

Multiview Drawing with Instruments

15.1 Introduction

Multiview drawing, the system of representing three-dimensional objects by separate views arranged in a standard manner, is readily understood by the technical community. Because multiview drawings are usually executed with instruments and drafting aids, they are often called **mechanical drawings**. They are called **working**, or **detail drawings**, when dimensions and notes are added to complete the specifications of the parts that have been drawn.

15.2 Orthographic Projection

The artist is likely to represent objects impressionistically, but the drafter must represent them precisely. The method of preparing a precise, detailed, clearly understood drawing is **orthographic projection**, or **multiview drawing**.

By **orthographic projection**, the views of an object are projected perpendicularly onto projection planes with parallel projectors (Fig. 15.1).

The front view is projected onto a vertical frontal plane with parallel projectors. The resulting front view is two dimensional since it has no depth and lies in a single plane described by two dimensions, width and height.

The top view of the same object is projected onto a horizontal projection plane perpendicular to the frontal projection plane in Fig. 15.2A. The right-side view is projected onto a vertical profile plane perpendicular to both the horizontal and frontal planes (Fig. 15.2B).

Imagine that the same object has been enclosed in a glass box showing the frontal, horizontal, and profile projection planes (Fig. 15.3). While in the glass box, the object's views are projected onto the projection planes. Then the box is opened into the plane of the drawing surface to give the standard positions for the three orthographic views.

A similar example of this principle is shown by the object in the projection box in Fig. 15.4. The three views are positioned in the same manner: the top view over the front view and the right-side view to the right of the front view.

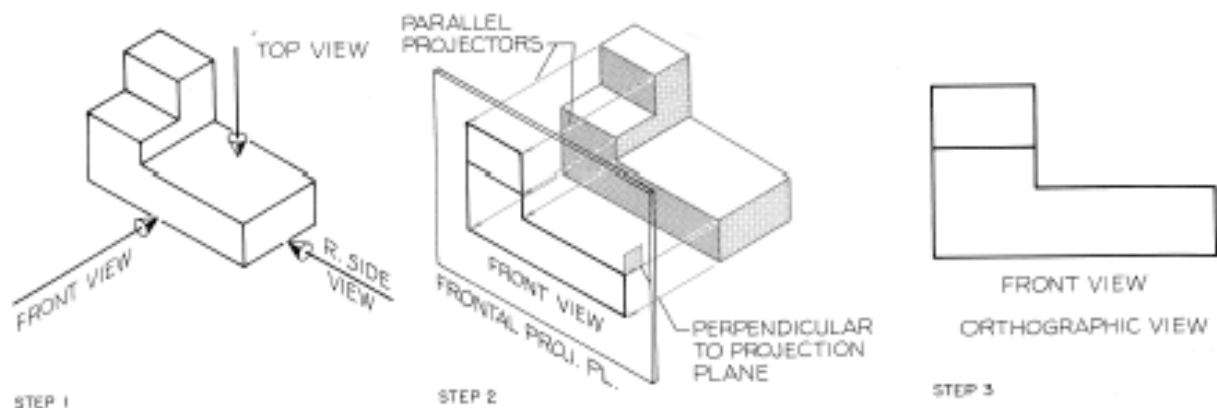


Figure 15.1 Orthographic projection.

Step 1 Three mutually perpendicular lines of sight are drawn to obtain three views of the object.

Step 2 The frontal plane is a vertical plane on which the front view is projected with parallel projectors perpendicular to the frontal plane.

Step 3 The resulting view is the front view of the object. This is a two-dimensional orthographic view.

The three principal projection planes of orthographic projection are the **horizontal (H)**, **frontal (F)**, and **profile (P)** planes.

Any view projected onto one of these principal planes is a **principal view**. The dimensions of an object used to show its three-dimensional form are height (H), width (W), and depth (D).

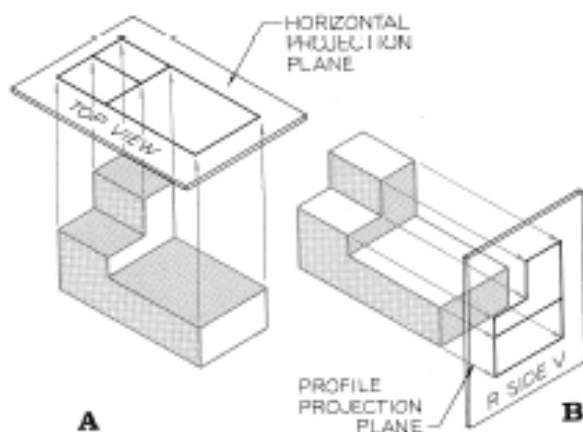


Figure 15.2 (A) The top view is projected onto a horizontal projection plane. (B) The right-side view is projected onto a vertical profile plane perpendicular to the horizontal and frontal planes.

15.3 Alphabet of Lines

Using proper line weights will greatly improve a drawing's readability and appearance. All lines should be drawn dark and dense, as if drawn with ink. Only by their width should the lines vary—except, that is, for guidelines and construction lines, which are drawn very lightly for lettering and laying out drawings.

The lines of an orthographic view are labeled, along with the suggested pencil grades for drawing them, in Fig. 15.5. The lengths of dashes in hidden lines and centerlines are drawn longer as the size of a drawing increases. Figure 15.6 gives additional specifications for these lines.

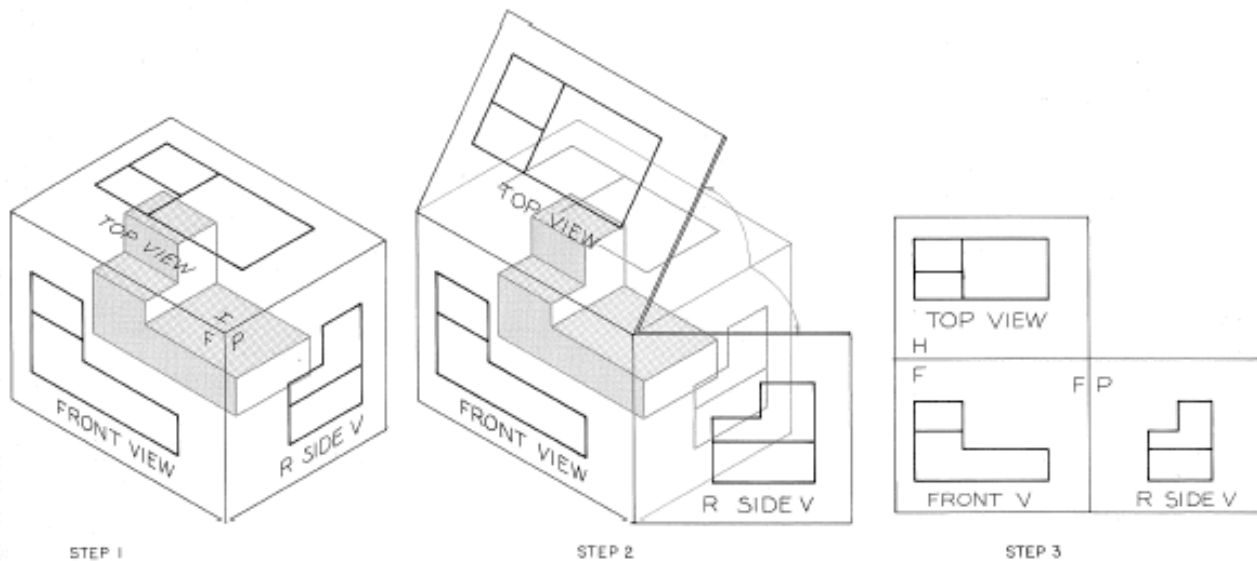


Figure 15.3 Glass-box theory.

Step 1 Imagine that the object has been placed inside a box formed by the horizontal, frontal, and profile planes onto which the top, front, and right-side views have been projected.

Step 2 The three projection planes are then opened into the plane of the drawing surface.

Step 3 The three views are positioned with the top view over the front view and the right-side view to the right. The planes are labeled *H*, *F*, and *P* at the fold lines.

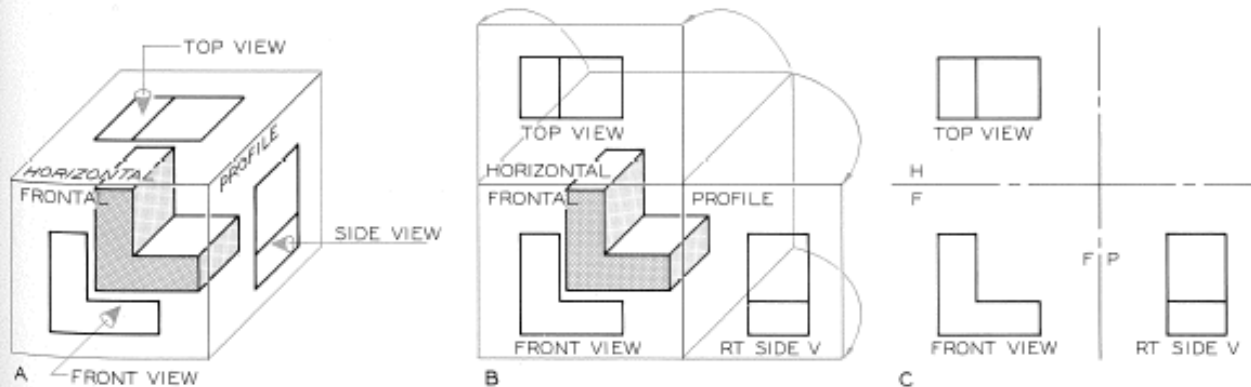


Figure 15.4 Principal projection planes. (A) The three principal projection planes of orthographic projection can be thought of as planes of a glass box. (B) The views of an object are projected onto the projection planes, which are opened into the plane of the drawing surface. (C) The outlines of the planes are omitted. The fold lines are drawn and labeled.

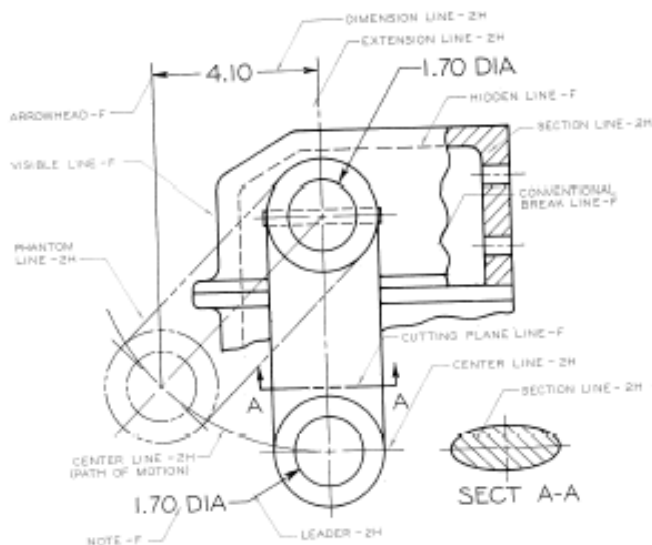


Figure 15.5 The line weights and suggested pencil grades recommended for orthographic views.

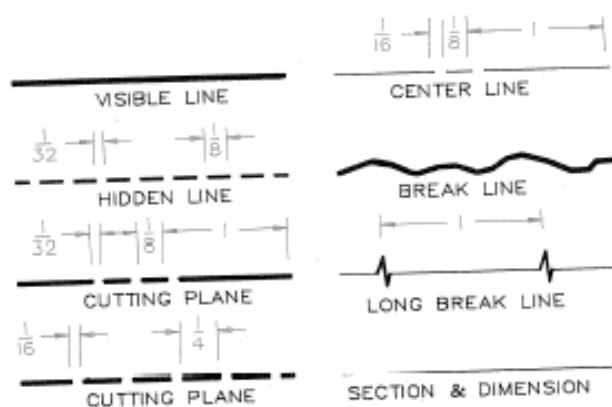


Figure 15.6 A comparison of the line weights for orthographic views. These dimensions will vary for different sizes of drawings and should be approximated by eye.



Computer Lines Smaller computer graphics plotters vary the widths of lines on a drawing by multiple-pen accessories that hold pens of different point widths, usually 0.7 mm and 0.3 mm wide. AutoCAD provides a command, **LTSCALE**, that varies dash and space lengths in dashed lines (Fig. 15.7).

A comparison of lines drawn with **LTSCALE**s of 0.4 and 0.2 and pen widths of 0.7 mm and 0.3 mm is given. Once the drawing has been com-

pleted, the line scales are changed with the **LTSCALE** command by changing one number (from 0.4 to 0.2 in this example), and the views are automatically redrawn to show the revised lines (Fig. 15.8).

VISIBLE: 0.7 mm
HIDDEN: 0.3 mm
CENTER: 0.3 mm
CUTTING PLANE: 0.7 mm
LTSCALE = 0.4

STEP 1

VISIBLE: 0.7 mm
HIDDEN: 0.3 mm
CENTER: 0.3 mm
CUTTING PLANE: 0.7 mm
LTSCALE: 0.2

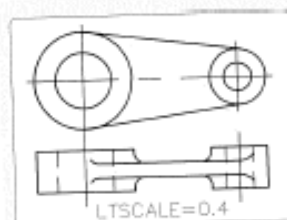
STEP 2



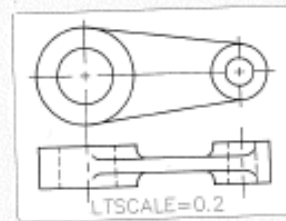
Figure 15.7 Line weights by computer.

Step 1 These lines were drawn using AutoCAD's standard **LINETYPE**s and two pens. The **LTSCALE** factor was 0.4, which affects the spacing between the dashes and the lengths of the dashes.

Step 2 By changing the **LTSCALE** factor from 0.4 to 0.2, the dashes and the spaces between them are reduced in size.



STEP 1



STEP 2



Figure 15.8 Line weights by computer.

Step 1 This two-view drawing was made using an **LTSCALE** of 0.4, which resulted in the omission of dashes in centerlines and hidden lines with dashes that were too long.

Step 2 By activating **LTSCALE** and giving a factor of 0.2, the views are redrawn, and centerlines and hidden lines appear with the appropriate dashes.

15.4 Six-View Drawings

If you visualize an object placed inside a glass box, you will see there are two horizontal planes, two frontal planes, and two profile planes (Fig. 15.9).

Therefore, the maximum number of principal views that can be used to represent an object is six.

The top and bottom views are projected onto horizontal planes, the front and rear views onto frontal planes, and the right- and left-side views onto profile planes.

To draw the views on a sheet of paper, imagine the glass box is opened up into the plane of the drawing paper; the views will then appear as shown in Fig. 15.10. The top view is placed over, and the bottom view under the front view; the right-side view is to the right of, and the left-side

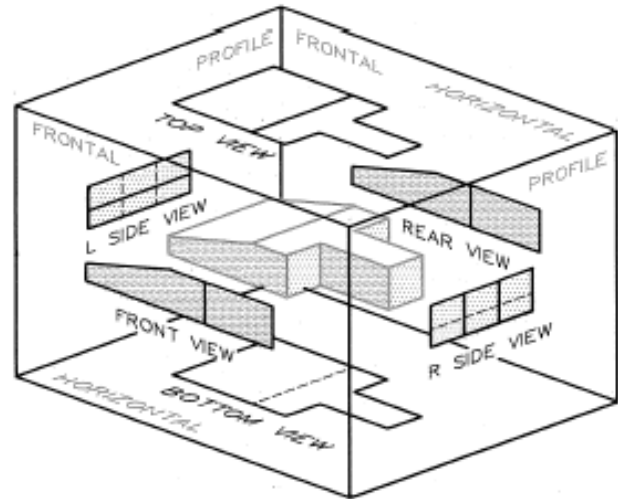


Figure 15.9 Six principal views of an object can be drawn in orthographic projection. You can imagine that the object is in a glass box with the views projected onto the six planes.

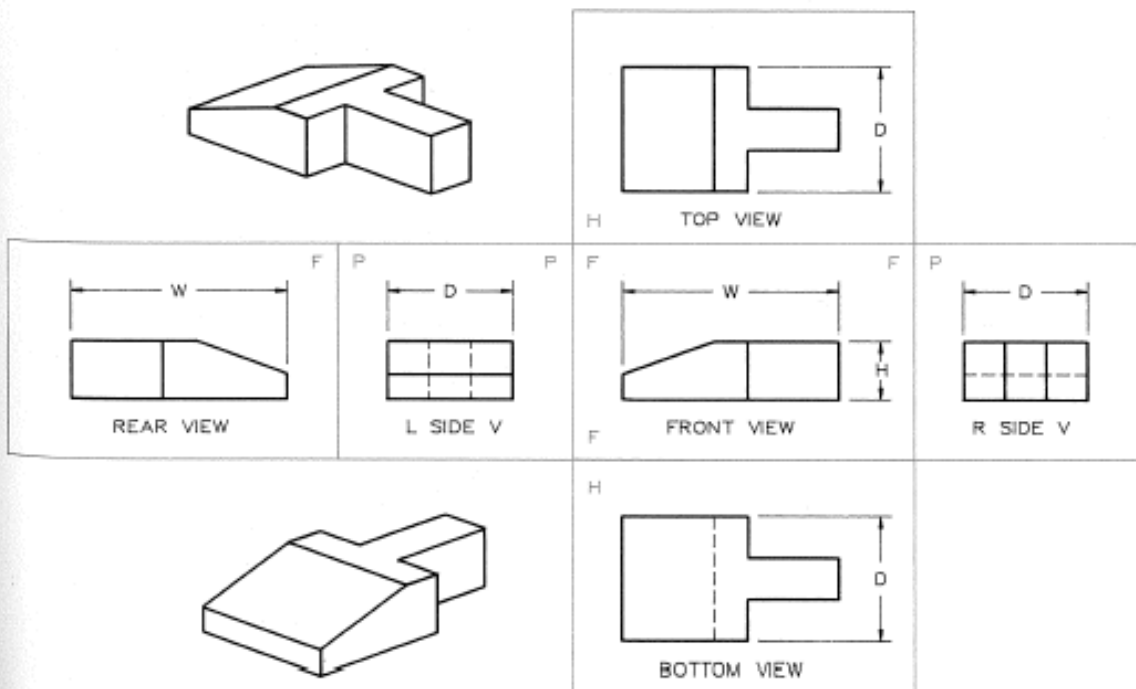


Figure 15.10 Once the box is completely opened into a single plane, the six views are positioned to describe the object. The outlines of the planes are usually omitted. They are shown here to help you relate this figure to Fig. 15.9.

view to the left of the front view; the rear view is to the left of the left-side view.

Height, width, and depth are three dimensions of an object necessary to give its size. The standard arrangement of the six views allows some of the views to share dimensions by projection. For example, the height dimension, which is shown only once between the front and right-side views, applies to the four horizontally arranged views. Furthermore, the width dimension is placed between the top and front views, but it also applies to the bottom view.

Projectors align the views both horizontally and vertically about the front view in Fig. 15.10. Each side of the fold lines of the glass box is labeled H, F, or P (horizontal, frontal, or profile) to identify the projection planes on a given side of the fold lines.

15.5 Three-View Drawings

Because three views are usually adequate to describe an object, the most commonly used orthographic arrangement is the **three-view drawing**.

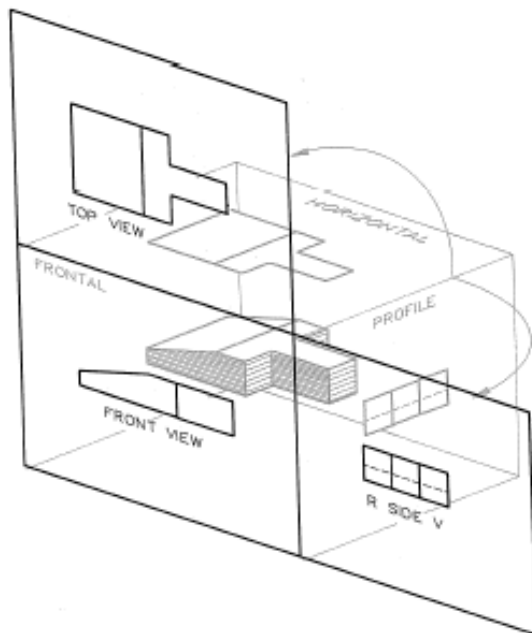


Figure 15.11 Three-view drawings are commonly used for describing small machine parts. The glass box is used to illustrate how the views are projected onto their projection planes.

ing, consisting of front, top, and right-side views. The object used in the previous example is shown placed in a glass box in Fig. 15.11, which is opened onto the plane of the drawing surface. The resulting three-view arrangement is shown in Fig. 15.12, where the views are labeled and dimensioned.

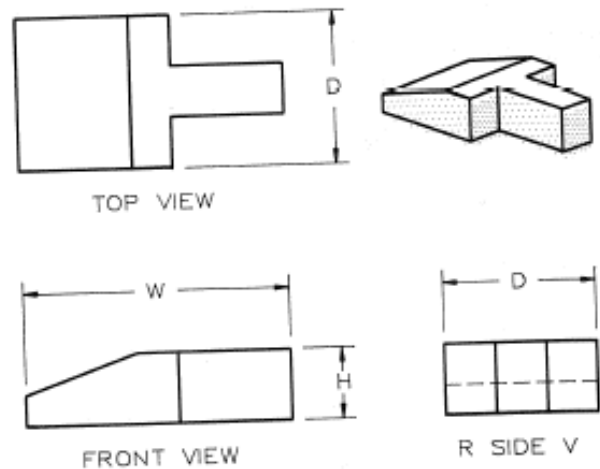


Figure 15.12 The resulting three-view drawing of the object from Fig. 15.11.

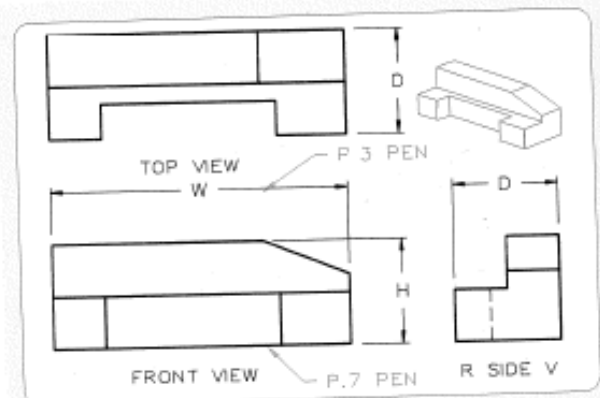


Figure 15.13 This three-view orthographic drawing was made by AutoCAD and an A-B size plotter using two pen sizes (0.7 mm and 0.3 mm). The same principles of orthographic projection are used whether drawings are made manually or by computer.

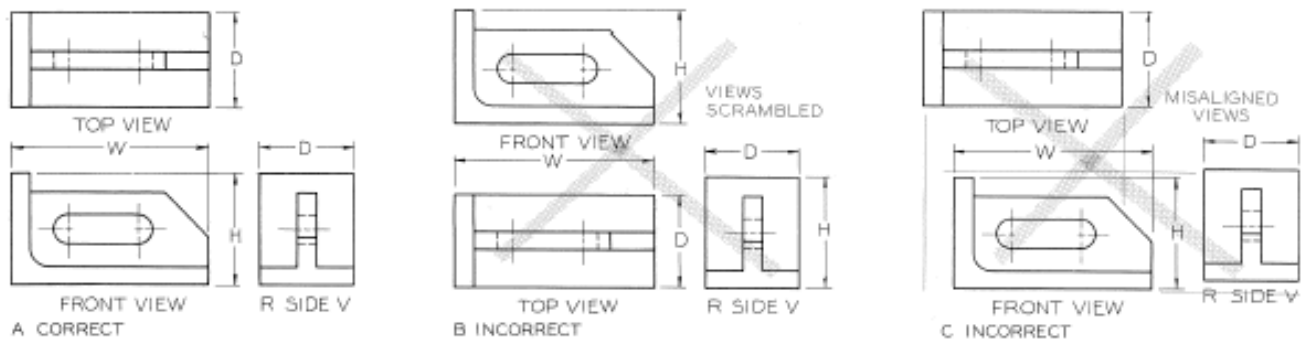


Figure 15.14 Positioning orthographic views. (A) This is a correct arrangement of views, labels, and dimensions. The views project from each other in proper alignment. (B) These views are scrambled into unconventional positions, making it hard to interpret them. Dimensions are needlessly repeated. (C) These views are misaligned, so they do not project from one to the other. This is an incorrect arrangement.



Computer Views The three-view drawing of a part (Fig. 15.13) was drawn by using two pen widths, 0.7 mm and 0.3 mm, and the DRAW and DIMENSION commands of AutoCAD.

are properly labeled and dimensioned. Views that are arranged in a nonstandard sequence (Fig. 15.14B) and that do not project from view to view (Fig. 15.14C) are incorrect. Figure 15.15 emphasizes these rules of arrangement and dimensioning.

15.6 Arrangement of Views

Figure 15.14A shows the standard positions for a three-view drawing: The top and side views are projected directly from the front view. The views

15.7 Selection of Views

When drawing an object by orthographic projection, you should select the views with the fewest hidden lines. In Fig. 15.16, Example 1, the right-side view is preferred to the left-side view because it has fewer hidden lines.

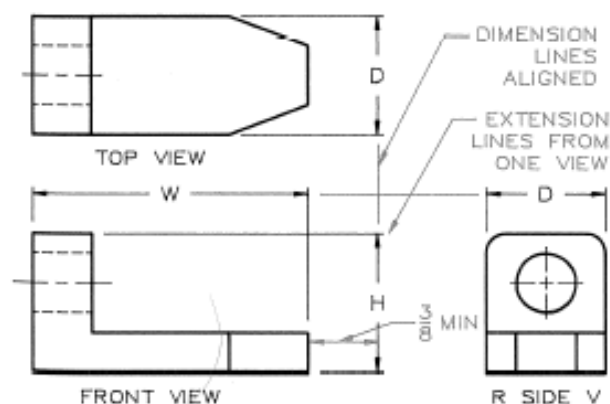


Figure 15.15 Dimension and extension lines used in three-view orthographic projection should be aligned. Notice that extension lines are drawn from only one view when dimensions are placed between two views.

Although the three-view arrangement of top, front, and right-side views is the most commonly used, the top, front, and left-side views is equally acceptable (Fig. 15.16, Example 2) if the left-side view has fewer hidden lines than the right-side view.

The most descriptive view is usually selected as the front view. Some objects have standard views that are regarded as the front view, top view, and so forth. A chair, for example, has front and top views that are recognized as such by everyone; therefore, a chair's accepted front view should be used as the orthographic front view.