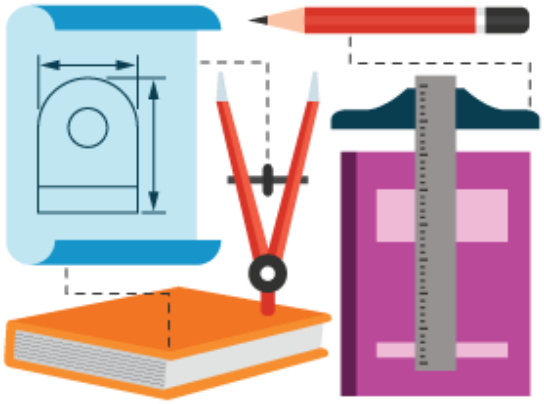
Introduction to Computer-Aided Design : Size and Shape Description

Lesson 2 Overview

A large part of planning to build any object involves knowing how to accurately describe the object's size and shape from different points of view. Helping you to develop this talent is the goal of this lesson.



Most of the information on a drawing indicates an object's size and shape. When you're on the job your drawings must be understood by each of the many people involved in the design, building, and sale of the object. Thus, accurately describing an object is a vital part of your job as a drafter. In this lesson, you'll concentrate on learning how to describe an object's shape; that is, you'll study how to draw different views, or sides, of an object and how to show these views in their proper relationship.

2.1 Identify the terminologies used in sketching and drawing

Defining Special Terms

READING ASSIGNMENT

Shape Description

Craftsworkers and technicians wouldn't be able to build any product effectively unless its shape was described on a drawing *in every detail.* They need to see many views of the product showing the product's different sides. Attempting to show a complete view is called giving a *shape description* of the product.

Size Description

In addition to knowing the intended shape of a product, the builders must know the various measurements of each of the product's components to construct the finished product correctly. *Dimensions* must be included on each of the different views of the components. The dimensions reveal the exact height, width, and depth intended for each component. This process of communicating all the dimensions of the various components is called the product's *size description.*

An image of a pictorial drawing intended to show the appearance of a finished mechanical part.

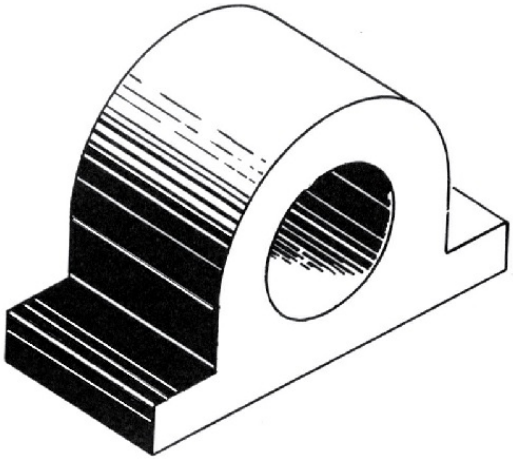


FIGURE 1—A pictorial drawing is an attempt at showing the "true" appearance of an object, as though the object were in a photograph.

Pictorial Drawing

A drawing that shows how an object would appear in "real life"—as though the object had been photographed—is called a *pictorial drawing.* Figure 1 shows an example of a pictorial drawing intended to show the appearance of a finished mechanical part.

A diagram showing a vertical line AB perpendicular to horizontal line CBD and creating a 90 degree angle.

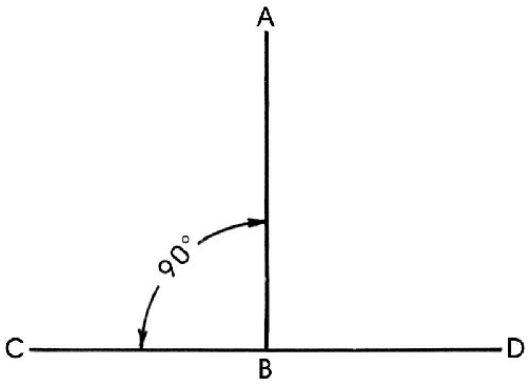


FIGURE 2—The word "perpendicular" means "at right angles to." In this drawing, line AB is perpendicular to line CBD.

Perpendicular

The term *perpendicular* means "at a right angle to." As shown in Figure 2, a right angle measures 90 degrees (90°). You'll often use perpendicular lines when estimating various angles as you draw and sketch objects.

Three-Dimensional

A simple drawing, such as of a circle or a square, will have only *two dimensions.* For example, when you draw a rectangle on a piece of paper, you're simply showing the shape's height related to its width. In contrast, a *three-dimensional* object, such as a block of wood, has height, width, and depth. The height, width, and depth dimensions are used to form an object's *size description.*

In your sketches and drawings, you're attempting to describe all three

dimensions graphically. Using Figure 3, you can compare the sketch of a two-dimensional shape with the sketch of a three-dimensional object. In the three-dimensional sketch, depth is revealed along with the object's height and width.

An image of two sketches where one sketch is two-dimensional with height and width marked and another sketch is a three-dimensional sketch with height, width, and depth marked.

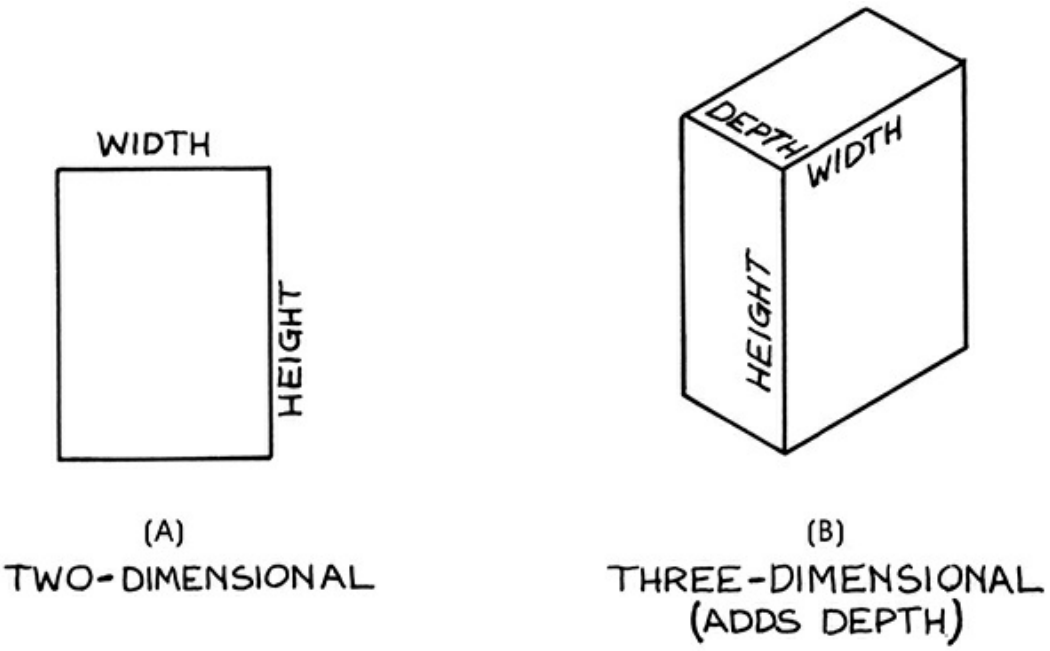


FIGURE 3—A two-dimensional sketch or drawing shows only height a width. A three-dimensional sketch, on the other hand, also shows the object's depth.

Adjacent

An illustration of a rectangle divided into three equal, vertical parts named Lot A, Lot B, and Lot C to illustrate the meaning

of adjacent.

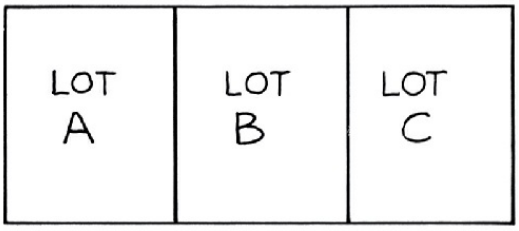


FIGURE 4—The word "adjacent" is used to describe things or areas that are adjoining each other.

The term *adjacent* means "adjoining." This concept is graphically illustrated in Figure 4. Lot A, for example, is adjacent to lot B. Also, lots B and C are adjacent to each other. However, lot A isn't adjacent to lot C because lot B is between them and keeps them separate.

Visualize

In discussions of sketching and drawing, you'll often come across the term *visualize,* which means "to form a mental image of" or "to make visible in your mind." The ability to effectively visualize three-dimensional objects is an essential part of becoming a skilled drafter.

Key Points and Links

READING ASSIGNMENT

Key Points

- Complete size and shape descriptions are necessary for any object that's to be built.
- Drafters should be familiar with terms related to size and shape

description, including *pictorial drawing, perpendicular, adjacent, two-* and *three-dimensional,* and *visualize.*

Discover More: Sketching Terminologies

Fill in the blank.

1. If any figure pair with two or three dimensions is drawn next to each other, they would be considered _____ figures.
2. When you attempt to use sketches to show a complete view of a machine, you're essentially trying to describe the machine's _____ graphically.
3. A drafter's skill depends to a large extent on the ability to _____—to imagine what an object would look like.
4. In a three-dimensional sketch, _____ is revealed along with an object's height and width.
5. If two lines meet to form a right angle, they would be considered _____ lines.
6. _____ drawings show how an object would appear from one perspective—as though the object were in a photograph.
7. The process of communicating all the dimensions of a product's several components is called the product's _____ description.

Discover More Answer Key:

Discover More: Sketching Terminologies

1. adjacent
2. shape

3. visualize
4. depth
5. perpendicular
6. Pictorial
7. size

2.2 Explain the process of making an orthographic projection for an object

Making an Orthographic Projection

READING ASSIGNMENT

An image of a pictorial drawing showing what an object will look like without a complete description.

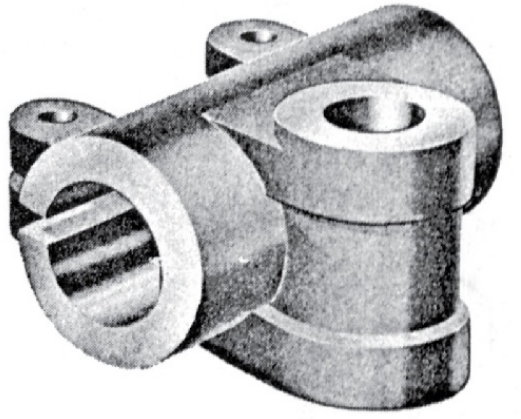


FIGURE 5—This pictorial drawing shows what the object would really look like, but it

doesn't give a complete
description because you can't
"see" all the sides of the object.

A photograph or a pictorial drawing shows an object as it appears from a single point of view—as though you were standing still while looking at a real object fixed in one position in space. However, because such a picture is made from a single *perspective,* or point of view, it can't fully describe an object. The shapes and sizes of some surfaces won't be visible in a pictorial illustration. For example, the pictorial drawing in Figure 5 may be a good likeness of the actual fixture, but this drawing—made from only a single perspective—can show only one end of the fixture.

For an object to be manufactured as intended by the designer, a complete and clear description of the shape and size of th*e whole* object must be drawn. In addition, this drawing must be *understood* by those people involved in the manufacturing process. Thus, to communicate the necessary information clearly and accurately, a drafter must provide a certain number of different views of an object. This grouping of related views used in drafting is called *orthographic projection,* or *multiview (many views) projection.*

Viewing an Object "Straight On"

The term *orthographic* is derived from two Greek words: *orthos,* meaning "right" or "straight," and *graphein,* meaning "to write" or "to describe by drawing lines." To create an orthographic view, you would draw a single, right-angle perspective of the object—as if you were actually looking at

one side of the object *straight on.* Figure 6 shows an example of how an orthographic view may be created. The important thing to remember is that, in an orthographic view, the surface being viewed is *perpendicular* (at a right angle) to the viewer's line of sight. If you look straight toward the face of an object, you'll get a true view of the shape and size of that one surface.

An image with two sketches showing an orthographic view.

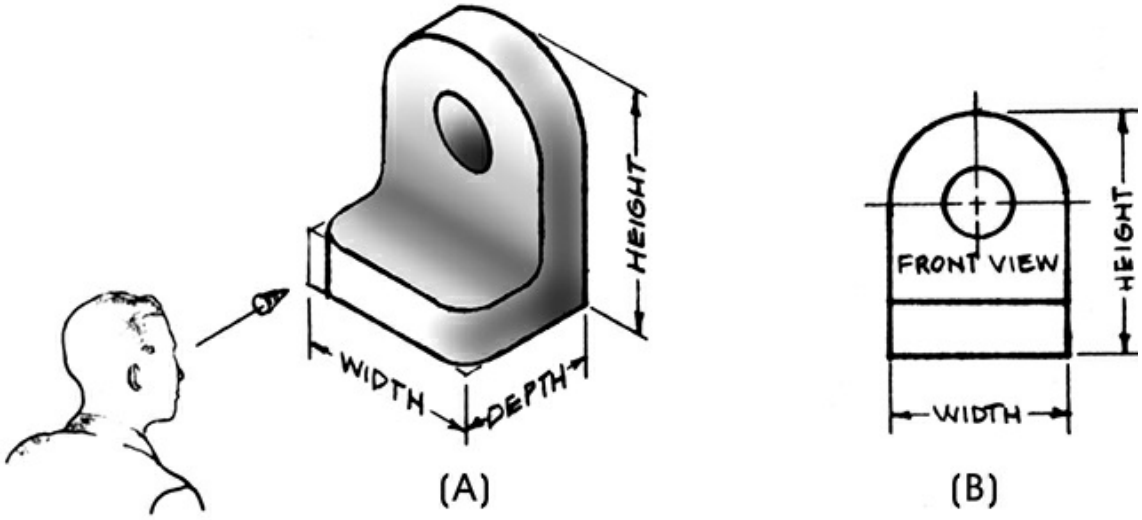


FIGURE 6—An orthographic view is taken "straight on," as though you were positioned at a right angle to the object's surface.

Combining Views to Make an Orthographic Projection

When making an orthographic view of an object, it's almost as though you were projecting an outline of a single surface straight onto your drawing pad. In drafting, however, the goal of the orthographic projection is to project a *number* of the object's surfaces to create several single views. Each view would be perpendicular to the other orthographic views.

For example, look at Figure 7. In Figure 7A, the object is being "turned"

90° from its front side so that the object's *right side* could be "viewed" straight on. The right side of the object is perpendicular to the object's front side. In Figure 7B, the object is being turned so that the *top side* can be viewed straight on. The top is perpendicular both to the object's front and to its right side. Figure 7C shows how these three separate views—top, front, and right side—are combined with a pictorial view to give a somewhat complete description of the object's shape. The front, top, and right-side views are called the *three regular views* because they're the ones most frequently used. Later, you'll learn other views used in orthographic projection.

An image with three sets of sketches showing an orthographic projectio which combines several perspectives to give a detailed description of a object.

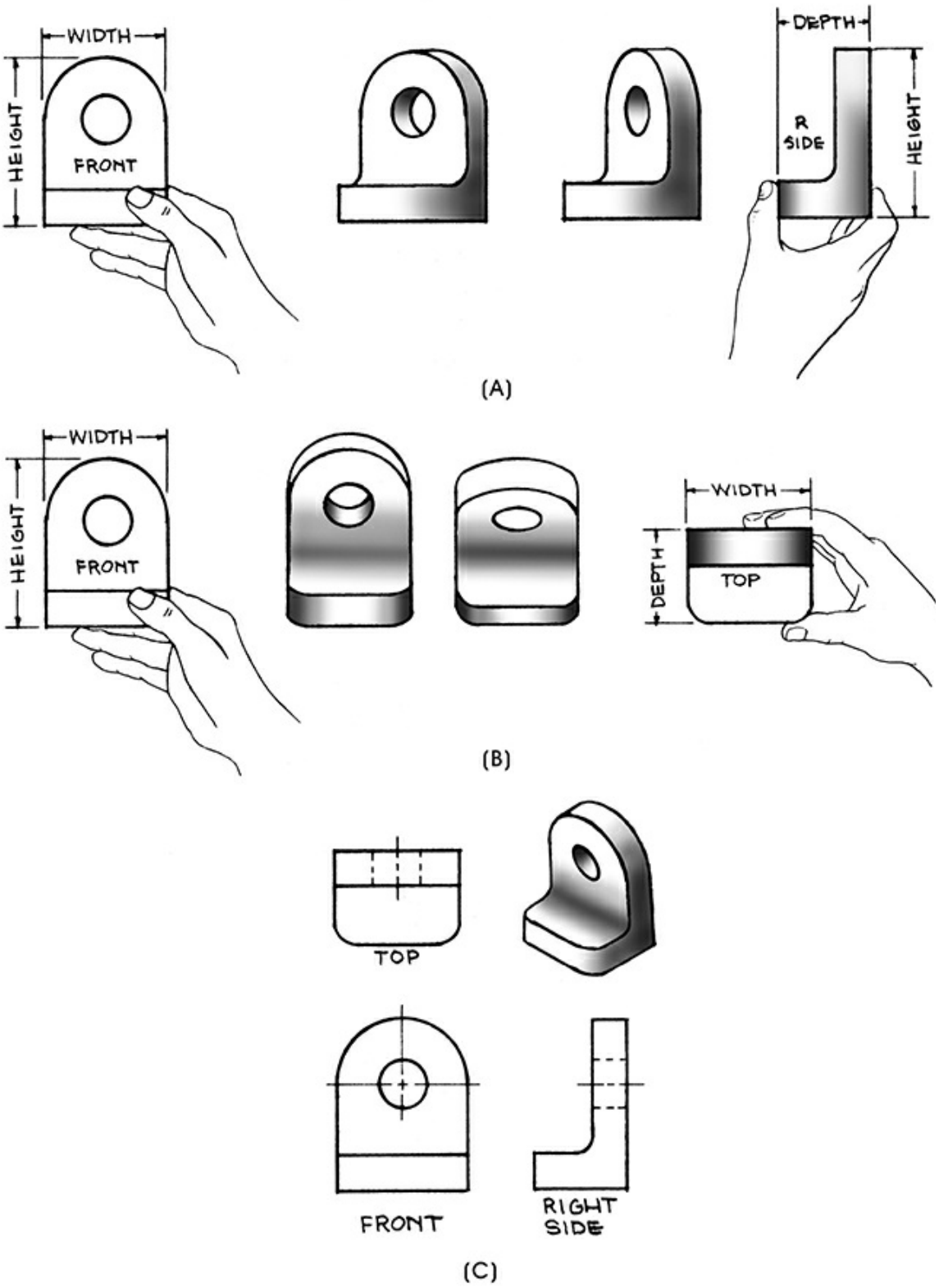


FIGURE 7—An orthographic projection combines several perspectives give a more complete description of an object. Each orthographic view

perpendicular to the others.

Selecting the Three Regular Views to Make a Shape Description

An image with two illustrations showing a pictorial view and the top view of a book.

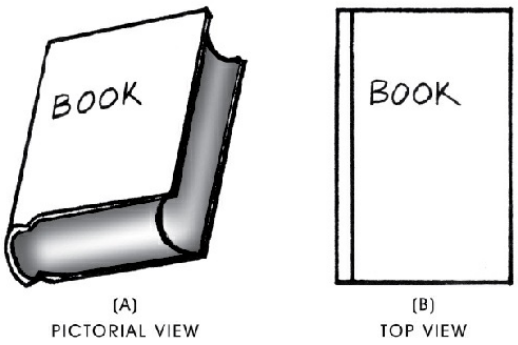


FIGURE 8—The drafter has selected the front cover of the book as the object's top view. This selection is logical because the front cover is the side of the object with the largest surface area. In drafting, such a surface would typically be chosen as the top view.

The drafter decides which side of an object will be the front view for a sketch. Usually, the largest surface of the object is selected to be the *top view.* A side perpendicular to the top view—perhaps the one with the most detail—would be selected as the *front view.* As part of the three regular views, the side perpendicular to and to the right of the front view would be

called the *right-side view.*

For example, consider the pictorial drawing of the book shown in Figure 8A. Normally, we would think of the *front* of a book as the book's front cover. However, what we would normally call the front of the book isn't necessarily the *front view* when we're trying to describe the book's shape. As shown in Figure 8B, the drafter decided to let the front cover of the book serve as the *top view.*

Now that the *top view* has been established, the drafter can select an appropriate *front view* for describing the size of the book. The front view would be a side at a right angle to the top view. The spine of this book offers the most detail out of all the other choices; therefore, in this instance, the drafter selected the spine as the front view. Thus, the right-side view in this projection is the side to the right of the spine. Figure 9 shows these three regular views together with a pictorial drawing of the book. Remember, you're not naming the sides of the book in an attempt to describe how it would sit on a shelf. The side that would rest on the bookshelf might be called the *bottom* edge of the book. However, because you're trying to create an orthographic projection, you'll name that edge the *right-side view.*

An image with four illustrations showing the top, the front, and the right side view of a book along with a pictorial view with the top, front, and ri side marked.

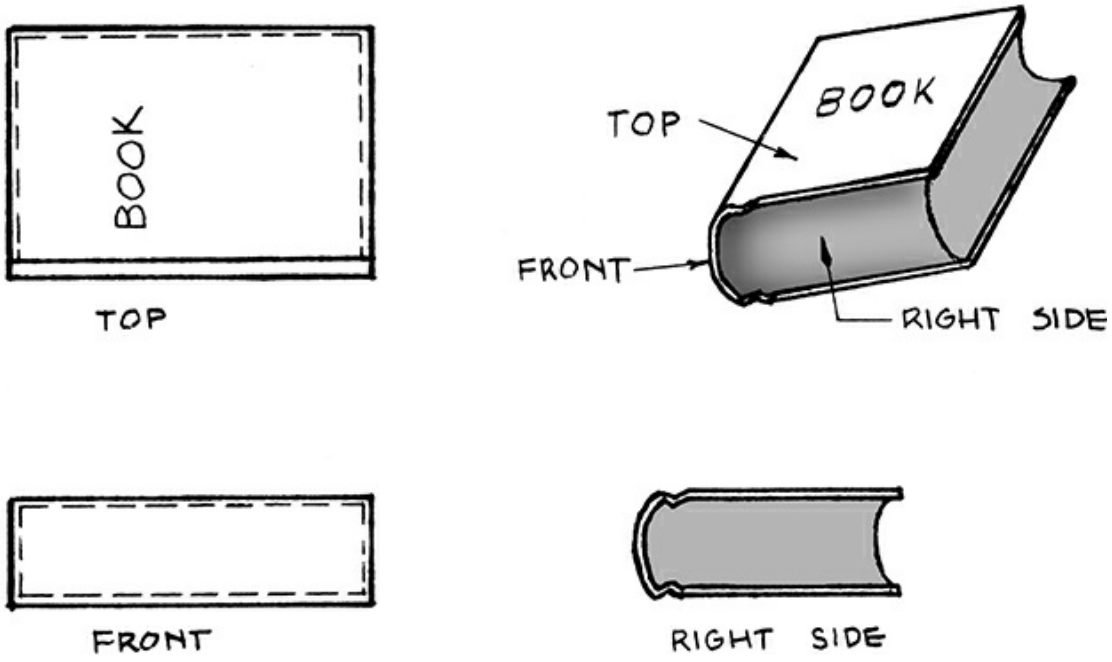


FIGURE 9—Here are shown the three regular views appropriate for an orthographic projection of a book. Whenever you lay out the three regu views of an object, try to choose those three surfaces that will show the most detail; that is, choose the views that will give the best shape description.

In Figure 9, the three regular views of the book have given the object its *shape description.* The solid black continuous lines, often called *visible lines,* form the outline of the object. The visible lines correspond to the edges you would see when you look at that surface of the object. The short dashed lines correspond to edges that are *not* visible when you view the surface. These dashed lines are called *hidden lines,* or *invisible lines.*

Using the Orthographic Projection to Make a Size Description

The Three Principal Dimensions

A finished orthographic projection can be used to provide a size description as well as a shape description. As shown in Figure 10, the completed drawing can include *dimensions* used to identify sizes in each view. If you were making an actual layout of the book, the words *height, width,* and *depth* would be replaced with actual measurements made of the object's top, front, and right side.

An image with four illustrations showing the top, the front, and the right side view of a book along with a pictorial view with the height, width, ar depth marked.

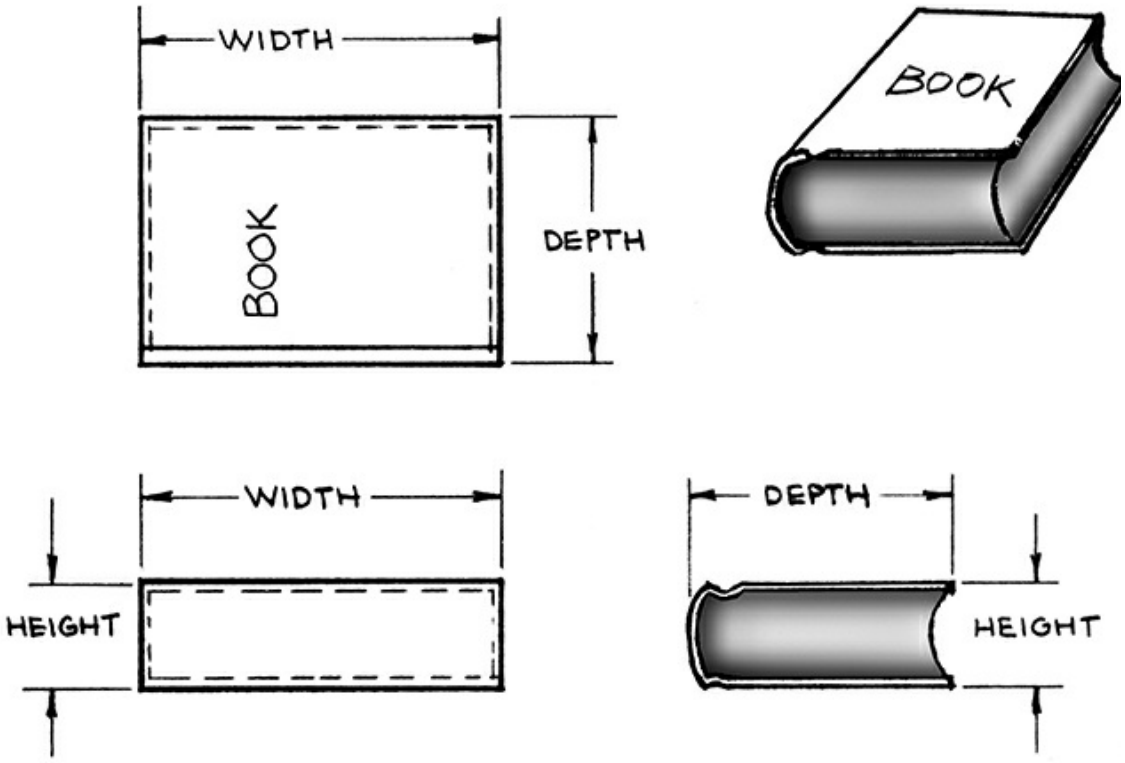


FIGURE 10—Here are the top, front, and right-side views of a book together with a pictorial view. Note that dimensions have been added t these three regular views. On a finished drawing, the dimension labels would be replaced with corresponding measurements made of the actu book.

The three principal dimensions shown in Figure 10 are the book's height, width, and depth. Generally, the terms *length* and *thickness* aren't used in drafting because they won't apply as dimensions in all cases. One such case where thickness *would* be used, however, is for describing sheet metal parts. With sheet metal, what you would normally call the height would be the metal's *thickness* dimension.

Note that the front view of the book shows the height and width of the object, but not the depth. In fact, *any* single view of a three-dimensional object shows only two dimensions; the third dimension is found in an adjacent view. The measurements corresponding to the height, width, and depth dimensions form the *size description* of an object.

Characteristics of Height, Width, and Depth

The height dimension. The height of an object is its size measured straight up and down. As an example, consider a dresser or a chest of drawers that you may have in your bedroom. The height of the dresser is measured from the floor to the top of the dresser. This measurement is of a vertical distance. Note that the height of the book in Figure 10 is shown in both the front and right-side views. Essentially, an object's height is its size from top to bottom.

The width dimension. The *width* of an object is its size measured straight across the front, from the left side to the right side. The width of a dresser, for example, is measured across its front, from the left side to the right side. Note that the width of the book in Figure 10 is shown in both the top and front views. Basically, an object's width is measured across the front of the object.

The depth dimension. The *depth* of an object is its size measured from front to back. The depth of a dresser, for example, is the distance from the front of the dresser to the back of the dresser. Note that the depth of the book in Figure 10 is shown in both the top and right-side views. In essence, depth is the size of an object from its front to its back.

Key Points and Links

READING ASSIGNMENT

Key Points

- An orthographic projection is a multi-viewed illustration of an object.
- Three regular views and three principal dimensions combine for a shape and size description of an object.
- Height, width, and depth are important measurement characteristics of an object.

Discover More: Fundamentals of Orthographic Projections

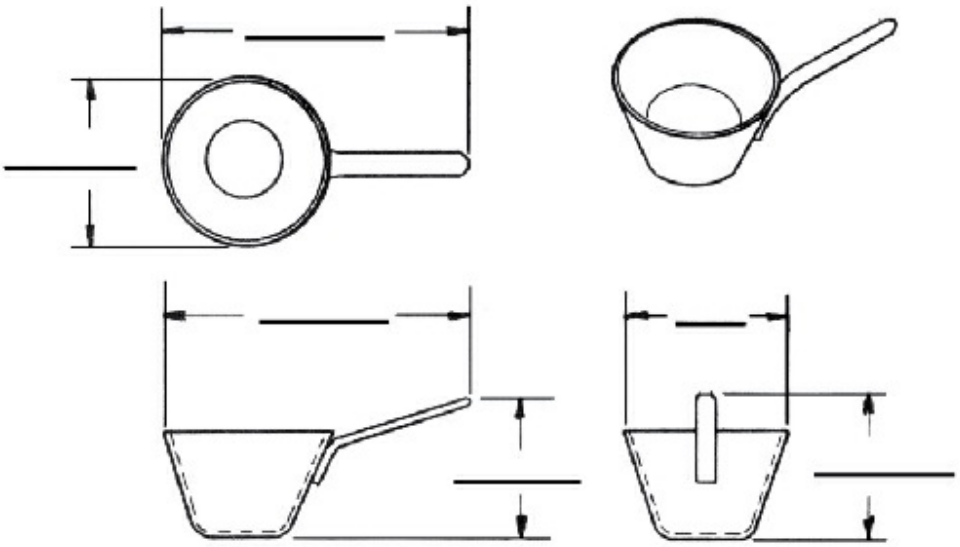
Fill in the blank.

1. A/An _____ drawing is simply an attempt to show how an object would appear as though it were in a photograph.
2. A/An _____ is often used to provide a size and shape description of an object.
3. The three regular views in an orthographic projection are top, front, and _____.
4. Another name for orthographic projection is _____ projection.
5. Orthographic views are at _____ angles to each other.

6. The three principal _____ are height, width, and depth.
7. Height and width are shown in an object's _____ view.

Identify the principal dimensions—the pan's height, width, and depth —where they would be shown in each orthographic view.

An illustration of the top view, pictorial view, front view and right side view of a pan.

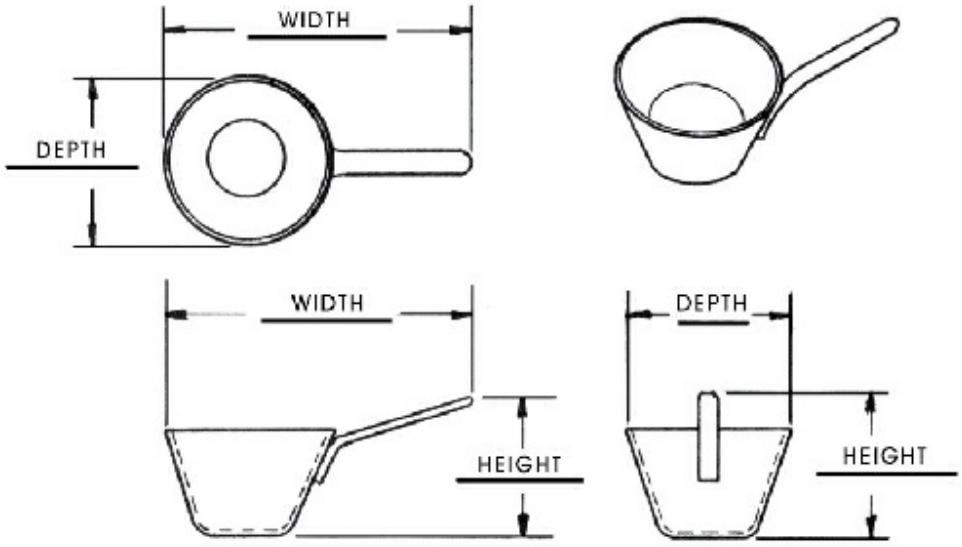


Discover More Answer Key:

Discover More: Fundamentals of Orthographic Projections

1. pictorial
2. orthographic projection
3. right-side
4. multiview
5. right
6. dimensions
7. front

An image with answer to problem 3 containing four sketches of different views of a pan with the height and width marked.



2.3 Describe how the surfaces are represented in various orthographic views

Distinguishing the Different Surfaces of an Object Shown in Different Views

READING ASSIGNMENT

When examining an orthographic projection, you'll need to recognize what surfaces are being presented in each view. The pictorial drawing in Figure 11A shows how surface 1 through surface 5 would appear if you were viewing the real object. Look at how surface 1 appears in the pictorial drawing, and compare it with how it's shown in the top, front, and right-side views featured in Figure 11B. Note that only a single edge of surface

1 is visible in the top view. In the front view, however, surface 1 is shown in its true shape. In the right-side view, an edge of surface 1 is once again all that's visible.

An image with two sets of sketches showing one pictorial drawing and three sets of regular orthographic views of an object with all the surface represented.

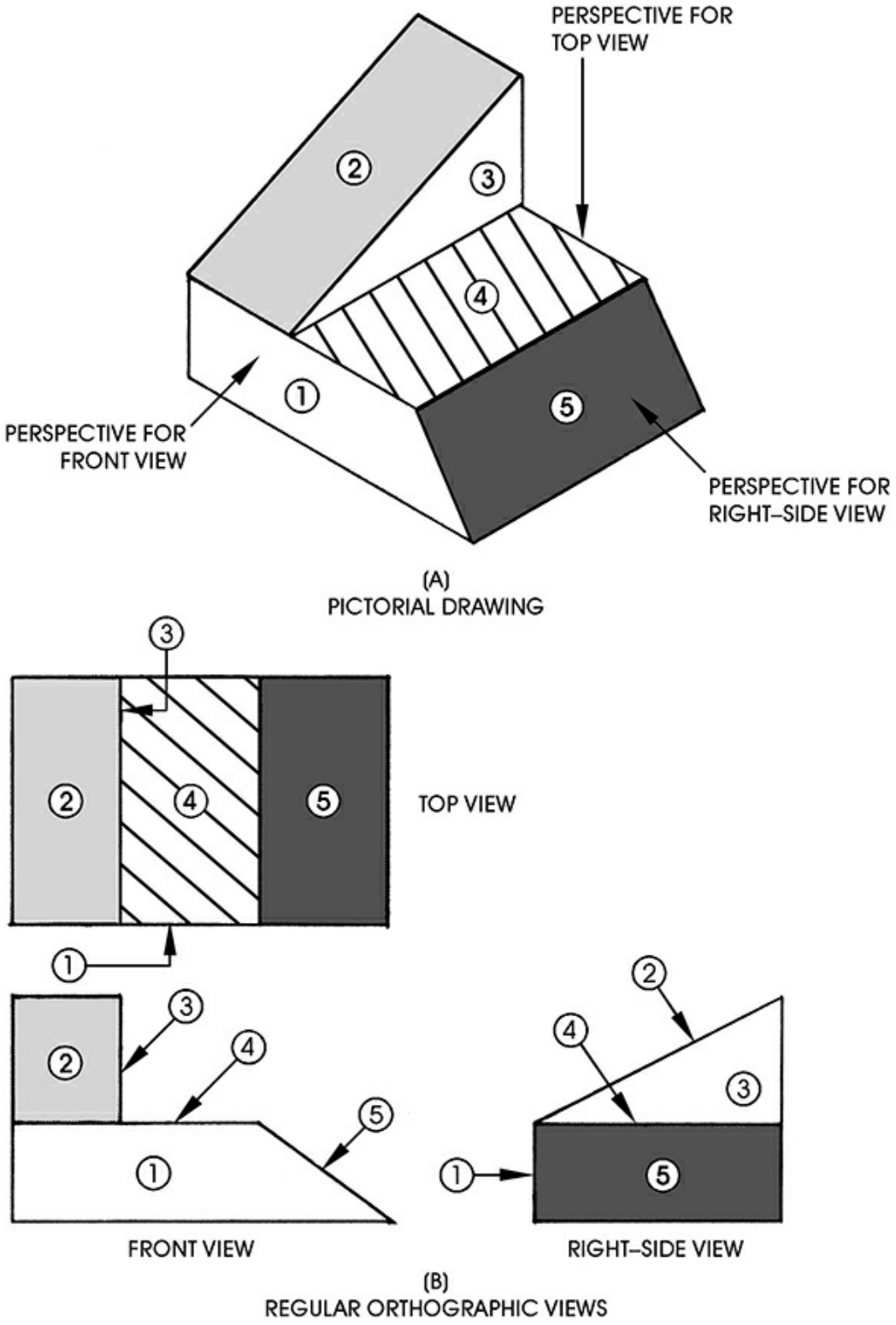


FIGURE 11—To "read" an orthographic projection, you need to recogn
which surfaces and edges of the object correspond to the areas and lir

shown in each orthographic view.

Examine how all the surfaces are represented in each view of the object featured in Figure 11. As you practice “reading” the various orthographic views, you’ll learn to *visualize* the three-dimensional shape of an object even when you don’t have a pictorial view. In addition, your practice will help you in laying out an orthographic projection when all you have is a pictorial view. Therefore, whenever you study an object, practice visualizing how the three views would be presented.

PRACTICE PLATES

Examine the sketches contained in the linked practice plates.

A *plate* is a completed drawing on a single sheet of paper or vellum. Any plates that you create during your training you should place in a personal file of drawings. Someday this file may help you obtain employment as a drafter. Practice Plate 1A contains four sets of drawings. Each set consists of a pictorial drawing and three corresponding orthographic views. Practice Plate 2A contains two sets of drawings. Note that, in both practice plates, the surfaces visible on all the pictorial drawings have been lettered.

For each pictorial drawing, identify the surfaces and surface edges shown on the corresponding orthographic views by printing the appropriate letters in the circles. The first set of orthographic views in Practice Plate 1A has been done for you. Once you’ve finished lettering the surfaces and edges in each regular view, go through both practice plates to check for errors. This proofing is a good habit that you should adopt as a standard

procedure in your studies as well as on the job.

Once you've completed Practice Plate 1A and 2A, check your answers with Practice Plate 2A and 2B.

- Practice Plate 1A–B (lessons.pennfoster.com/pdf/Practice_Plates_1A-B.pdf)
- Practice Plate 2A–B (lessons.pennfoster.com/pdf/Practice_Plates_2A-B.pdf)

Key Points and Links

READING ASSIGNMENT

Key Points

- Drafters should be able to recognize which surfaces are being presented in each view of an orthographic projection.
- The ability to visualize allows a drafter to “see” an object without a physical representation.

Lesson 2 Review

Self-Check

1. The depth dimension, as shown in an object’s top view, is usually measured in what direction?

a. From right to left

b. From corner to corner

c. From the center out

d. From front to back

2. As shown in the top and front views of an object, the width dimension is usually measured in what direction?

a. From left to right

b. From back to front

c. From corner to corner

d. From bottom to top

3. As shown in the side view of an object, the depth dimension is usually measured in what direction?

a. From left to right

b. From top to bottom

c. From corner to corner

d. From the center out

4. The front view of an object shows which two dimensions?

a. Height and width

b. Depth and width

c. Height and thickness

d. Height and depth

5. The top view of an object shows which dimensions?

a. Depth and width

b. Height and thickness

c. Height and depth

d. Height and width

6. A technician requiring many views of a product, in full detail, is likely to receive a/an

a. size description.

b. object description.

c. full-view description.

d. shape description.

7. A builder requiring the complete dimensions of an object is likely to receive a/an

a. size description.

b. shape description.

c. object description.

d. full-view description.

8. A pictorial drawing is most likely to be _____-dimensional.

a. one

b. three

c. two

d. four

9. Two lines that are perpendicular to one another meet at which angle?

a. 15 degrees

b. 60 degrees

c. 90 degrees

d. 180 degrees

10. In a diagram, three squares of equal size are placed in a row next to each other and labeled A, B, and C. If square A is directly to the left of square B and square C is directly to the right of square B, how would you describe the location of square B in relation to square A?

a. Perpendicular

b. Horizontal

c. Adjacent

d. Supplementary

11. Being able to _____ will help a drafter imagine an object without a physical representation.

a. visualize

b. sketch

c. project

d. describe

12. How many perspectives are available with a pictorial drawing?

a. 2

b. 3

c. 1

d. 4

13. At which angle is the surface of an object being observed in an orthographic view?

a. Right

b. Acute

c. Obtuse

d. Straight

14. Which surfaces constitute the "three regular views" of an orthographic projection?

a. Front, top, and right-side

b. Top, bottom, and right-side

c. Top, right-side, and left-side

d. Front, top, and left-side

15. Which part of an object is selected for the "top view"?

a. The smoothest surface of the object

b. The surface of the object that faces up

c. The surface of the object that faces down

d. The largest surface of the object

16. Where is the "right-side view" located in relation to the "front view"?

a. Perpendicular and to the left

b. Parallel and to the right

c. Perpendicular and to the right

d. Parallel and to the left

17. In which situation would a drafter encounter the term "thickness"?

a. When describing the "width" dimension of sheet metal

b. When describing the "length" dimension of sheet metal

c. Never

d. When describing the "height" dimension of sheet metal

18. Orthographic views must be _____ to create an accurate orthographic projection.

a. combined

b. symmetrical

c. identical

d. presented individually

19. When sketching an object, which features identify its outline?

a. Dotted lines

b. Light shading

c. Solid black lines

d. Arrows

20. When viewing a surface of an object, some edges won't be visible. How are these features identified?

a. Jagged lines

b. Dashed lines

c. Points

d. Labels

21. You're given an object that measures 11 inches up and down, 4.5 inches straight across the front, and 7.25 inches front to back. What's the object's height?

a. 4.5 inches

b. 7.25 inches

c. 11 inches

d. 11.75 inches

22. You're given an object that measures 2 inches up and down, 18 inches straight across the front, and 2.5 inches front to back. What is the object's width?

a. 18 inches

b. 2 inches

c. 2.5 inches

d. 20.5 inches

23. You're given an object that measures 1.75 inches up and down, 3 inches straight across the front, and 3.75 inches front to back. What is the object's depth?

a. 1.75 inches

b. 3.75 inches

c. 3 inches

d. 5 inches

24. How many dimensions are visible in any single view of a three-dimensional object?

a. Only two dimensions

b. Only one dimension

c. All three dimensions

d. No dimensions

25. What should a drafter be able to recognize when viewing an orthographic projection?

a. Materials

b. The cost to construct the object

c. The time to construct the object

d. Surfaces

Self-Check Answer Key

1. From front to back
   Explanation: The depth dimension of an object is its size measured from front to back. The depth dimension of an object is the distance from the front of the object to the back of the object.
   Reference: Section 2.2

2. From left to right
   Explanation: The width of an object is its size measured straight across the front, from the left side to the right side. The width of an object is measured across its front, from the left side to the right side.
   Reference: Section 2.2

3. From left to right
   Explanation: The side view of an object is its size measured straight across the front, from the left side to the right side.
   Reference: Section 2.2

4. Height and width
   Explanation: The front view of an object shows the height and width of the object, but not the depth.
   Reference: Section 2.2

5. Depth and width
   Explanation: The top view of an object shows the depth and width of the object, but not the height.
   Reference: Section 2.2

6. shape description.
   Explanation: A shape description shows a complete and detailed view of an object from different sides.
   Reference: Section 2.1

7. size description.
   Explanation: A size description shows the various measurements and dimensions of an object.
   Reference: Section 2.1

8. three
   Explanation: Pictorial drawings show how an object would appear in "real life," often as if photographed, and include the object's height, width, and depth.
   Reference: Section 2.1

9. 90 degrees

Explanation: Perpendicular means "at a right angle to" and a right angle equals 90 degrees.
Reference: Section 2.1

10. Adjacent
    Explanation: The word *adjacent* is used to describe things or areas that are lying near to, close to, or adjoining one another.
    Reference: Section 2.1

11. visualize
    Explanation: Visualizing is forming a mental image of something.
    Reference: Section 2.1

12. 1
    Explanation: A pictorial drawing offers only a single perspective of an object.
    Reference: Section 2.2

13. Right
    Explanation: In an orthographic view, the surface being viewed is perpendicular (at a right angle) to the viewer's line of sight.
    Reference: Section 2.2

14. Front, top, and right-side
    Explanation: The front, top, and right-side views are called the "three regular views" because they're the ones most frequently used.
    Reference: Section 2.2

15. The largest surface of the object
    Explanation: Usually, the largest surface of an object is selected to be the "top view."
    Reference: Section 2.2

16. Perpendicular and to the right
    Explanation: As part of the three regular views, the side perpendicular to and to the right of the front view would be called the right-side view.
    Reference: Section 2.2

17. When describing the "height" dimension of sheet metal
    Explanation: While the term "thickness" (along with "length") isn't used in drafting because it doesn't apply as a dimension in all cases, it's used to describe the height of sheet metal.
    Reference: Section 2.2

18. combined
    Explanation: The goal of the orthographic projection is to project a number of the object's surfaces to create several single views.
    Reference: Section 2.2

19. Solid black lines
    Explanation: The outline of an object is identified with solid black, continuous lines.
    Reference: Section 2.2

20. Dashed lines

    Explanation: Dashed lines are used to identify edges that aren't visible when viewing a particular surface of an object.

    Reference: Section 2.2

21. 11 inches

    Explanation: An object's height is measured straight up and down, its width straight across the front (from left to right), and its depth front to back.

    Reference: Section 2.2

22. 18 inches

    Explanation: An object's height is measured straight up and down, its width straight across the front (from left to right), and its depth front to back.

    Reference: Section 2.2

23. 3.75 inches

    Explanation: An object's height is measured straight up and down, its width straight across the front (from left to right), and its depth front to back.

    Reference: Section 2.2

24. Only two dimensions

    Explanation: Any single view of a three-dimensional object will show only two dimensions; the third dimension will be found in an adjacent

view.
Reference: Section 2.2

25. Surfaces
    Explanation: When examining an orthographic projection, a drafter needs to recognize what surfaces are being presented in each view.
    Reference: Section 2.3

Flash Cards

1. Term: Shape Description
Definition: A complete view of an object showing different sides

2. Term: Size Description
Definition: The process of communicating all the dimensions of the various components of an object

3. Term: Pictorial Drawing
Definition: An illustration that shows how an object would appear in "real life"—as though it had been photographed

4. Term: Perpendicular
Definition: At a right angle to

5. Term: Adjacent
Definition: Lying near to, close to, or adjoining

6. Term: Two-Dimensional Drawing

Definition: An illustration of an object showing its height and width

7. Term: Three-Dimensional Drawing
Definition: An illustration of an object showing its height, width, and depth

8. Term: Visualize
Definition: To form a mental image of

9. Term: Perspective
Definition: Point of view

10. Term: Orthographic Projection
Definition: A multiviewed illustration

11. Term: Visible Lines
Definition: Solid black continuous lines that form the outline of an object

12. Term: Hidden Lines
Definition: Dashed lines corresponding to edges that aren't visible when viewing an object's surface

13. Term: Height
Definition: An object's size measured straight up and down

14. Term: Width
Definition: An object's measurement straight across the front, from left to right

15. Term: Depth

Definition: An object's measurement from front to back