CHAPTER 8 Multiview Drawings

OBJECTIVES

After completing this chapter, the student will be able to:

1. Explain orthographic and multiview projection.
2. Identify frontal, horizontal, and profile planes.
3. Identify the six principal views and the three space dimensions.
4. Apply standard line practices to multiview drawings.
5. Create a multiview drawing using hand tools or CAD.
6. Identify normal, inclined, and oblique planes in multiview drawings.
7. Represent lines, curves, surfaces, holes, fillets, rounds, chamfers, runouts, ellipses, and space curves in multiview drawings.
8. Apply visualization by solids and surfaces to read multiview drawings.
9. Explain why it is important to use multiview drawings.
10. Identify limiting elements, hidden features, and intersection of two planes in multiview drawings.

INTRODUCTION

Engineering and technical graphics are dependent on projection methods. The two projection methods primarily used in engineering graphics are: perspective, and parallel. Projection theory comprises the principles used to represent graphically 3-D objects and structures on 2-D media. All projection theory is based on two variables: line of sight, and plane of projection.

PROJECTION THEORY

8.1 Two projection methods used in projection theory: perspective and parallel.

8.2 Projection theory comprises the principles used to represent graphically 3-D objects and structures on 2-D media.

8.3 Drawing more than one face of an object by moving your line of sight relative to the object helps in understanding the 3-D form. A line of sight is an imaginary ray of light between an observer's eye and the object.

8.4 In perspective projection, all lines of sight start at a single point, and the object is positioned at a finite distance and viewed from a single point.

8.5 In parallel projection, all lines of sight are parallel, the object is positioned at infinity and viewed from multiple points on an imaginary line parallel to the object. The 3-D object is transformed into a 2-D representation or a plane of projection that is an imaginary flat plane upon which the image created by the lines of sight is projected. The paper or computer screen on which the graphic is created is a plane of projection.
ORTHOGRAPHIC PROJECTION

8.6 Orthographic projection is a parallel projection technique in which the plane of projection is positioned between the observer and the object, and is perpendicular to the parallel lines of sight. Orthographic projection techniques can be used to produce both pictorial and multiview drawings.

MULTIVIEW DRAWING

8.7 Multiview projection is an orthographic projection for which the object is behind the plane of projection, and is oriented so only two of its dimensions are shown. Generally three views of an object are drawn, and the features and dimensions in each view accurately represent those of the object.

8.8 The front view of an object shows the width and height dimensions. The frontal plane of projection is the plane onto which the front view of a multiview drawing is projected.
8.9 The top view of an object shows the width and depth dimensions. The top view is projected onto the horizontal plane of projection.
8.10 The side view of an object shows the height and depth dimensions. The side view is projected onto the profile plane of projection. The right side view is the standard side view normally used.
8.11 The top view is always positioned above and aligned with the front view, and the right side view is always positioned to the right of and also aligned with the front view.
8.12-15 The advantage of multiview drawings over pictorial drawings is that multiview drawings shows the true size and shape of the various features of the object, whereas pictorials distort true dimensions which are critical in manufacturing and construction.
8.16 3-D graphical data base used in CNC manufacturing.

PRINCIPAL VIEWS

8.17-18 There are six principal mutually perpendicular views projected onto three mutually perpendicular projection planes. these views are the top, front, right, left, bottom and back.
8.19-20 The width dimension is common to the front and top views. The height dimension is common to the front and side views. The depth dimension is common to the top and side views.
8.21 The arrangement of views may vary as long as the dimension alignment is correct.
8.22A Third angle projection is the standard projection for the United States and Canada. The ANSI third angle icon is shown.
8.22B First angle projection is the standard in Europe and Asia. The ANSI first angle icon is shown.
8.23-25 The difference between first and third angle projection is the placement of the object and the projection plane.
8.26 Adjacent views are two orthographic views placed next to each other such that the dimension they share in common is aligned. Every point or feature in one view must be aligned on a parallel projector in any adjacent view. Related views are two views that share the same adjacent views. Distances between any two points of a feature in related
views must be equal. The view from which adjacent views are aligned is the central view.

8.27  The alphabet of lines specifies the line type and thickness for the allowable types of lines to be used on a technical drawing. These linetypes are standardized and specified by ANSI.

HIDDEN FEATURES

8.28  Hidden features are represented by dashed lines. Some examples include:

- **Holes** - to locate the limiting elements.
- **Surfaces** - to locate the edge view of the surface.
- **Change of planes** - to locate the position of the change of plane or corner.

CENTER LINES

8.29  Center lines are alternate long and short thin dashes and are used for the axes of symmetrical parts and features, such as cylinders and drilled holes.

8.30A-B Correct center lines for holes and slots.

8.30C  Center lines should not terminate at another line or extend between views. Very short, unbroken center lines may be used to represent the axes of very small holes.

8.30D  Center lines as bolt circles.

8.30E  Center lines as paths of motion.

CREATING MULTIVIEW DRAWINGS

8.31  Some objects can be adequately described with only one view.

8.32  Cylindrical, conical, and pyramidal objects can be described with two views

8.33-38 Creating three view drawings by traditional and CAD methods.

8.39  Before a multiview drawing can be created four basic decisions must be made. Determine the best position of the object.

8.40  Select the views that will show the least amount of hidden features.

8.41  Determine the front view which should show the object in its natural view or assembled state, such as the front view of a car.

8.42  Determine the minimum number of views needed to describe the object.

8.43  Once the front view is selected, determine the other views needed to describe the object with the fewest number of lines.

EDGE VIEWS

8.44  An edge, or corner, is the intersection of two planes, and is represented as a line on a multiview drawing. A normal edge, or true-length line, is an edge that is parallel to a plane of projection and thus perpendicular to the line of sight.
8.45 An inclined edge, or line, is parallel to a plane of projection, but inclined to the adjacent planes and appears foreshortened in the adjacent views. Features are foreshortened when the lines of sight are not perpendicular to the feature. An oblique line is not parallel to any principal plane of projection, therefore, never appears in its true length or point in any of the six principal views.

NORMAL PLANES

8.46 A normal or principal plane is parallel to one of the principal planes of projection, and therefore is perpendicular to the line of sight.

A frontal plane is parallel to the front plane of projection and is true shape and size in the front and back views. (plane A)

A horizontal plane is parallel to the horizontal plane of projection and is true shape and size in the top and bottom views. (plane B)

A profile plane is parallel to the profile plane of projection and is true shape and size in the right and left views. (plane C)

A inclined plane is perpendicular to one plane of projection (edge) and inclined to adjacent planes (foreshortened), and cannot be viewed in true size and shape in any of the principal views. (plane D)

An oblique plane is oblique to all principal planes of projection. An oblique surface does not appear in its true shape or size, or as a line in any of the principal views: instead, an oblique plane always appears foreshortened in any principal view.

REPRESENTATIONS OF COMMON GEOMETRIC SHAPES

8.47 Multiview representations of common geometric shapes. A point represents a specific position in space and has no width, height, or depth. A point can represent:

The end view of a line.
The intersection of two lines.
A specific position in space.

8.48 A plane surface will always be represented by an edge (line) or an area (surface). Areas that are the same feature will always be similar in configuration from one view to the next, unless viewed on edge. Parallel features will be parallel in all views. Surfaces that are parallel to the lines of sight will appear as edges (lines).

8.49 Angles are true size when they are in a normal plane.

8.50 Curved surfaces are used to round the ends of parts and to show drilled holes and cylindrical features. Only the far outside boundary, or limiting element, of a curved surface is represented in multiview drawings.

8.51-52 Rounded ends or partial cylinders are represented in the circular view by arcs and by rectangles in the adjacent views. If the cylinder is tangent no change of plane is shown, but if tangency does not exist then a line is used to represent the change of plane between the partial cylinder and the prism.

8.53-54 An ellipse is used to represent a hole or circular feature that is viewed at an angle other than perpendicular or parallel.
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REPRESENTATION OF HOLES

8.55A A **through hole** is a hole that goes all the way through an object, is represented in one view as two parallel hidden lines for the limiting elements, and is shown as a circle in the adjacent view.

8.55B A **blind hole** is a hole that is not drilled all the way through the object.

8.55C **Counterbored holes** are used to allow the heads of bolts to be flush or below the surface of the part.

8.55D **Countersunk holes** are commonly used for flathead screws, and are represented by 45 degree lines.

8.55E A **spotface hole** provides a place for heads of fasteners to rest by creating a smooth surface on cast parts.

8.55F The representation of a **threaded hole** is shown. In all hole representations a line must be drawn to represent the change that occurs between the large and small diameter.

FILLETS, ROUNDS, AND CHAMFERS

8.56 A **fillet** is a rounded interior corner and a **round** is a rounded exterior corner normally found on a cast or forged part.

8.57 When a surface is to machined to a finish, a **finish mark** in the form of a v is drawn on the edge view of the surface to be machined.

8.58-59 Conventional practices used to represent fillets and rounds on multiview drawings.

8.60 A **chamfer** is a beveled corner used on the openings of holes and the ends of cylindrical parts, to eliminate sharp corners.

8.61-62 A runout is a special method of representing filleted surfaces that are tangent to cylinders.

CYLINDERS AND IRREGULAR CURVES

8.63-64 If a right cylinder is cut at an acute angle to the axis, an ellipse is created.

8.65 Irregular or space curves are created by plotting points along the curve in one view, and then transferring or projecting the points into the adjacent views.

8.66 When two cylinders intersect a line of intersection is formed.

8.67 When cylinders intersect prisms large prisms are represented using true projection, while small prisms are not.

8.68 When cylinders intersect cylinders large holes or slots are represented using true projection, while small holes and slots are not.

VISUALIZATION OF MULTIVIEW DRAWINGS

8.69 Visualization of multiview drawings by projection.
8.70 Visualization of multiview drawings by physical model construction.

8.71 Visualization of multiview drawings by decomposing the object into its basic geometric forms that create the object.

8.72-73 **Adjacent areas** are surfaces which reside next to each other. The boundary between the surfaces is represented as a line indicating a change in planes. No two adjacent areas can lie in the same plane and adjacent surfaces represent:

- Surfaces at different levels.
- Inclined surfaces.
- Cylindrical surfaces
- A combination of the above.

8.74 Similar-shaped surfaces retain their basic configuration or shape an all planer views.

8.75 When multiview drawings are created from a given pictorial view, surfaces can be labeled to check the accuracy of the solution.

8.76 Missing line problems can be used to develop visualization.

8.77 Vertices labeling can also be used to check the accuracy of multiview drawings.

8.78 Example of using the analysis by solids for the advancement of spatial abilities.

8.79-81 Example of using the analysis by surfaces for the advancement of spatial abilities.

8.82 No two contiguous areas can lie in the same plane.

**ANSI STANDARDS**

ANSI standards of multiview drawings form the common language used by engineers and technologists for communication information.

**PARTIAL VIEWS**

8.83 A **partial view** shows only what is necessary to completely describe the object. A conventional break line is placed in a location where it does not coincide with a visible or hidden line.

8.84 Partial views can be used to unnecessary geometry in a projection, including features which will primarily be shown in hidden lines and better seen in another view.

**REVOLUTIONS**

8.85 ANSI revolution conventions allow geometry to be revolved into positions that allow an object to be viewed true size and shape.

8.86 Objects can be revolved on bolt circles to eliminate hidden lines and improve visualization.

8.87 Inclined arms can also be revolved perpendicular to the line of sight to allow for better visualization of the object.

8.88 A removed view may have to be created that is at a different scale and thus cannot be aligned with the existing views.
SUMMARY

Multiview drawings are an important part of engineering and technical graphics. To create multiview drawings takes a high degree of visualization skill and much practice. Multiview drawings are created by closely following orthographic projection techniques and ANSI standards.

KEY TERMS

adjacent areas
adjacent views
alphabet of lines
analysis by solids
analysis by surfaces
blind hole
bottom view
central view
chamfer
change of planes
corner
counterbored hole
countersunk hole
deege
edge view
fillet
finish mark
fold line
foreshortened plane
frist-angle projection
front view
frontal plane
frontal plane of projection
horizontal plane
horizontal plane of projection
inclined line
inclined plane
left side view
line of sight (LOS)
multiview projection
multiview drawings
normal line
normal plane
oblique line
oblique plane
orthographic
parallel projection
partial view
perspective projection
plane of projection
point
principal line
principal views
profile plane
projection theory
rear view
removed view
revolution conventions
right side view
round
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QUESTIONS FOR REVIEW

1. Define orthographic projection.

2. How is orthographic projection different from perspective projection? Use a sketch to highlight the differences.

3. Define multiview drawings and make a simple sketch of an object using multiviews.

4. Define frontal, horizontal, and profile planes.

5. List the six principal views.

6. Define fold lines.

7. List the space dimensions found on a front view, top view and profile view.

8. Define a normal surface.


10. Define an oblique surface.

11. List the 8 rules of orthographic projection.

TRUE AND FALSE QUESTIONS

1. When laying out orthographic views, it is the usual practice to consider the frontal plane as lying in the plane of the paper and the horizontal and profile planes as being revolved into the frontal plane.

2. Perspective projection is sometimes substituted for parallel projection in a multiview projection.

3. The top view is always vertically above the front view, but the side view may not always be horizontally in line with the front view.

4. The right side view is created using the profile plane of projection.

5. The front of the object in both the top and side views faces the front view.

6. There are three principal views of an object.

7. First-angle projection is the multiview projection convention used in the United States.

8. Ordinarily, in selecting the front view, the object is placed to obtain the smallest number of hidden surfaces.

9. In making an orthographic multiview drawing, one view should be completed before starting the others.
10. The alphabet of lines is specified by ANSI standards.

11. Points of tangency between surfaces are represented with center lines in a multiview.

12. A fillet is a rounded interior corner.

13. In making any orthographic multiview drawing, true projection is never violated.
MULTIPLE CHOICE QUESTIONS

1. The selection of the front view in executing a multiview drawing of an object is dependent upon the following factors:
   a. size and shape of the object and their relationship to all views.
   b. the number of principal views required and the related auxiliary views needed to describe the object.
   c. the greatest contour shape, the related dashed lines, and the position of use.
   d. the size of the object, size of the paper, position of use, and least number of hidden lines

2. All of the following statements about multiview drawings are true, except:
   a. each view is a 3-D pictorial image
   b. based on orthographic projection
   c. at least two views of the object
   d. views are defined by planes of projection

3. Which type of projection does not have the projection rays parallel to each other?
   a. axonometric projection
   b. oblique projection
   c. orthographic projection
   d. perspective projection

4. Which is not a principal view?
   a. bottom
   b. left side
   c. auxiliary
   d. front

5. Principle planes will appear as:
   a. normal planes or edges
   b. oblique planes or edges
   c. normal planes or oblique planes
   d. skewed planes or edges

6. In orthographic projection, visual rays or lines of sight for a given view are ____________ to each other.
   a. perpendicular
   b. oblique
   c. normal
   d. parallel

7. What two types of projections give a pictorial view of the object without convergence?
   a. orthographic and perspective
   b. oblique and axonometric
   c. perspective and oblique
   d. isometric and orthographic
8. Inclined planes in a three-view drawing will appear as:
   a. two surfaces and one edge
   b. two edges and one surface
   c. three edges
   d. foreshortened in each view

9. Oblique planes in a three-view drawing will appear as:
   a. two surfaces and one edge
   b. two edges and one surface
   c. three edges
   d. three surfaces

10. Normal planes in a three-view drawing will appear as:
    a. one surface and two edges
    b. three surfaces
    c. one edge and two surfaces
    d. three edges

11. A viewing direction which is perpendicular to the surface in question gives a(n) __________ view.
    a. inclined
    b. normal
    c. oblique
    d. perspective

12. A viewing direction which is parallel to the surface in question gives a(n) __________ view.
    a. inclined
    b. normal
    c. edge
    d. perspective

13. When a surface of an object is inclined to a plane of projection, it will appear __________ in the view.
    a. foreshortened
    b. in true size and shape
    c. as a line
    d. as a point

14. What are the three principle planes in orthographic projection?
    a. front, top, profile
    b. back, top, profile
    c. top, front, right side
    d. frontal, horizontal, profile

15. The top view of an object should typically be drawn:
    a. to the right of the front view.
    b. anywhere on the same page.
    c. directly above the front view.
    d. on a separate piece of paper.

16. A horizontal surface of a multiview drawing will appear as a(n) __________ in the front view.
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a. edge
b. normal surface
c. point
d. foreshortened surface

17. Which view is usually developed first, contains the least amount of hidden lines, and shows the most contours in multiview drawings?
   a. right side
   b. top
   c. back
   d. front

18. A sphere can be described in how many views?
   a. 4
   b. 3
   c. 2
   d. 1

19. An asymmetric object is usually described by how many views?
   a. 6
   b. 3
   c. 4
   d. 2

20. An axially symmetric object, such as one turned on a lathe, normally can be shown in ________ view(s).
   a. one
   b. two
   c. three
   d. four

21. In orthographic projection, visual rays are __________ to the projection plane.
   a. parallel
   b. adjacent
   c. perpendicular
   d. tangent

22. The top and right side views have what common dimension(s)?
   a. height and width
   b. width and depth
   c. height
   d. depth

23. For orthographic projection, the engineering custom in the United States dictates the use of:
   a. first-angle projection
   b. second-angle projection
   c. third-angle projection
   d. fourth-angle projection
24. For orthographic projection, the engineering custom in Europe dictates the use of:
   a. first-angle projection
   b. second-angle projection
   c. third-angle projection
   d. fourth-angle projection

25. The sequence for the direction of view (or line of sight) for any orthographic projection as utilized in the United States is:
   a. eye of observer>projection plane>object
   b. eye of observer>object>projection plane
   c. projection plane>object>eye of observer
   d. projection plane>eye of observer>object

26. Depending on its relationship to the projection plane on which the view is projected, a line may project:
   a. true length
   b. foreshortened
   c. as a point
   d. all of the above

27. If a surface on an object is parallel to one of the principal planes of projection, then the angular relationship of that surface to at least two other principal projection planes is:
   a. parallel
   b. perpendicular
   c. inclined
   d. unknown

28. Good practice dictates that the characteristic contour shape of the object be shown in what view?
   a. top
   b. front
   c. right side
   d. any side

29. The height, width, and depth of an object can be shown with a minimum of how many orthographic projection views?
   a. six
   b. three
   c. two
   d. four

30. Which of the following pairs of orthographic views both show the height dimension?
   a. left side and front
   b. top and front
   c. top and rear
   d. bottom and right side