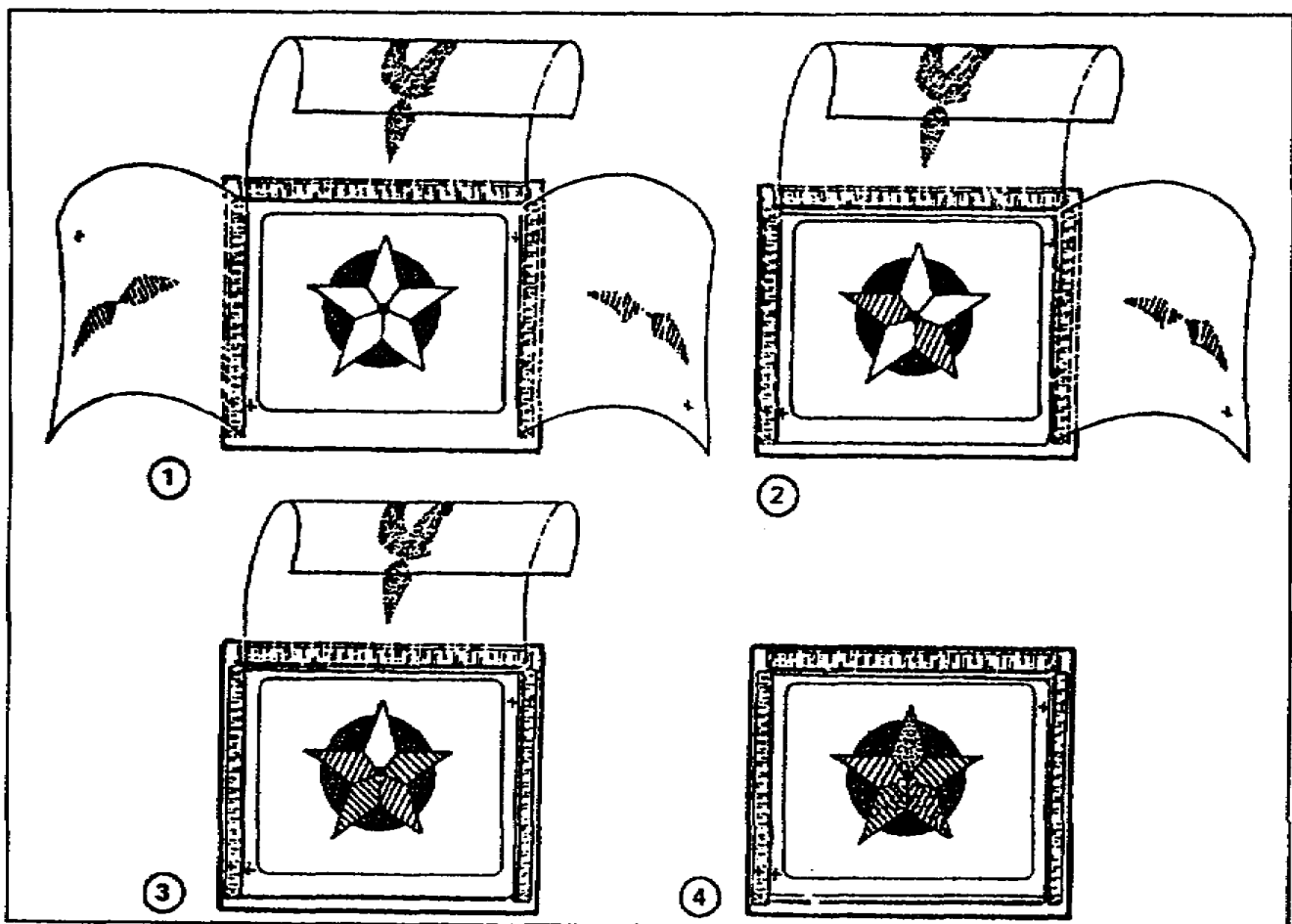


Figure 2-28. Graphic overlays

b. Map Overlays. Map overlays show the routes of travel, unit movements, and decision graphics for both enemy and friendly forces using standard military symbols (FM 101-5-1). You can prepare a map overlay as a one-color or multicolor presentation.

(1) One-color presentation. When preparing the overlay as a one-color presentation, use solid single lines to construct the symbols for the friendly forces and solid double lines to construct the symbols for enemy forces. Additionally, all symbols representing enemy equipment, ground positions, and activities have the abbreviation "EN" shown in them.

(2) Multicolor presentation. When preparing the overlay as a multicolor presentation and showing the symbols representing friendly units, posts, installations, equipment, and ground activities, use blue or black for symbols identifying friendly forces and red for enemy forces.

Use yellow to show both friendly and enemy chemical or radiological areas and enemy biological areas and use green to indicate friendly and enemy man-made obstacles. To help show who made or created any of the areas, place the abbreviation EN in the enemy forces symbols. If you use any other color in your presentation, ensure that a legend explains the color's use.

(3) Preparing a map overlay. To prepare the overlay, tape the required map or map section to the drawing surface and attach a sheet of tracing paper over the area for which you must prepare the overlay. Then trace and label two grid registration marks on the tracing paper, one in the upper left-hand corner and the other in the lower right-hand corner (figure 2-29). All map overlays must have two grid registration marks, each showing horizontal and vertical grid identifiers.

When you have the tracing paper correctly orientated and marked, place the security classification at the top and bottom center of the overlay, and plot the data from the VI work order or information sheet provided, using standard military symbols. Using a coordinate scale and protractor to plot the symbols ensures the symbols are located accurately on the overlay.

This concludes lesson 2 of the subcourse. Before proceeding to the examination, complete the practice exercise that follows this lesson. When you have completed the practice exercises and have a thorough understanding of the lesson, then complete the examination for the subcourse.

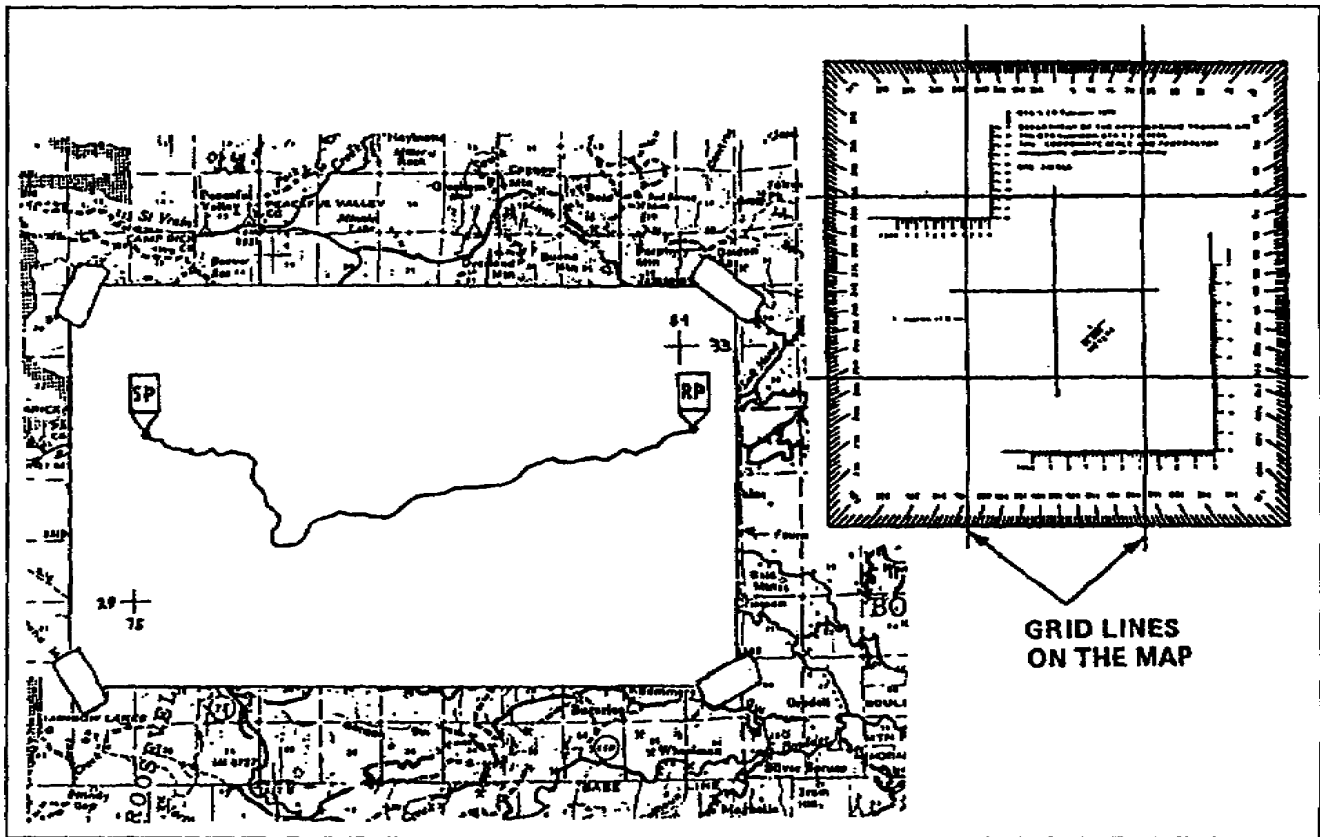


Figure 2-29. Grid register marks on a map overlay and coordinate scale and protractor



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## LESSON 2

### PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. You are constructing a viewgraph frame. Which of the following indicates the size of the aperture opening you should cut?
  - A. 8 1/2 by 6 1/2 inches
  - B. 9 1/2 by 7 1/2 inches
  - C. 10 1/2 by 8 1/2 inches
  - D. 11 1/2 by 9 1/2 inches
2. You must produce a large number of copies of graphics using the diazo process. Which of the following types of diazo films should you use to make a duplicate copy of the original?
  - A. KSP
  - B. KR D
  - C. PBL
  - D. PYL
3. You are preparing the layout for an article. Which of the following types of copy should you use to complete the comprehensive layout?
  - A. Slick
  - B. Street
  - C. Morgue
  - D. Galley
4. You are lettering a graphic for television. Which of the following describes the spacing you should use between the letters?
  - A. At least one-half the thickness of the largest of the two letters it separates.
  - B. No more than one-half thickness of the largest of the two letters it separates.
  - C. At least one-quarter the thickness of the largest of the two letters it separates.
  - D. No more than one-quarter thickness of the largest of the two letters it separates.

5. You have a work order to create a television graphic using the phantom method. For this graphic to produce the desired effect on television, which of the following principles should you use when preparing the graphic?
- A. Diazo
  - B. Color tones
  - C. Technamation
  - D. Color separation
6. You are preparing a multicolored map overlay that shows a man-made obstacle the enemy constructed. Which of the following colors should you use on the overlay for this symbol?
- A. Red
  - B. Blue
  - C. Green
  - D. Black

## LESSON 2

### PRACTICE EXERCISE

#### ANSWER KEY AND FEEDBACK

<u>Item</u>	<u>Correct Answer and Feedback</u>
-------------	------------------------------------

- |    |                          |
|----|--------------------------|
| 1. | B. 9 1/2 by 7 1/2 inches |
|----|--------------------------|

If you make the aperture opening too small, you cut off part of the graphic when mounting the film to the frame. Cutting the aperture too large allows any registration marks or errors normally outside to be projected onto the screen. An oversized or small aperture both cause an undesirable effect (page 6, para 1b(3)).

- |    |        |
|----|--------|
| 2. | A. KSP |
|----|--------|

When you must make a large number of copies from an original using the diazo process, you would make a sepia line intermediate. The standard weight sepia film has the designation KSP (page 10, para 1d(1)).

- |    |           |
|----|-----------|
| 3. | D. Galley |
|----|-----------|

Since you still have the opportunity to make changes in the comprehensive layout, you do not want to destroy your best copy, the slick copy. Therefore, you would use the gallery copy to prepare the comprehensive layout. The comprehensive layout is the last layout you prepare before the final layout, using the slick copy (page 23, para 5c(1)).

- |    |  |
|----|--|
| 4. | A. At least one-half the thickness of the largest of the two letters it separates. |
|----|--|

The television camera closes the distance between lettering. To overcome the effect the camera has on lettering, you would have to use slightly more space between letters than normal. This space should be at least half of the thickness of the largest of the two letters it separates (page 30, para 6d(2)).

Item      Correct Answer and Feedback

5.          B.      Color tones

Because a television camera distinguishes gray tones only, using a color with the same tone as the background color tone hides the graphic from the camera. Using the same color tone allows the person in the studio with the graphic to see the graphic on the background, but the camera does not show the graphic to the viewer. All the viewer sees on the screen is the blank background (page 34, para 6h(4)).

6.          C.      Green

You use the colors black or blue for the symbols that indicate friendly forces, installations, and posts; whereas the same symbols drawn in red indicates enemy forces, installations, and posts. You would use green lines for the symbol of any man-made obstacles. To further identify the obstacle as created by the enemy, you add the abbreviation EN (page 50, para 10b(2)).

## APPENDIX - LIST OF ACRONYMS

ACCP	Army Correspondence Course Program
CPU	central processing unit
DA	Department of the Army
FM	field manual
Pam	Pamphlet
RAM	random access memory
ROM	read only memory
STP	Soldier's Training Publication
VI	visual information