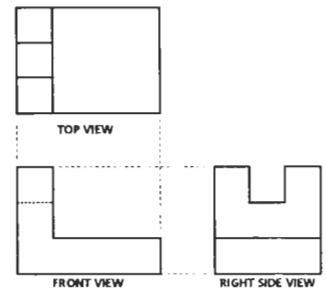
Drafting: An Introduction



Introduction

Drafting is a graphic language that is part of what is called **graphic communications**. It is a very exact language that allows engineers and designers to tell others what they are to construct or manufacture. A **draftsperson** is the communicator for the engineering or design team. He or she receives the sketches and specifications from the designer, architect, or engineer, and using the knowledge and skills of drafting, transforms these ideas into plans that can be used to create products or complete construction projects.

There are two major fields or areas of drafting; architectural and mechanical. **Architectural drafting** is a field of technical knowledge that provides the techniques for describing buildings. **Mechanical drafting** describes mechanical or manufactured products.

To become a draftsperson, you must have a knowledge of basic drafting techniques. Being a draftsperson often requires that you can solve visual puzzles as well. You will need to learn how to use different line symbols and methods to represent an object so that there is no doubt about what is wanted. Information on a drawing is provided in a specific form, and you will need to learn how to letter in this way. Drafting is work that requires care and patience, and you must be able to pay attention to detail.

There is a variety of different types of drawings that engineers use. Each has a specific purpose. The two basic types of mechanical drawings are **multiview** and **pictorial**.

Multiview drawings are used when accurate details and dimensions need to be communicated. This type of drawing is usually prepared as a plan to follow when objects are to be manufactured. These drawings are called **working drawings**.

Multiview drawings are prepared in a certain arrangement with separate views which describe the front, top, and sides of an object. (See Figure 1.) Usually only three views are required to show or explain the detail of a part fully. Sometimes, however, a great deal of detail is needed and drawings will be prepared to show bottom and rear views as well.

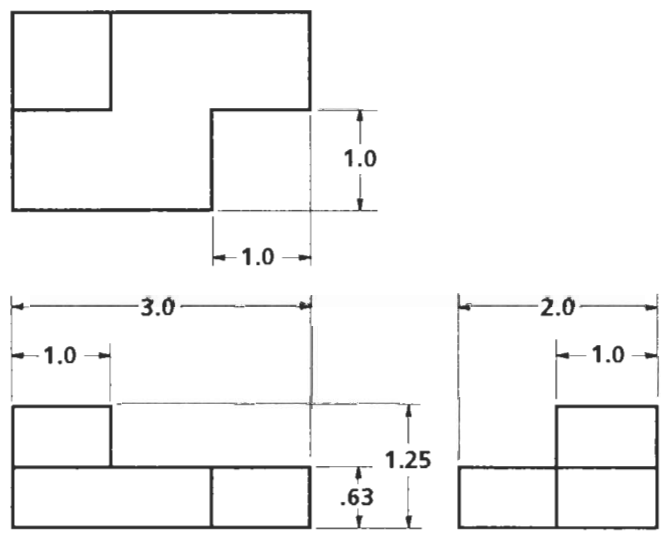


Figure 1 - Sample Multiview Drawing

Pictorial drawings generally show the front, top, and sides of an object in one view. The term "pictorial" tells you that the drawing resembles a picture of the object. Pictorial drawings are used to show what an object will look like, and how it is assembled. Pictorial drawings are often included in assembly instructions and repair and maintenance manuals. There are three basic types of pictorials. They are (1) isometric, (2) perspective, and (3) oblique.

Isometric drawings are prepared on lines drawn at 30 degree angles to the horizontal plane. The front, top, and side are drawn to their true length, which produces an approximate view of the object. (See Figure 2.)

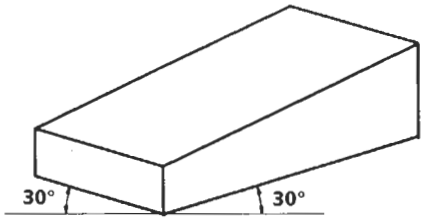


Figure 2 - Sample Isometric Drawing

Perspective drawings describe an object as it appears to the eye. The most distant points appear smaller than those closest to the observer even if they are actually the same size. The most common types of perspective drawings are the one-point and two-point perspective. (See Figure 3.)

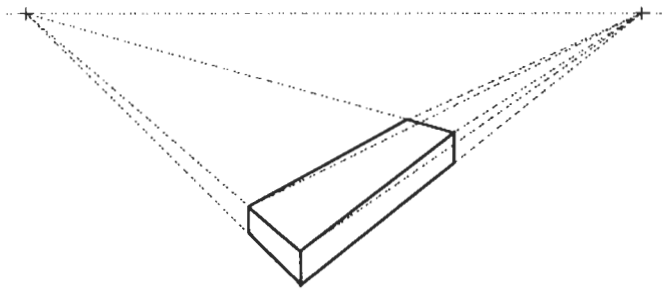


Figure 3 - Sample Two-point Perspective

Oblique drawings are prepared in a similar manner to isometric; the difference, however, is that the oblique drawing is prepared with one side of the object on the horizontal plane. The view that represents the side of the object is drawn at any angle between 0 and 90 degrees. (See Figure 4.)

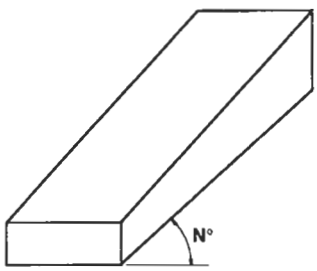


Figure 4 - Sample Oblique Drawing

Job Description

Drafting technology requires a knowledge of basic drafting skills. In this activity package, you are going to practice the skills of a draftsperson. You will need to know the uses of drafting tools, materials, and media. You will need to learn the drafting alphabet of lines, and learn to letter the Gothic single stroke alphabet. You will then learn the methods of describing shape and size using orthographic projection and dimensioning. Lastly, you will be developing some skills in pictorial drawing, using isometric, oblique, and perspective drawing techniques.

Materials and Supplies

To complete this activity, you will need the following materials:

drawing paper, 9" x 12"
tracing vellum, 9" x 12"
HB, 2H, & 4H drawing pencils
eraser
T-square
45 degree triangle
30-60 degree triangle
architect scale
ruler
compass
drafting dots or drafting tape

How to Use Drafting Tools

1. Before you begin, you need to make sure that your drafting board and all your tools are clean.
2. Place your drawing paper on the drafting board approximately in the middle.
3. Press the head of the T-square firmly against the left edge of the drawing board. Note: If you are left-handed, reverse the T-square and press the head against the right edge.
4. Slide the paper in line with the T-square until the blade is lined up with the bottom edge of the paper. When you have the paper **perpendicular** to the edge of the drawing board, tape the top corners. Slide the T-square up and tape the bottom corners.
5. Using the 4H pencil and the T-square, draw several **horizontal** lines.
6. Place the 45° triangle against the edge of the T-square and draw several **vertical** lines.
7. Draw a few lines using the angled side of the triangle. Check to see that these lines are straight and **parallel**.
8. Draw a number of circles using your compass. Set your compass to the desired radius, which is one half the **diameter** of the circle.
9. After you have completed this activity, remove the tape and save your drawing for later use.

Drawing the Alphabet of Lines

1. Place Exercise Sheet #1 on your drawing board.
2. Slide the paper in line with the T-square until

the blade is in line with the bottom edge of the paper. When you have the paper **perpendicular** to the edge of the drawing board, tape the top corners. Slide the T-square up and tape the bottom corners.

3. Use your set of drafting pencils to construct six examples of the alphabet of lines.

The Single Stroke Gothic Alphabet

1. Place Exercise Sheet #2 on your drawing board.
2. Slide the paper in line with the T-square until the blade is in line with the bottom edge of the paper. When you have the paper **perpendicular** to the edge of the drawing board, tape the top corners. Slide the T-square up and tape the bottom corners.
3. Use your HB pencil to produce three copies of each Gothic letter.

Measuring Accurately

The ruler or scale is the instrument the drafter uses for measurement. Since not all objects are in full inches, you will need to be able to use the **subdivisions** of the ruler. Look at the enlargement of the inch shown in Figure 5. Note that the inch is divided into 16 equal parts. Each part is 1/16 of an inch.

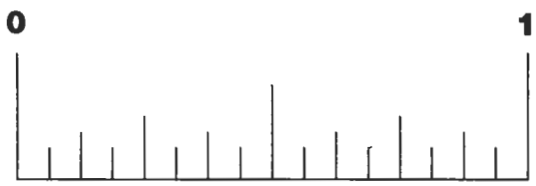


Figure 5 - Subdivisions of an Inch

1. Place Exercise Sheet #3 on your drawing board.
2. Use your ruler or architect scale to measure each line segment; place your answers in the blanks. If you are using the scale, be sure to use the 16 scale to measure.

Describing the Shape of an Object

Three dimensional objects can be represented in a two dimensional drawing by using more than one view. In the drawing of the object in Figure 6, the "dimensions" are described as **length, width,** and **height**. A multiview drawing shows an object in multiple views. Each view contains two of the three dimensions. In Figure 7 the same object is shown as an **orthographic** drawing. Notice that the **front** view shows the length and height of the object; the

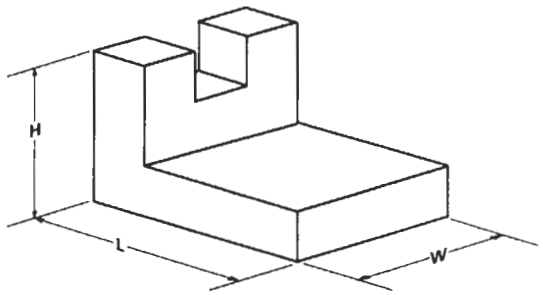


Figure 6 - Sample Pictorial Drawing

top view shows the length and width; and the **side** view shows the width and height.

1. Place Exercise Sheet #4 on your drawing board.
2. Slide the paper in line with the T-square until the blade is in line with the bottom edge of the paper. When you have the paper perpendicular to the edge of the drawing board, tape the top corners. Slide the T-square up and tape the bottom corners.
3. Use your 4H pencil to complete each of the orthographic views. When the views are complete and you are sure each one is correct, use your HB pencil to darken in the **object lines** only. You may leave light **construction lines**.

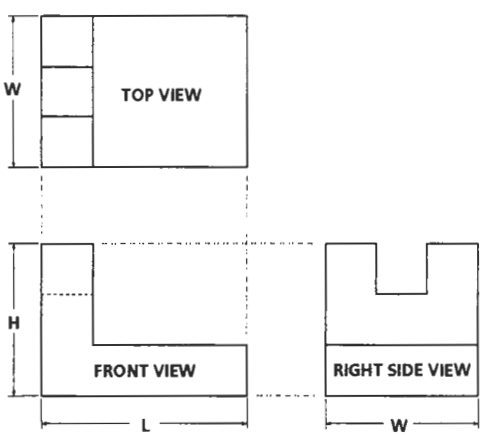


Figure 7 - Sample Orthographic Drawing

Using Dimensions

Just as there are standards for line weights, lettering, and other areas of drafting, there are standards for **dimensioning** a drawing. Dimensioning standards are rules that drafters use so that anyone who knows the rules will be able to understand and read a drawing. A group of professional engineers called the American Society of Mechanical Engineers (ASME) are the ones who have set these standards which are published by the American National Standards Institute (ANSI). You will see the ANSI notation on many drawings, this indicates the standards used in that set of drawings.

A drawing must have complete and accurate dimensions. A good rule for the drafter to follow when dimensioning is to think of "how many dimensions are needed to make the part." The *Rules for Dimensioning* handout contains simple guidelines you should follow as you complete the following exercise.

Place Exercise Sheet #5 on your drawing board. Use the "rules for dimensioning" to place the dimensions on the object. Use the 16 scale, and make all dimensions full size.

Using Pictorial Drawings

Pictorial drawings show an object as it would look to a person viewing it. They show the three dimensions (length, width, and height) of the object in a single view. In this exercise you will draw an object in each of the pictorial methods.

1. Place Exercise Sheet #6 on your drawing board.
2. Use a 4H pencil to draw construction lines.
3. Follow the instructions and complete a view of the object in **isometric.**
4. When you have completed the drawing, use your HB pencil to darken object lines.
5. Place Exercise Sheet #7 on your drawing board.
6. Use a 4H pencil to draw construction lines.
7. Follow the instructions and complete a view of the object in **oblique**.
8. Use your HB pencil to darken object lines when you have completed the drawing.
9. Place Exercise Sheet #8 on your drawing board.
10. Use a 4H pencil to draw construction lines.
11. Follow the instructions and complete a view of the object in **perspective**.
12. Use your HB pencil to darken object lines when you have completed the drawing.

Drawing a Border & Title Block

1. Make sure all your tools and materials are clean before you begin.
2. Using the T-square, align your drafting paper and tape down.
3. Duplicate the sample border and title block layout. Refer to the dimensions written on the layout. Use a very light dash to mark the correct measurement for the lines. Draw your border first using construction lines.
4. Check the lines for accurate measurements. Use your HB pencil to darken your lines.
5. Letter your title block as directed by your teacher.
6. After you have completed the exercise, put your border and title block in a safe place so that you may refer to it at a later time.

Basic Drafting Exercises

Being able to use your drafting tools and applying the knowledge you have gained is an important skill. In the following exercises, you will use the standard border and title block layout for each of the drawing problems included in the Exercise Sheets. You will prepare a drawing as specified:

Problem 1 - Draw the border and title block.
Problem 2 - Draw the multiview drawing.
Problem 3 - Draw the multiview drawing.
Problem 4 - Draw the multiview and pictorial.

Vocabulary

engineer	architect
mechanical drafting	specifications
architectural drafting	orthographic projection
pictorial	multiview
diameter	parallel
vertical	horizontal
isometric	oblique
perspective	alphabet of lines
gothic single stroke alphabet	architect scale
drawing to scale	construction line
center line	hidden line
object line	dimension
dimension line	extension line
perpendicular	

On Your Own

1. Look for drawings around your house. Look for assembly drawings for appliances, toys, or models. Check out the instruction books for your TV, stereo, and VCR. Look in the glove compartment of your car for the owner's manual. Are there drawings? What kind are they? Bring these drawings to class and share what you have found.

2. Look in the Sunday newspaper and find the Home & Design Section. Look for drawings of houses. What kind of drawing can you find? Bring them to class to share what you have found.

Office of Vocational, Adult, Career, and Community Education
Technology Education
Dade County Public Schools
Miami, Florida

TEACHER GUIDE
DRAFTING: AN INTRODUCTION

Objectives: Upon completion of this assignment, students will be able to:

- Describe the use of drafting to communicate technical information.
- Use basic drafting tools properly.
- Measure to the nearest 1/16".
- Draw an object to scale.
- Describe the alphabet of lines and its uses.
- Demonstrate proper lettering techniques using the single stroke Gothic alphabet.
- Draw an object using the orthographic projection technique.
- Draw an object in isometric, oblique, and perspective.
- Describe the function of dimensions and use them correctly to dimension an object.

Helpful Hints:

1. Collect a series of different types of drawings you can find around the home. Use these in your opening presentation of how drawings are used.

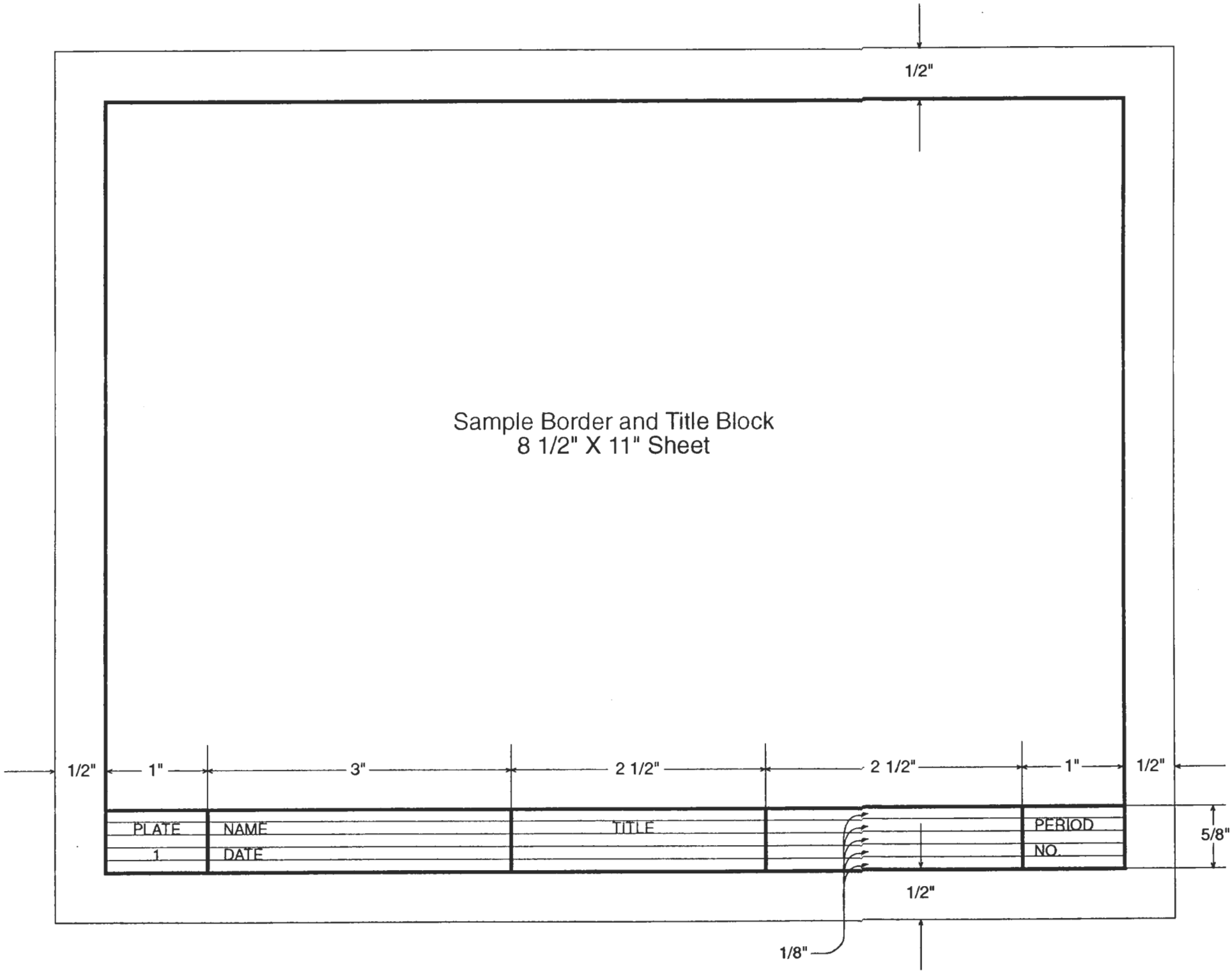
2. Get a set of blueprints for a rather complicated mechanical object and for a house. Show and compare the two different types of drawings.

3. There are many good drafting workbooks available that contain exercise sheets that can be used for additional practice and reinforcement of the concepts presented in this unit. Remember to adhere to copyright laws.

4. Use an overhead projector with "miniature" drafting tools (T-square & triangles) to demonstrate the procedures contained in this activity.

5. Make styrofoam models of the objects in the exercises so students can "visualize" the objects to be drawn.

6. A fun way to practice lettering is to get copies of popular song lyrics. Have students letter them out.


1/2"
Sample Border and Title Block
8 1/2" X 11" Sheet
1/2"
1"
3"
2 1/2"
2 1/2"
1"
1/2"
PLATE
1
NAME
DATE
TITLE
PERIOD
NO.
5/8"
1/2"
1/8"

RULES FOR DIMENSIONING

Dimension Lines

Dimension lines are thin, black, solid lines that show where a dimension begins and ends. Draw them parallel to the surface or edge being described. Break the dimension line to allow room for the dimension on engineering drawings. On architectural drawings, draw a continuous dimension line and place the dimension above it. (See Figure 1.)

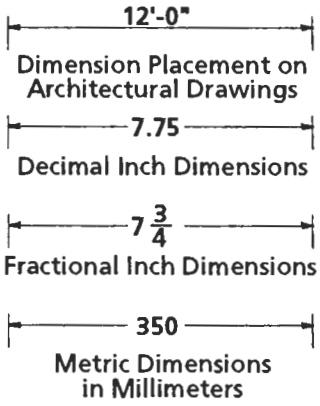


Figure 1

Draw the dimension line nearest to the view 3/8 inch (10 mm) away from the object line. Space all other dimension lines 1/4 inch (6 mm) away from the first dimension line and each other. (See Figure 2.) Do not

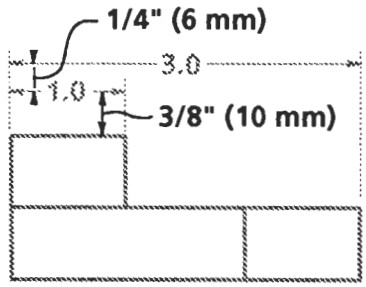


Figure 2

use object line, center lines, or extension lines as dimension lines. Whenever possible, line up dimension lines to give your drawing an orderly appearance and make it easier to read. (See Figure 3.)

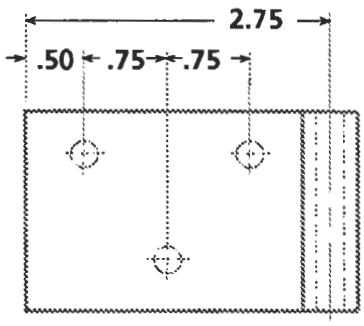


Figure 3

Arrowheads

Arrowheads show the beginning and the end of a dimension line. Draw arrowheads freehand using two or three strokes and make them one-third as high as they are long. They may be open or closed. (See Figure 4.) Draw all the arrowheads on a drawing the same size. Make the length of the arrowheads on a drawing the same size. Make the length of the arrowhead on a small drawing approximately 1/8 inch (3 mm) and up to 3/16 inch (5 mm) on a large drawing.

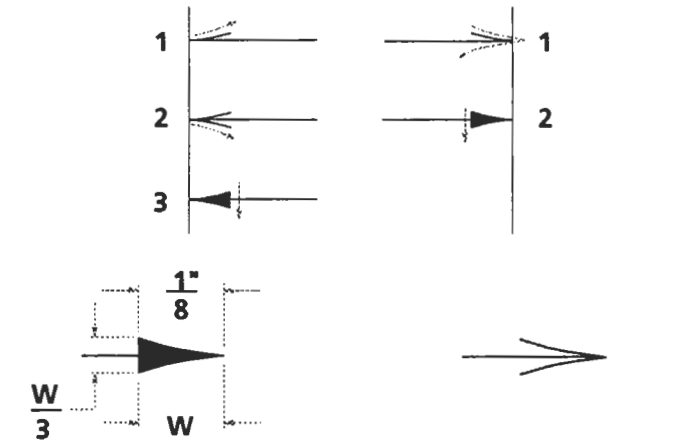


Figure 4

Extension Lines

Extension lines are used to extend the lines on a view to show where dimension lines start and end. Place them outside the view beginning about 1/16 inch (1.5 mm) away from the view. Extend them about 1/8 inch (3 mm) past the last dimension. (See Figure 5.) Make extension lines like dimension lines: thin, solid, and black.

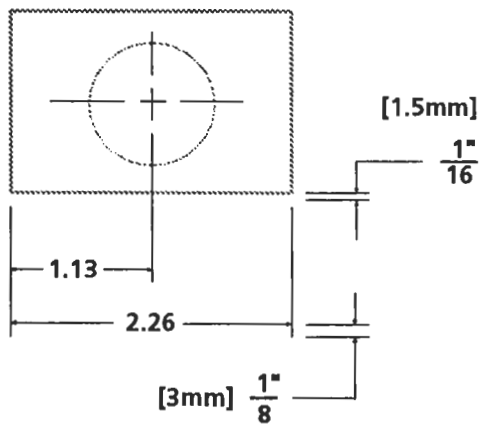


Figure 5

LANGUAGE ARTS APPLICATION
DRAFTING: AN INTRODUCTION

_____
Student Name

In all types of jobs you will find that you need the ability to communicate your ideas effectively. Writing skills are necessary in all occupations. Here are a few examples of how writing skills are related to this activity.

The ability to conduct research is an important skill that any business person, professional, or student must possess. This assignment will require you to visit the library and do some research on a career in drafting.

Use the resources available in your school media center to do your research. Ask the media specialist for help. You might find information in the card catalog, career file, occupational catalogs, college catalogs, or other sources to answer the following questions:

1. What local colleges, community colleges, and universities offer courses or programs in Drafting?

_____

_____

_____

_____

2. What education is required for a career in Drafting?

_____

_____

_____

_____

3. What kinds of businesses hire draftspersons?

_____

_____

_____

_____

LANGUAGE ARTS APPLICATION
DRAFTING: AN INTRODUCTION (Cont'd.)

4. What kinds of skills do drafters need to possess?

5. What is the pay scale for drafters? How much can one expect to earn in this occupation?

6. For a career in drafting, what types of high school courses are recommended?

MATH APPLICATION
DRAFTING: AN INTRODUCTION

_____
Student Name

In all types of occupations you will need the ability to apply mathematics effectively. Here are a few examples of how math skills are used in relation to this activity.

Drafting is a precise language that involves working with measurements. Draftspersons work with specifications given to them by designers, architects, or engineers, and they must transform these specifications into plans that can be used to create products. The ability to work with measurements is one skill used often by the draftsperson. In the drafting activity package you will be using the ruler to measure and lay out line lengths. It is important that you are able to add and subtract measurements accurately to do this.

In this exercise you will be asked to add and subtract measurements that have like and unlike denominators. When the fractions have different denominators, you must change the fractions to equivalent fractions with common denominators. Whole numbers can simply be added or subtracted.

Example: $1\frac{1"}{8} + 3\frac{1"}{2} = ?"$

Find the least common denominator (LCD) of the fractions.

In this example, the LCD is 8.

Change to equivalent fractions.

Solution: $1\frac{1"}{8} + 3\frac{4"}{8} = ?"$

$1\frac{1"}{8} + 3\frac{4"}{8} = 4\frac{5"}{8}$

Try these:

Addition:

1. $4\frac{3"}{8} + 3\frac{5"}{16} =$ _____
2. $3\frac{5"}{16} + 9\frac{1"}{8} =$ _____
3. $7\frac{1}{2}" + 2\frac{3}{16}" =$ _____

Subtraction:

4. $7\frac{11"}{16} - 3\frac{1"}{4} =$ _____
5. $9\frac{7"}{8} - 4\frac{5"}{16} =$ _____
6. $11\frac{3}{4}" - 2\frac{3}{8}" =$ _____

MATH APPLICATION
DRAFTING: AN INTRODUCTION (Cont'd.)

Try the following word problems: (Show your work in the area provided.)

7. _____ Mr. Pierce wrote the following measurements on the chalk board: $4\frac{5"}{8}$, $6\frac{1"}{4}$, and $8\frac{3"}{16}$. What is the sum of the three measurements?

8. _____ A student in the manufacturing laboratory needs to cut four boards from a piece of pine. The lengths needed are $11\frac{3"}{16}$, $3\frac{5"}{8}$, $4\frac{7"}{16}$, and $9\frac{1"}{8}$. Each time the student cuts a length of wood, $\frac{1"}{8}$ will need to be added to the overall length to allow for the width of the saw kerf. What length piece of wood will the student need to use?

9. _____ It takes 5 pieces of metal measuring 2" wide by $3\frac{3"}{8}$ long to make a pencil box. How many inches of 2" wide material would you need to make 5 pencil boxes?

10._____ A student wants to make plastic key chains $1\frac{1"}{4}$ wide by $4\frac{3"}{8}$ long. How many plastic key chains could the student make from a piece of plastic measuring $1\frac{1"}{4}$ inches wide by 48" long?

QUIZ
DRAFTING: AN INTRODUCTION

_____
Student Name

True or False:

_____ 1. Drafting pencils come in various grades of hardness. The HB pencil lead is harder than the 4H pencil lead.

_____ 2. All of the following are pictorial drawings: isometric, oblique, orthographic, and perspective.

_____ 3. Three dimensions that will describe the overall size of an object are length, width and height.

_____ 4. Dimensions are placed on a drawing so that they are hard to find and read.

_____ 5. The type of drafting used by architects to draw and describe buildings is called mechanical drawing.

_____ 6. T-squares are used to draw horizontal lines, while triangles are used to draw vertical lines.

_____ 7. The single stroke Gothic alphabet is often used in drafting because it is easy to read.

_____ 8. A line that is used to indicate a part or surface that is not visible in a view is called a hidden line.

_____ 9. The dimensions that describe the front view of an object in an orthographic drawing are width and height.

_____ 10. In an orthographic drawing the front and right sides will have the same height.

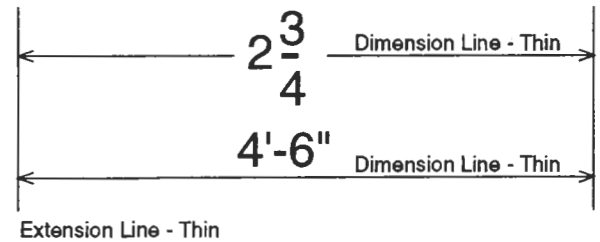
ANSWER KEY
QUIZ
DRAFTING: AN INTRODUCTION

1. false
2. false
3. true
4. false
5. false
6. true
7. true
8. true
9. false
10. true

Visible Line - Thick

Hidden Line - Thin

Center Line - Thin



The Alphabet of Lines

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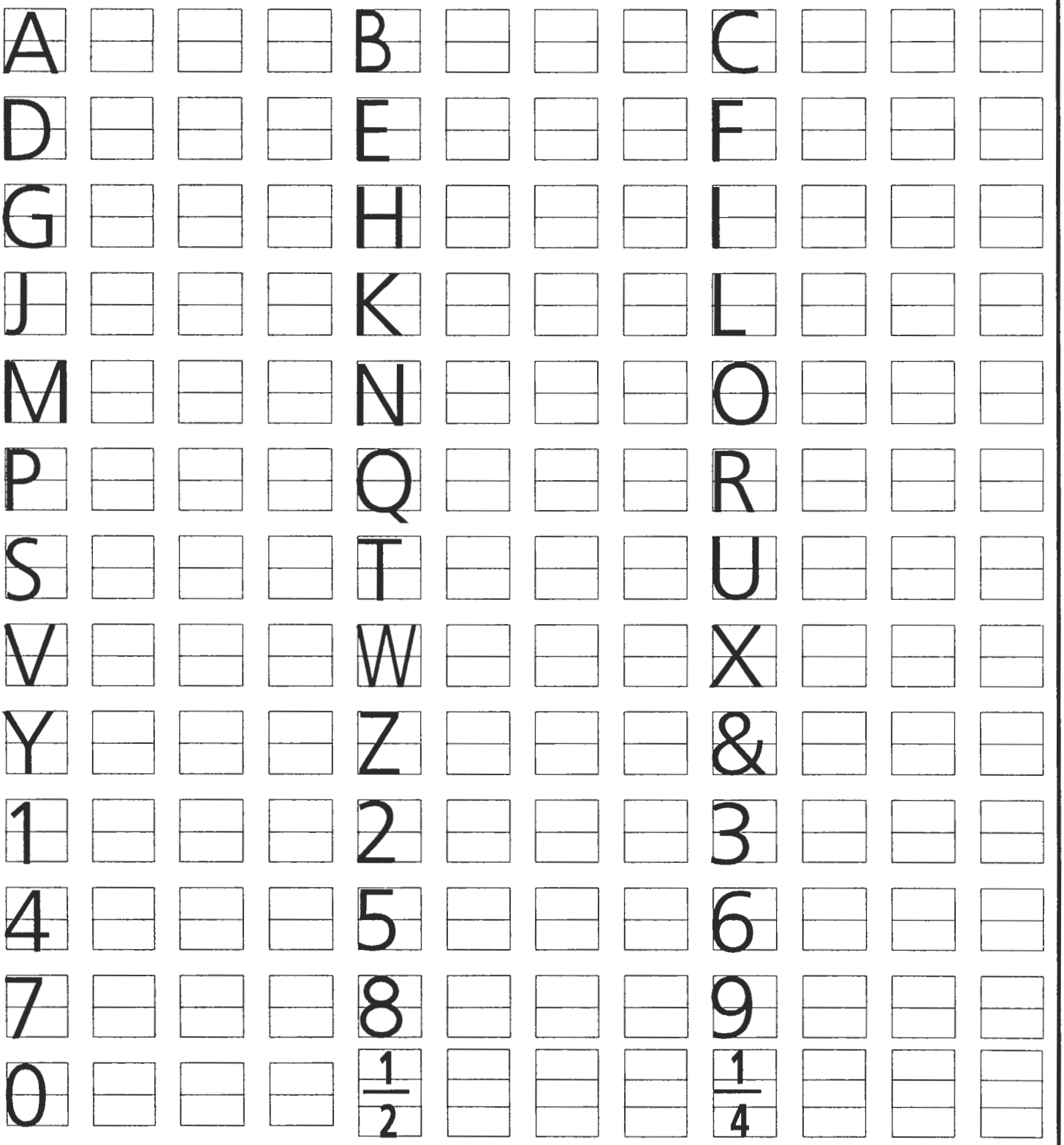
LETTERING

Using an F or HB pencil with a slightly rounded point, construct each letter in the spaces provided. Observe the form and proportion of each letter to assist you in improving your lettering in future assignments.



NAME:	DATE:	PERIOD:	2

	Answer		Answer
1.		13.	
2.		14.	
3.		15.	
4.		16.	
5.		17.	
6.		18.	
7.		19.	
8.		20.	
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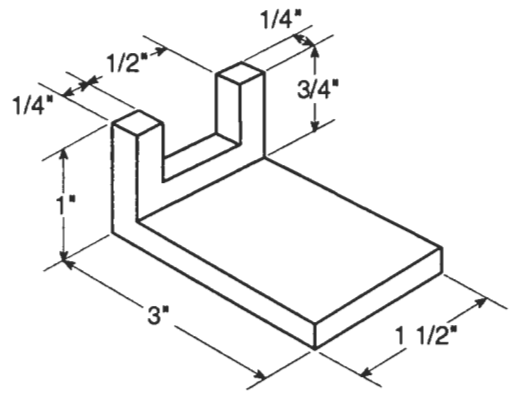
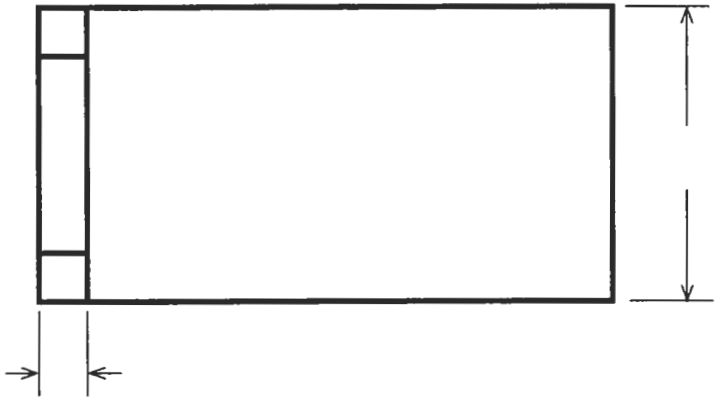


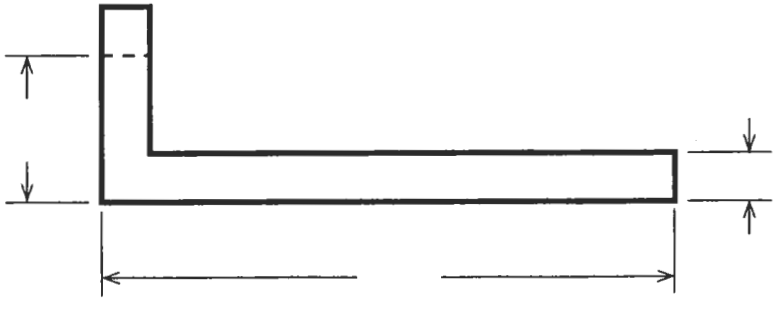
TOP VIEW

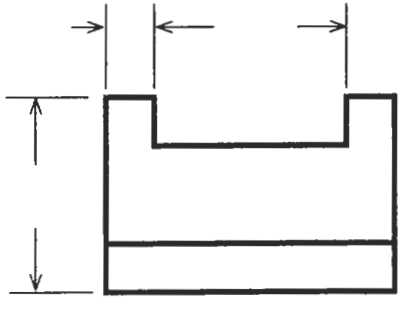
FRONT VIEW

RIGHT SIDE VIEW

NAME:	DATE:	PERIOD:	4







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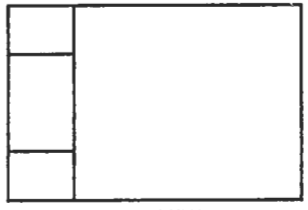
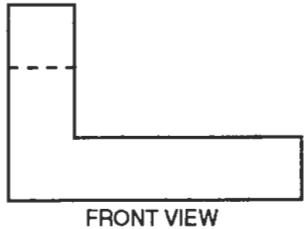
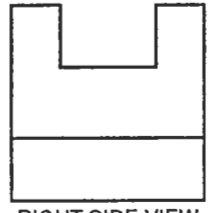


TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW

ISOMETRIC PICTORIAL

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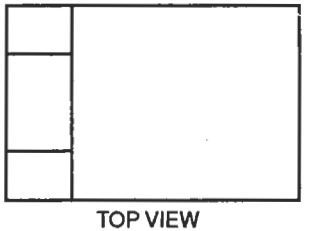
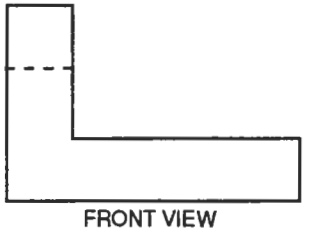


TOP VIEW



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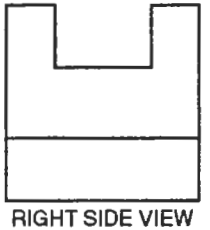
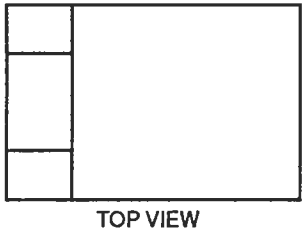


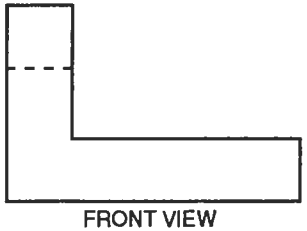
RIGHT SIDE VIEW

OBLIQUE

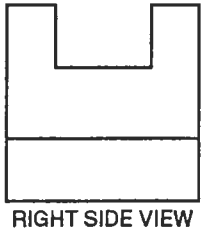
NAME:	DATE:	PERIOD:	7



TOP VIEW



FRONT VIEW



RIGHT SIDE VIEW

PERSPECTIVE

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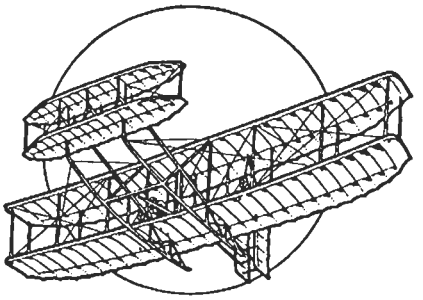
Drafting & Design: Midget Glider



Introduction

Throughout history, drawings have been used to communicate ideas. The ability to communicate technical information is a primary reason that humans have been able to expand their use of technology at such a rapid pace. Technical information is often communicated through drafting, which is considered the language of industry.

Drafting is a technical language that allows engineers and designers to tell others what it is they are to build or manufacture. Because international **standards** in drafting have been established, a technical drawing can be read by anyone who has been trained to do so. This is important because in the world of industry, products are made using parts from a variety of different sources. Very often, the designers and engineers work thousands of miles away from the tradespeople who actually manufacture these products.

Drafting utilizes a variety of lines and symbols that represent the products being produced. Often called **mechanical drawing**, it is generally used when special consideration must be given to size, shape, and detail. There are a variety of drawings that engineers use; each has a specific purpose. The three basic types of mechanical drawings are: (1) orthographic projection; (2) pictorial; and (3) schematic.

Job Description

To prepare a mechanical drawing, a basic understanding of drafting tools and techniques is required. In this activity package, you are going to use drafting tools and techniques to prepare a set of plans for a "Midget Glider". You will complete an orthographic working drawing and an isometric assembly drawing. From your drawings, you will construct a cardboard **mock-up** and a balsa wood **prototype** which you will be able to fly.

Materials and Supplies

To complete this activity, you will need the following materials:

HB, 2H, & 4H drawing pencils
drawing paper, 9" x 12"
eraser

T-square	cutting surface
30°-60° triangle	balsa wood, 1/8" x 1/4" x 5"
masking tape	balsa wood 1/16" x 1" x 11"
tracing paper	plastic modeling clay
carbon paper	paper clips
tag board	fine sandpaper
X-Acto knife	glue, white or CA

Creating Your Working Drawings

1. Study the designer's sketch for the midget glider carefully. Note that this drawing is **not** drawn to scale, so it cannot be used to build the actual aircraft. You will first need to draw the plane to scale, making any desired design changes in the shape of your glider. However, you cannot build it any larger than the overall sizes given for each part.

2. Begin your drawing by carefully measuring a rectangle that is 5" long and 1/4" high. This is the size of the material you will use to build the **fuselage**, or body of the glider. Use a 4H pencil and draw light **construction lines**. Do not darken your drawings until they are completed, and you have had your teacher check

them for accuracy.

3. Inside the rectangle, draw the fuselage full size as shown in the designer's sketch. Notice that the nose of the glider is rounded, and that the fuselage tapers to a narrow 1/8" at the tail. Measure 1 3/4" back from the nose, and indicate the placement of the leading (front) edge of the wing. The width of the wing is 1". Measure 1" from the leading edge to the trailing edge of the wing, and mark the placement of the wing on the fuselage. Now measure 1 1/4" from the tail of the fuselage forward. This is the placement for the **vertical stabilizer**. Measure up 1/2" for the height of the **rudder**; then forward 5/8" for the top of the rudder. Complete the drawing by connecting the forward point of the rudder on the fuselage with the top. This is the **detail drawing** of your fuselage.

4. Draw a rectangle 1" x 6" on your drawing paper. This is the size of the material you will use to construct your **wing**. Find the center of the 6" side. Draw a **hidden line** at this point to represent the center of the wing where the fuselage will connect to the wing. Measure along the top of the rectangle 1 1/2" and make a mark; repeat this for the other side of the wing.

5. From the top of the rectangle, measure down 1/4" on both sides. Connect these points to draw the taper for the trailing edge of the wing. This is the detail drawing for your wing.

6. Now draw a rectangle that measures 5/8" x 2 1/2". This is the material you will use to build your **horizontal stabilizer**. Measure 5/16" to locate the center of this wing. Measure down 3/8" on both sides and connect these points to the center of the leading edge of the wing, to form the taper on the leading edge of the wing. This is the detail drawing for your horizontal stabilizer.

7. Use an HB pencil to darken your **object lines**. These are the lines that describe the three parts of the glider: the fuselage, wing, and stabilizer.

8. Place **extension lines** on your detail drawings using a 2H pencil. Extension lines are used to indicate where dimensions will be given from. They do not touch the object lines. An example of a completed extension line with dimension line and dimension is shown below.

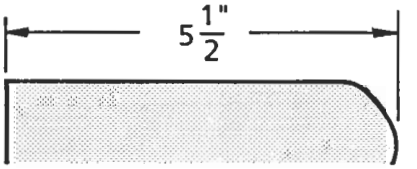


Figure 1 - Dimension line detail

9. Draw in the **dimension line**. Notice it is broken to leave a place for the measurement.

10. Measure the part, and place the proper size dimension inside the dimension line. Then draw in **arrowheads** at the ends of the dimension lines.

11. Repeat the process until you have fully dimensioned each part. Ask yourself "Do I know what size is needed for each part of each piece?" Place dimensions that will describe the size of each part on your drawing.

12. Add notes to your drawings. Indicate the thickness of the material each part is made out of. For example, the fuselage is constructed out of 1/8" balsa wood; the wing, stabilizer, and the rudder from 1/16" balsa.

Creating Your Assembly Drawing

1. Begin with a new sheet of drawing paper. You will first need to construct an **isometric** rectangle, using a 4H pencil for the construction lines. The front of the rectangle is 1/4" high; the length is 5". The bottom of the box is drawn 30 degrees to the right. (See Figure 2.)

Figure 2 - Isometric box forms the fuselage

2. The shape of the fuselage is then drawn in inside this rectangle. Make sure you show the round nose and the taper down to the tail.

3. Now measure 1 3/4" from the nose along the side of the rectangle. This is the point where the leading edge of the wing attaches to the fuselage. Measure the width of the wing 1"

back from this point.

4. Draw lines perpendicular from these points, away from the fuselage. Measure 3" along these lines; then complete the two rectangles for the wings.

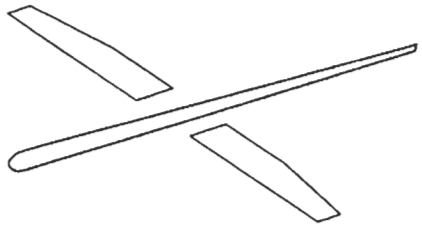


Figure 3 - Fuselage and wings

5. Measure the taper for the wings; then complete the wings by drawing in the taper at the trailing edge. (See Figure 3.)

6. Draw a box for the rudder or vertical stabilizer. It is 1 3/4" forward from the end of the fuselage (tail). The height of the box should be 1/2". Measure 5/8" across the top of the stabilizer. Then connect to complete the vertical stabilizer. (See Figure 4.)

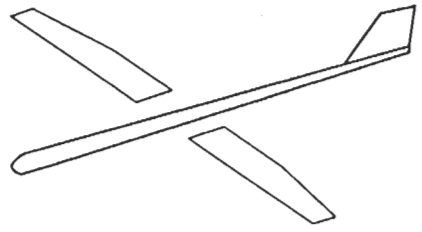


Figure 4 - Fuselage with stabilizer

7. The last part is the horizontal stabilizer; it sits atop the vertical stabilizer or rudder. From the top of the rudder, draw a box that is 5/8" x 2 1/2". Note that the center of the stabilizer is attached at the top of the rudder. Draw in the box as shown. (See Figure 5.)

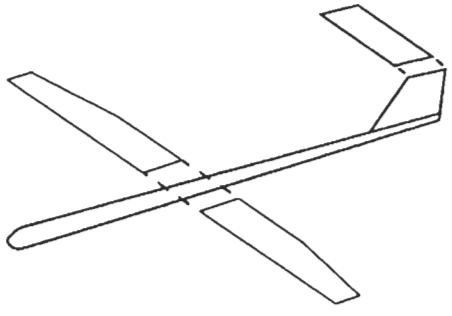


Figure 5 - Horizontal stabilizer

8. Measure and draw in the taper at the front of the stabilizer wing.

9. Measure and draw in the thickness of each part. Note: the thickness is shown only on the front and top of each part on your drawings.

10. Complete your assembly drawing by placing **part names** and **leaders** at appropriate places. Indicate the material size for each part.

11. Darken in your object lines with an HB pencil and erase any unwanted construction lines.

Constructing a Mock-Up

1. Place a sheet of tracing paper over your original drawing. Carefully trace the outline (shape) of each part. You should trace each of these parts separately: fuselage, main wing, rudder, and stabilizer.

2. Place the tracing paper over your cardboard with a sheet of carbon paper between the tracing paper and the cardboard, carbon side down. Then transfer your design to the cardboard.

3. Use an X-Acto knife on a cutting surface to cut out each part of the glider. Do not cut on your desk!

4. To check the accuracy of your parts, place the cardboard cut-out **patterns** over your original drawing. They should match exactly.

5. Assemble the cardboard patterns into a **mock-up**, using small pieces of masking tape. Does your mock-up look like the assembly drawing? In industry, mock-ups are used to check the accuracy of manufactured parts and patterns. If your patterns match your original drawings and your mock-up looks like the assembly drawing, you have "checked" your work for accuracy. You are now ready to build your prototype.

Building the Prototype

While mock-ups look like the actual glider, they won't fly. This is because mock-ups are often made out of less expensive materials than would be required for working models. A **prototype** is a working model, or the first production model

of a product. It is built to test and evaluate a design. Very often the first prototype will look quite different from the actual production model of a product.

1. Disassemble your mock-up carefully. You will use the cardboard patterns to cut out your balsa wood parts.

2. Place the cardboard patterns over your balsa wood parts. Make sure your have the right material for each part. Notice that the fuselage is constructed from the 1/8" balsa, and the wing, rudder, and stabilizer from the 1/16" balsa. Use small pieces of masking tape, and tape the patterns in place.

3. Use an X-Acto knife on a cutting surface and cut out each part carefully. When cutting with the grain, be careful; cut slowly or you will cut off portions of the balsa that you want to keep!

4. After the parts have been cut out, sand them lightly. Leading edges of wings should be very fine and smooth.

5. Use white glue or CA glue to assemble your Midget Glider.

6. When assembling the wings, give them some **dihedral**. This is the angle of the wing above the horizontal plane. Wings should not be flat or level with the horizontal plane, but angled upward about 15 degrees.

7. After the glue is dry, add some weight to the nose of the fuselage. Plastic clay or a paper clip will work. You will have to do some **flight testing** to determine how much weight you need. Launch the glider with a side arm motion. The glider should spiral up and glide down in a wide circle.

Safety

Be careful when working with X-Acto knives, as the blades are very sharp. Store knives carefully so the blade is not exposed. Do not cut on desks or drawing boards; use a cutting surface.

When using any type of glue, read the instructions carefully. Know what to do if you get glue on your skin, in your eyes, or on your clothing.

Vocabulary

model	mock-up
prototype	pattern
isometric	orthographic projection
perspective	view
object line	perpendicular
symbol	dimension
extension line	center line
hidden line	pictorial
working drawing	assembly drawing
horizontal	vertical

Environment

Do not waste materials. Carbon paper can be reused several times. Read the label on glue bottles and dispose of properly.

On Your Own

1. Redesign the Midget Glider, and build another prototype. See if you can improve on its performance.

2. Do some research on gliders and flight. Find out what makes a glider fly. Get a copy of the *Metric Glider Book* from Pitsco and do some research on the Aerospace Technology TSA Competitive Event. Build a full size TSA Model, and enter it in competition at the district or state conference.

3. Write some letters to aircraft manufacturers; ask for photographs and literature on their products. Make a bulletin board on aircraft technology for your lab.

Office of Vocational, Adult, Career, and Community Education
Technology Education
Dade County Public Schools • Miami, Florida

TEACHER GUIDE
DRAFTING & DESIGN: MIDGET GLIDER

Objectives: Upon completion of this assignment, students will be able to:

- Describe how engineers and designers use drafting as a means of technical communication.
- Describe orthographic projection and the term "working drawing".
- Differentiate between isometric, oblique, and perspective pictorial drawings.
- Draw to scale.
- Construct a set of working drawings for a prototype glider using proper drafting tools and techniques.
- Build a prototype of a glider and design product performance tests.
- Describe and apply each step in the design process.

Helpful Hints:

1. Draft a set of drawings for the midget glider, including an isometric assembly drawing, as examples of what the working drawings should look like. However, you should not allow students to copy your drawings.

2. Obtain several examples of various types of mechanical drawings, such as orthographic, isometric, perspective, and oblique, to show students.

3. Get a copy of the *PITSCO Metric Glider Book* to use as a resource. It explains the theory of flight, the design process, and the research and development used by industry to create new products, utilizing the glider as an example.

4. Visit a local hobby shop. Buy a few commercial balsa wood gliders as demonstration models.

5. This glider will fly very well if constructed correctly. One important aspect is the dihedral angle of the wings. This must be equal for both sides! You can "score" the balsa with a ball point pen along the center line of the main wing in order to bend it to achieve the angle, or cut the wing into two parts and glue them into position.

LANGUAGE ARTS APPLICATION
DRAFTING & DESIGN: MIDGET GLIDER

_____
Student Name

In all types of jobs you will find that you need the ability to communicate your ideas effectively. Writing skills are necessary in all occupations. Here are a few examples of how writing skills are related to this activity.

In this activity package, you will be exposed to some new vocabulary related to aeronautics. An important skill you will need throughout your life is the ability to use a dictionary to find out what a specific word or technical term means. In the space below, use a regular dictionary or a technical aviation/space dictionary to discover the meaning of each of the terms. Remember that words may have several different meanings; you are to select that meaning that relates to aeronautics!

1. Airfoil: _____

_____

2. Lift: _____

_____

3. Drag: _____

_____

4. Stall: _____

_____

5. Gravity: _____

_____

6. Dihedral: _____

_____

7. Fuselage: _____

_____

8. Vertical Stabilizer: _____

_____

LANGUAGE ARTS APPLICATION
DRAFTING & DESIGN: MIDGET GLIDER (Cont'd.)

9. Horizontal Stabilizer: _____

_____

10. Thrust: _____

_____

11. Bernoulli's Law: _____

_____

12. Angle of Attack: _____

_____

13. Flap: _____

_____

14. Rudder: _____

_____

15. Aileron: _____

_____

MATH APPLICATION
DRAFTING & DESIGN: MIDGET GLIDER

_____
Student Name

In all types of occupations you will need the ability to apply mathematics effectively. Her are a few examples of how math skills are used in relation to this activity.

A small glider is made from pieces of different shapes. Some pieces are shaped like triangles. Others are shaped like rectangles and parallelograms. The area of these shapes can easily be found using the proper formulas. To find the area of a rectangle, simply multiply the length by the width.

Example 1: If you need a piece of balsa wood that is 8" long by 2" wide, you could easily find the area using the following formula.

Area = length x width
Area = 8" x 2"
Area = 16 square inches

Try these: Use this formula to find the area of the following rectangles.

1. length = 10", width = 3"

   Area = _____ square inches

2. length = 24", width = 5"

   Area = _____ square inches

3.. length = 12", width = 2"

   Area = _____ square inches

4. length = 15", width = 6"

   Area = _____ square inches

5. length = 36", width = 8"

   Area = _____ square inches

MATH APPLICATION
DRAFTING & DESIGN: MIDGET GLIDER (Cont'd.)

A parallelogram can be rearranged to form a rectangle. The area of a parallelogram is equal to the base times the height.

Example 2: If you need a piece of balsa wood that has a base of 11" and a height of 4" you could easily find the area using the following formula.

Area = base x height
Area = 11" x 4"
Area = 44 square inches

Try these: Use this formula to find the area of the following parallelograms.

6. base = 15", height = 6"

   Area = _____ square inches

7. base = 12", height = 3"

   Area = _____ square inches

8. base = 9.5", height = 4 "

   Area = _____ square inches

9. base = 24", height = 7"

   Area = _____ square inches

10. base = 32", height = 11"

    Area = _____ square inches

The area of a triangle is one-half the area of a parallelogram. To find the area of a triangle, use the formula below.

$$\text{Area} = \frac{1}{2} \times \text{base} \times \text{height}$$

Try these: Given the base and height, find the area of each of the following triangles.

11. base = 6", height = 3"

    Area = _____ square inches

MATH APPLICATION
DRAFTING & DESIGN: MIDGET GLIDER (Cont'd.)

12. base = 12", height = 8"

    Area = _____ square inches

13. base = 16", height = 12"

    Area = _____ square inches

14. base = 20", height = 6"

    Area = _____ square inches

15. base = 30", height = 10"

    Area = _____ square inches

QUIZ
DRAFTING & DESIGN: MIDGET GLIDER

_____
Student Name

True or False:

_____ 1. Drafting uses lines and symbols as a language that can be understood by engineers to communicate ideas.

_____ 2. Isometric drawings are a form of pictorial drawing.

_____ 3. An orthographic projection drawing uses separate views of an object to fully describe its shape and size.

_____ 4. Perspective drawings show objects as the eye would see them.

_____ 5. An oblique drawing has one orthographic surface, with a pictorial view of the other two surfaces.

_____ 6. Lines are not symbols.

_____ 7. Assembly drawings are used to show how an object with several parts is put together.

_____ 8. Using different drafting pencil leads provides for a variety of line values so that object, dimension, and construction lines appear different on a drawing.

_____ 9. Drafting manufactured parts is also called mechanical drawing.

_____ 10. A drawing that shows a system or flow is called a schematic drawing.

_____ 11. Orthographic drawings are also called working drawings.

_____ 12. Isometric drawings are drawn using an angle of 30 degrees.

_____ 13. T-squares are used to draw horizontal lines.

_____ 14. Triangles are used to draw vertical and angular lines.

_____ 15. Perpendicular lines are drawn at 90 degree angles to each other.

_____ 16. A model is a non-working example of what a product will look like, usually built at a reduced scale.

QUIZ
DRAFTING & DESIGN: MIDGET GLIDER (Cont'd.)

_____ 17. A mock-up is a full scale, non-working model used to test the accuracy of parts.

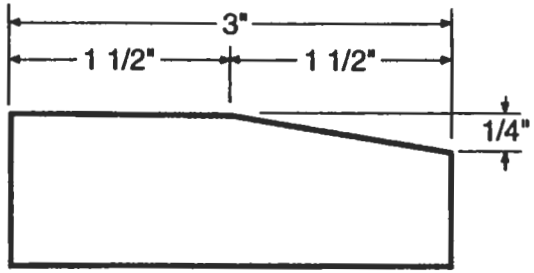
_____ 18. A prototype is the first working test model of a product.

_____ 19. A pattern is used to copy the shape and size of a part accurately.

_____ 20. Oblique drawings often use an angle of 45 degrees for the pictorial views.

Midget Glider

0 1/2" 1"



Wing Detail