3. INTERPRETATION OF DRAWINGS:

Fabrication drawings (also called detail or part drawings) are used to communicate the design intent to the “fabricator”. To avoid ambiguities in interpretation, these drawings are prepared according to specific “rules”.

3.1 Orthographic projection:

Orthographic projection defines the choice of views of a part and their location with respect to each other. Orthographic means at right angles to each other and refers to the lines of sight used to describe a 3-dimensional object on 2-dimensional paper or a 2-dimensional computer screen.

For simple parts a single view may be enough to fully describe the shape of the part; Figure 3.1.1 defines the shape of a (flat) part, the note at the bottom defines it’s thickness.

Once parts become a bit more complex and of varying thickness, additional views will be required to fully describe the part.

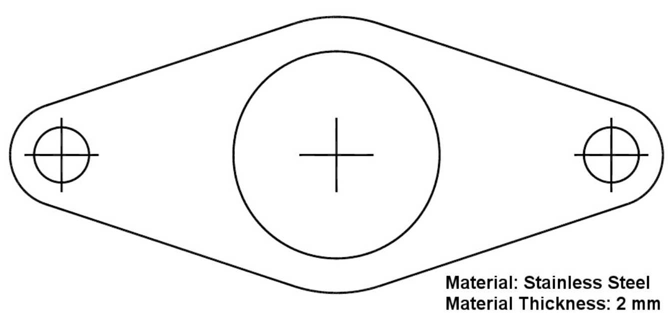

Figure 3.1.1: Single View of a Part

Orthographic projection theory requires that any additional views are horizontally or vertically aligned with the principal (first) view.

The following figures will be used to show the concept of multi-view drawings based on orthographic projection principles:

Figure 3.1.2: Bracket

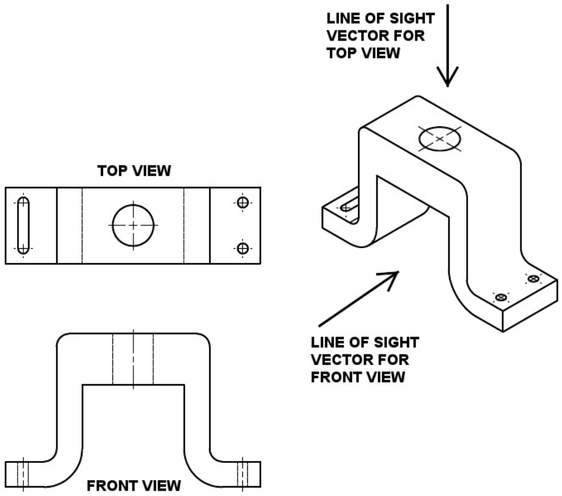

Figure 3.1.3: Two View Representation of Bracket

The top view MUST be vertically aligned with the front view.

Any left side view or right side view must be horizontally aligned with the principal (front) view.

The third view in this example is only for illustration purposes and is normally not needed.

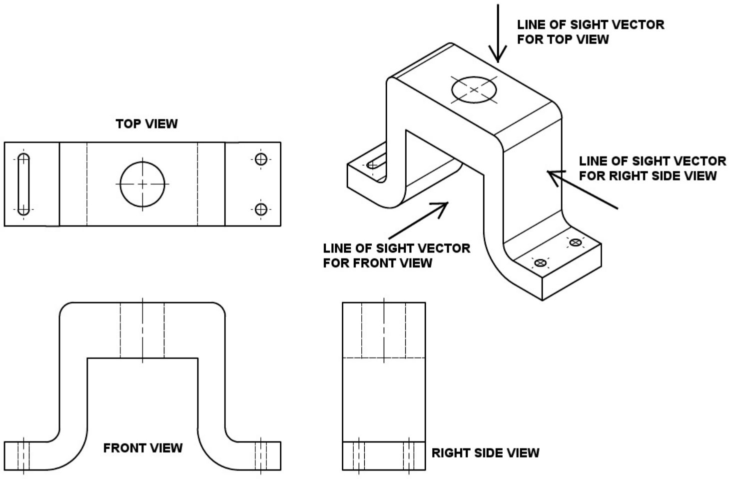

Figure 3.2.4: Three View Representation of Bracket

Another example of a three-view drawing:

Figure 3.1.5: Support Bracket

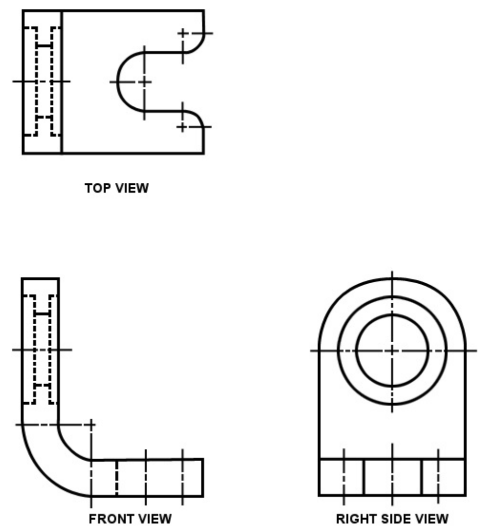

Figure 3.1.6: Three View Alignment

Figure 3.1.6 shows a 3-view representation of the support bracket from Figure 3.1.5. Note that on standard drawings the specific views will not be labelled.

More than 3 orthographic views are rarely required to fully describe (and dimension) a part. Only very complex parts may require more than 3 orthographic views.

To complicate matters somewhat, there are two different approaches to orthographic projection:

-third angle projection, used in North America

-first angle projection, used in the rest of the world.

So far we have only looked at third angle projection, since this is used here.

Figure 3.1.7 shows a part in third angle projection, Figure 3.1.8 shows the same part in first angle projection.

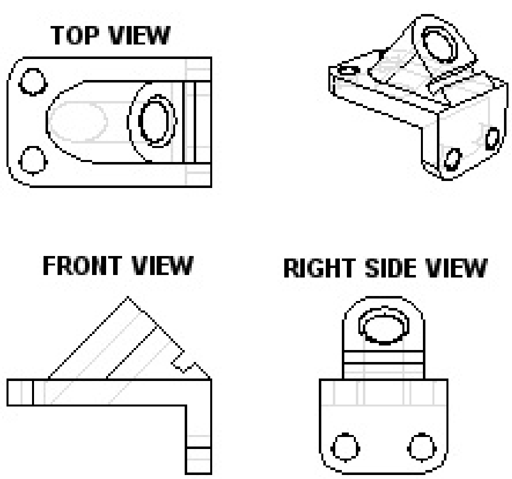

Figure 3.1.7: Third Angle Projection

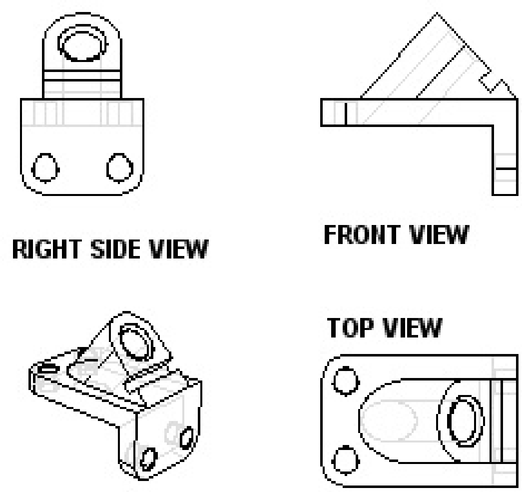

Figure 3.1.8: First Angle Projection

To avoid confusion, drawings must be identified by means of the symbols shown in Figure 3.1.9 as either first angle or third angle projection drawings. These symbols are either part of the title-block of a drawing or they are placed close to the title-block.

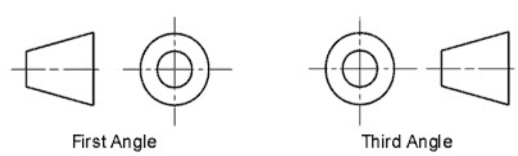

Figure 3.1.9: Type of Projection Identifier

3.2 Line-types:

In Figures 3.1.3, 3.1.4 and 3.1.6 you will have noticed the use of 3 line-types: continuous (solid), dashed and dash-dot. Based on their purpose they are commonly referred to as: visible, hidden and centre lines.

By convention: all edges of a part which are fully visible in a particular view, must be represented by solid lines in that view; edges which are obscured (not visible) must be shown as hidden lines. Centre lines are used to define the centres of holes and the axes of cylinders; they can also be used to define axes of symmetry.

The use of different line-types contributes significantly to the clarity of views and drawings. Figures 3.2.1 shows the same part as Figure 3.1.6 on page 69, but without hidden or centre lines. Figure 3.2.2 shows the same part with hidden and centre lines.

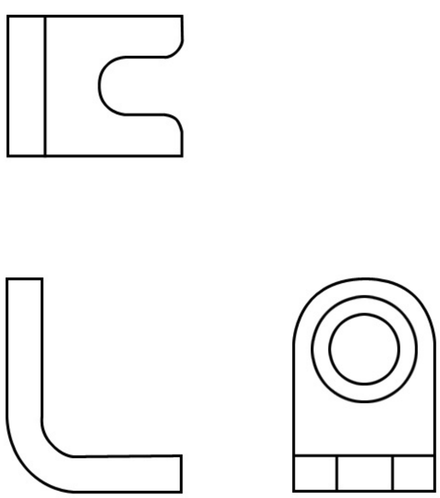

Figure 3.2.1: No Hidden or Centre Lines

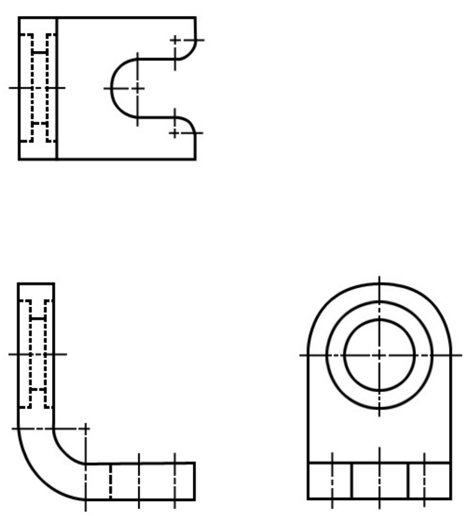

Figure 3.2.2: With Hidden and Centre Lines

3.3 Sectioned views:

Sectioned views, which are standard orthographic views, are used to make hidden part features, which would otherwise have to be shown in hidden lines, fully visible in a particular view.

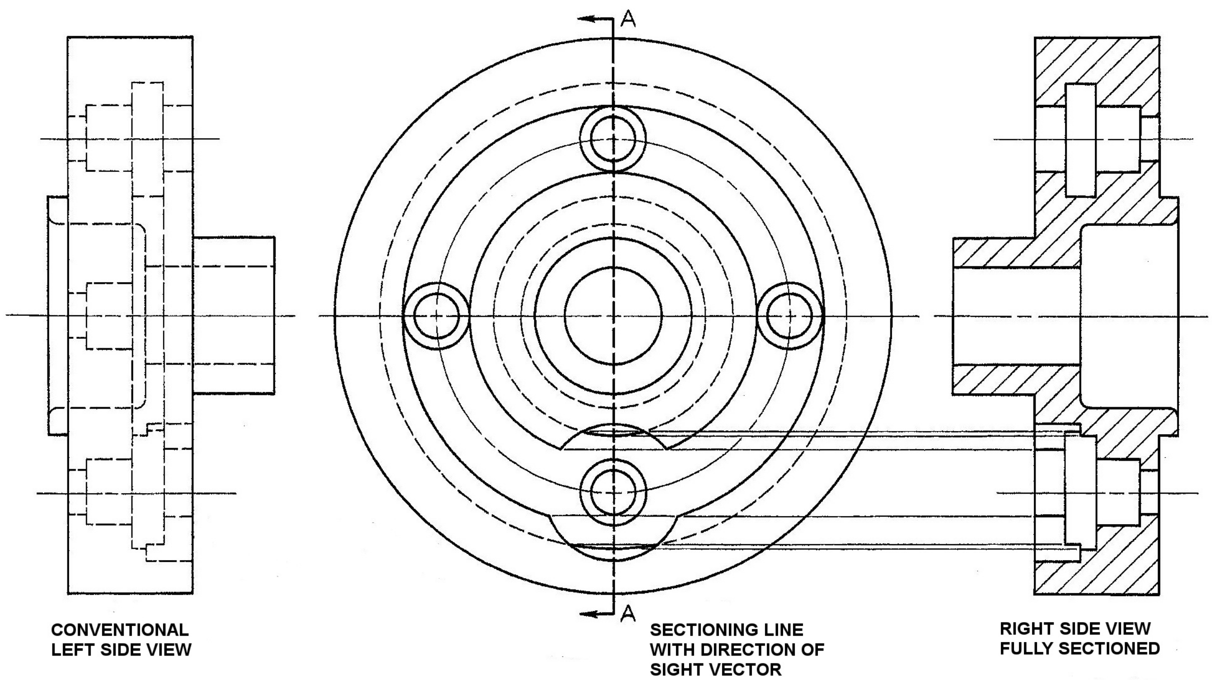

Figure 3.3.1: Comparison of Conventional Left Side View with Fully Sectioned Right Side View

The sectioned view provides a much clearer “picture” of the part. This view is arrived at by cutting the part, as shown in the front view, along a sectioning line (actually a plane) and by removing the right half of the part, as shown in Figure 3.3.2 on the next page.

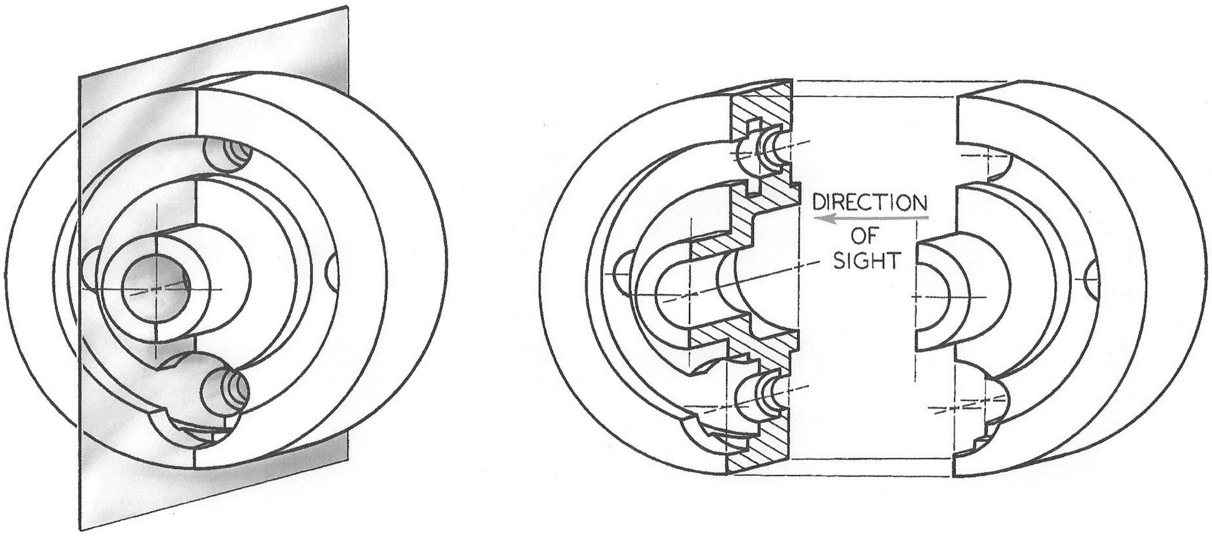

Figure 3.3.2: Sectioning Process

Although different types of sections can be used in the preparation of drawings, they all have one common identifier: cross-hatched faces (indicating that the “interior” of a part has been exposed).

Other examples of sections:

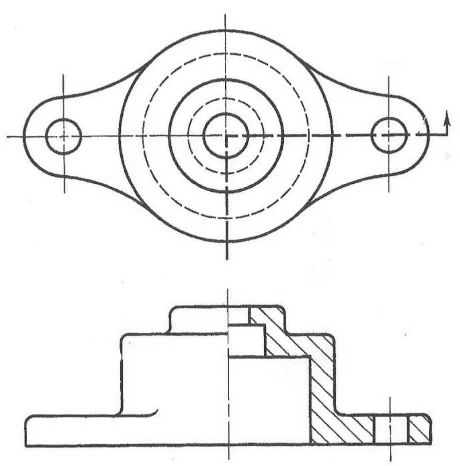

Figure 3.3.3: Half Section

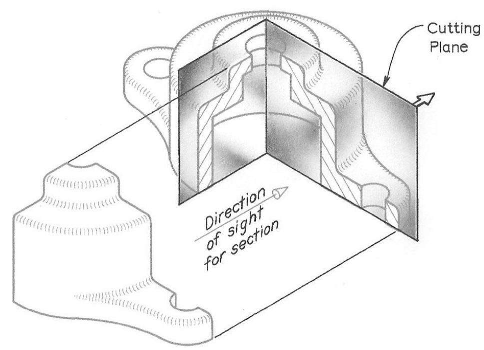

Figure 3.3.4: Cutting Plane for Half Section

Another type of section that is quite frequently used is the so-called broken-out section:

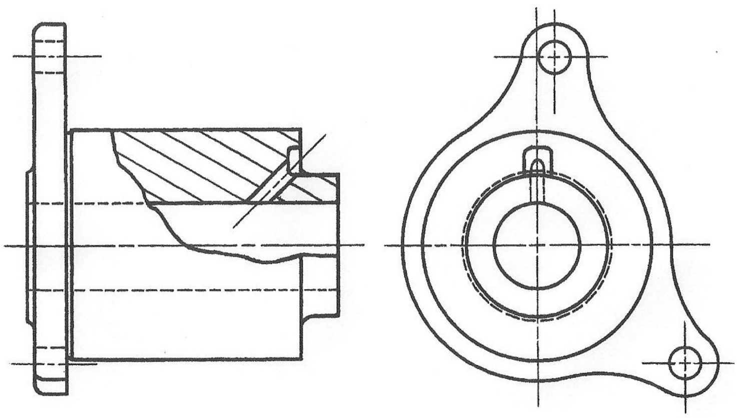

Figure 3.3.5: Broken-out Section

In this case there is no cutting plane, simply an irregular break line.

Some examples of multi-view drawings:

Example 1:

The front view shows the whole part, the right side view is a sectioned view of the part as seen from the right side.

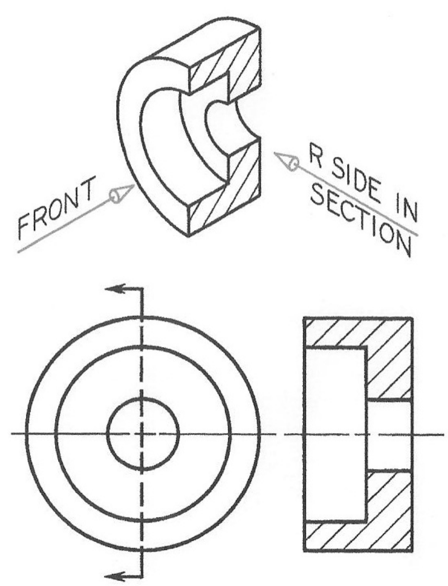

Figure 3.3.6: Two View Drawing

Example 2:

This is a drawing consisting of a top view and a sectioned front view (this type of section is called an offset section). Based on these 2 views, the 3-dimensional shape of the part can be pictured.

Sketch or form a mental image of the actual part.

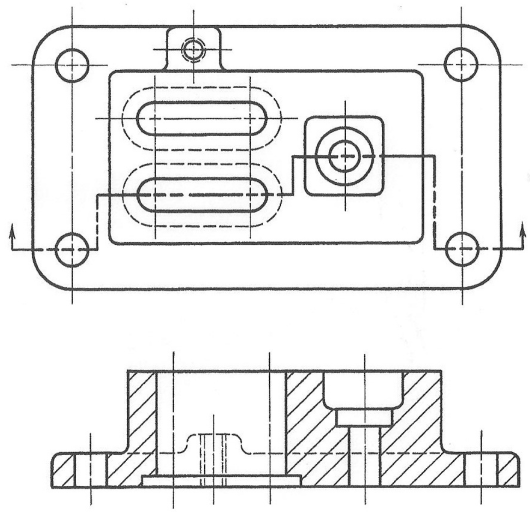

Figure 3.3.7: Two View Drawing

Example 3:

Based on the 3 views shown, what does the 3-dimensional part look like?

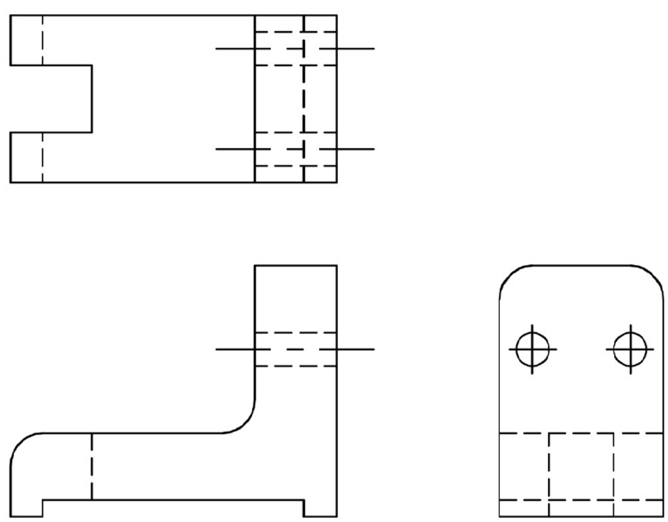

Figure 3.3.8: Three View Drawing

Solutions:

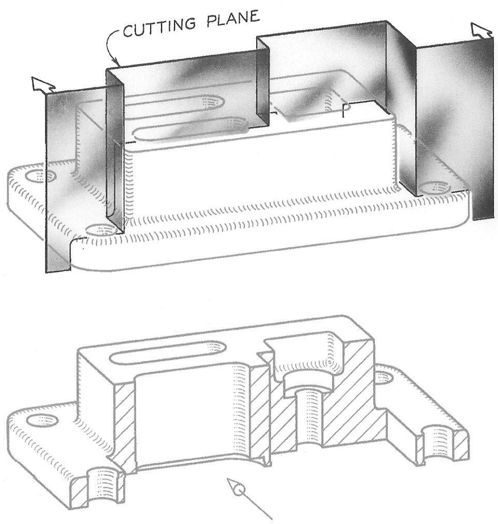

Figure 3.3.9: 3-Dimensional Image of Example 2

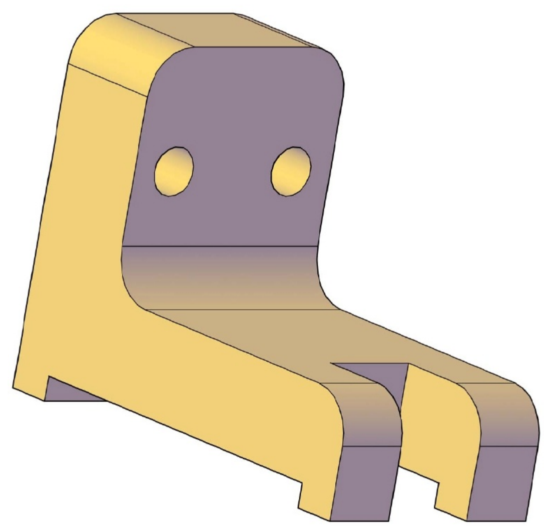

Figure 3.3.10: 3-Dimensional Image for Example 3

3.4 Thread representation:

Showing threads as they actually appear, would be very time consuming.

Instead, threads are typically shown in what is called a "simplified" representation.

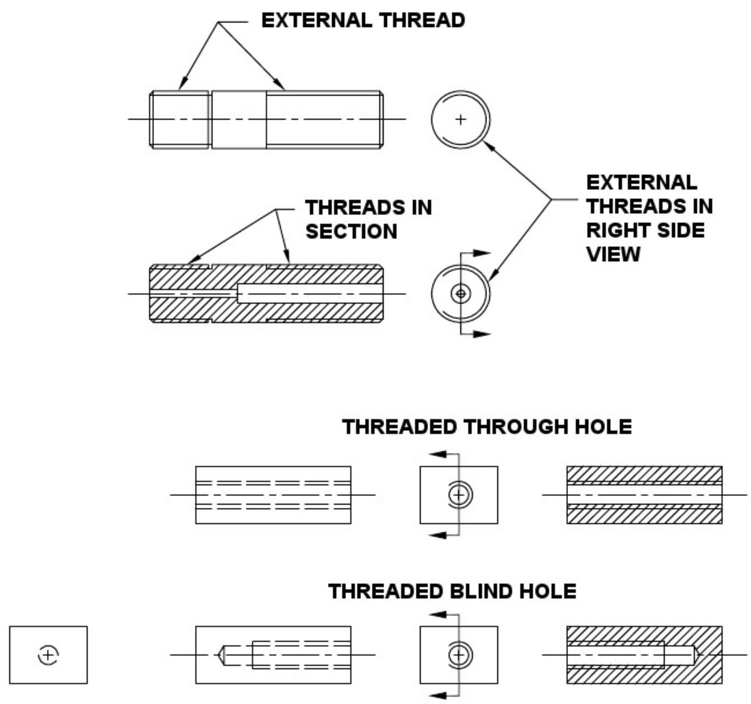

Figure 3.4.1: Simplified Canadian Thread Representation

Some drawings still use an outdated form of the so-called "schematic" representation:

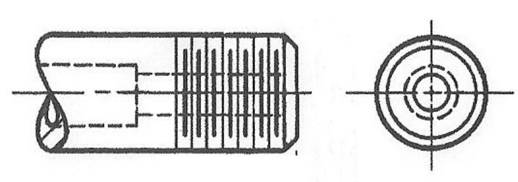

Figure 3.4.2: Schematic Thread Representation

3.5 Dimensioned drawings:

So far we have looked at the arrangement and type of views as well as the line-types used in those views to represent a 3-dimensional object 2-dimensionally.
In order to be able to produce a part from drawings it is necessary that all critical dimensions are shown on the respective views.

Shown dimensions always define the true size of a feature, even if the views are not drawn to actual size.

Note: never use rulers or scales to determine the dimension of a feature from a view in a drawing.

Dimensions and other notes on drawings are often referred to as “call-outs”.

Most dimensions are easy to interpret:

-the value of 48.00 in the front view of Figure 3.5.1 defines the distance between the centre of the large hole and the centre of the smaller hole on the left

-numeric values preceded by "R" define a radius

-numeric values preceded by ∅ define a diameter

-if dimensions are preceded by, for example "2 x" (R17.00), that means that the radius of 17.00 units occurs twice

-"M6.00 x 1" specifies the size and type of a threaded hole (see chapter 1.5.3, page 45)

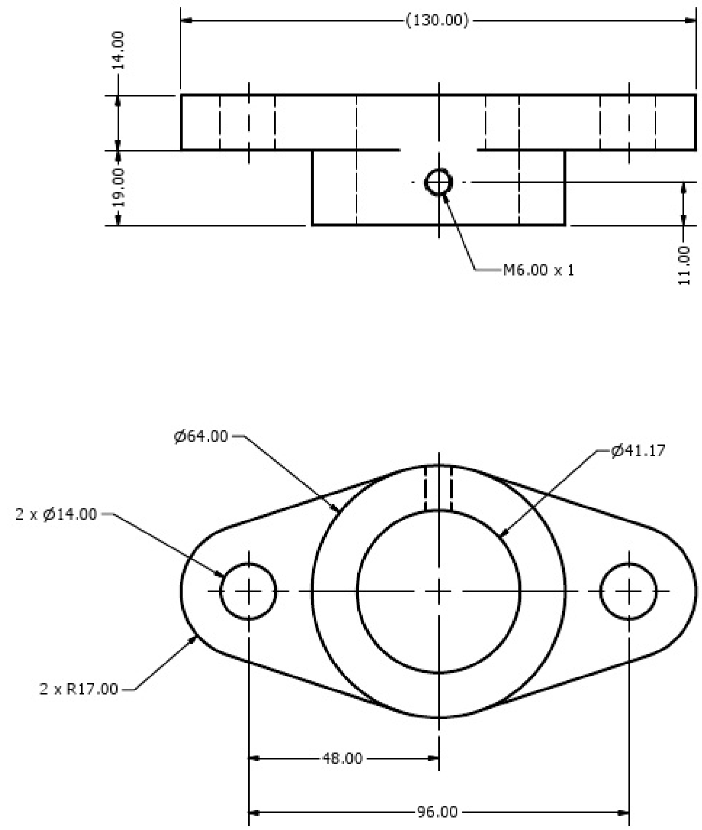

Figure 3.5.1: Dimensioned Front and Top Views

-dimensions in brackets, such as (130.00) are so-called redundant dimensions which could have been found by adding up other dimensions; in the case of this drawing: add 96.00 + 2(17.00) = 130.00

-in Figure 3.4.2 an angle is defined using the "°" symbol: this dimension means that the 3 "ears" are each 120 degrees apart.

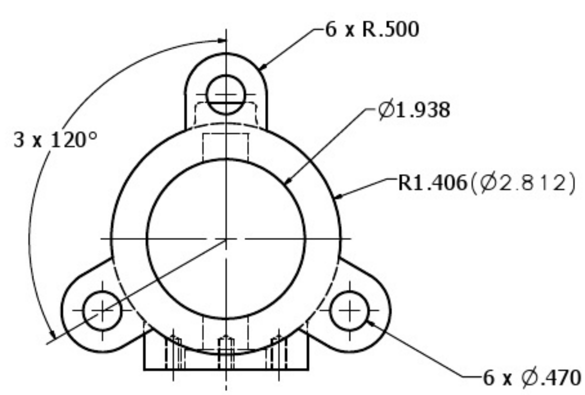

Figure 3.5.2: Dimensioned View

The call-outs on this view are more complex:

⌴ this symbol means "Counter-bore" (see Chapter 1.1.3)

↧ this symbol is a "depth" indicator

⌵ this symbol is a "Counter-sink" symbol (see Chapter 1.1.3); it does not appear in the view on the right.

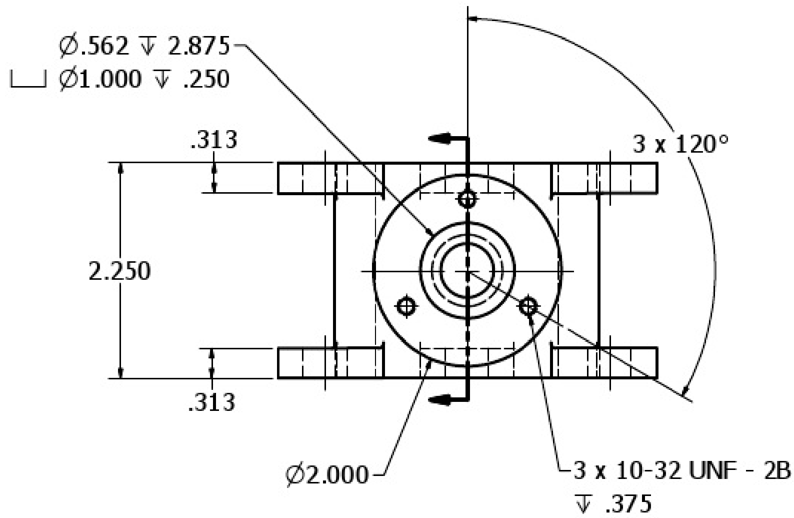

Figure 3.5.3: Special Dimensions

Ø.562 ↧ 2.875
⌴ Ø1.000 ↧ .250

The call-out on the left means:
drill a hole of 0.562" diameter to a depth of 2.875" and produce a counter-bore, diameter 1.000" with a depth of 0.250" that is coaxial with the 0.562" diameter hole.

The part from which the above views were taken, is shown below:

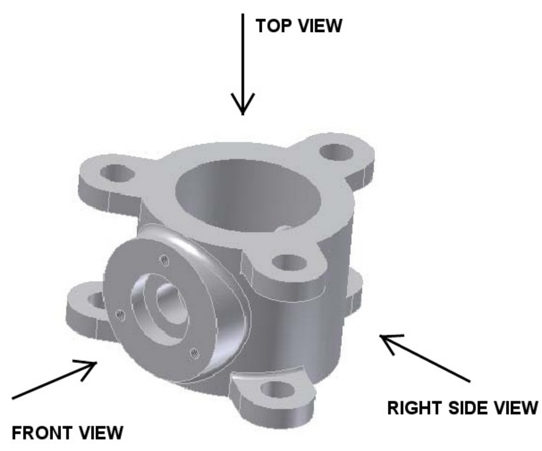

Figure 3.5.4: Valve Body

The complete drawing for this part is shown below:

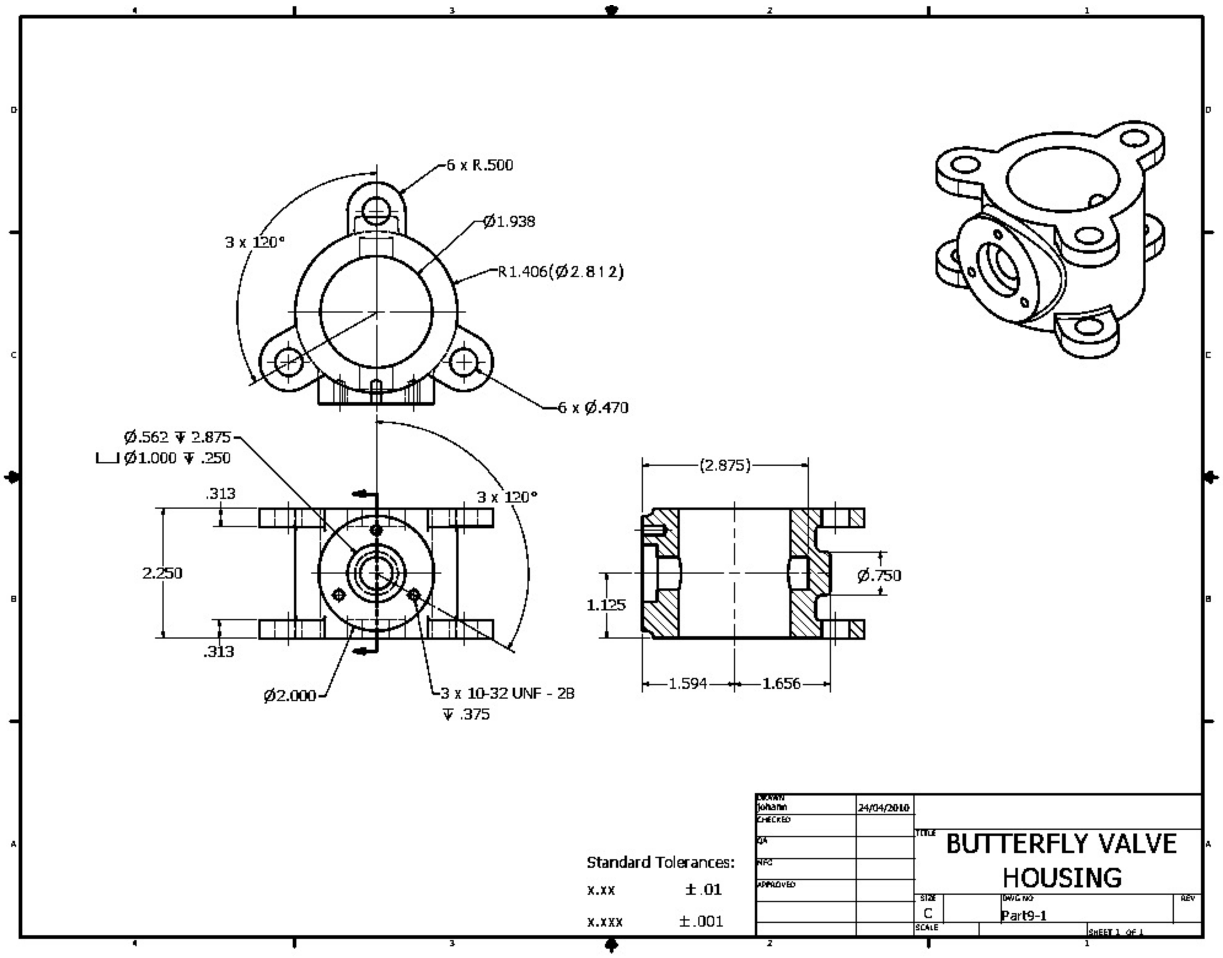

Figure 3.5.5: Detail or Fabrication Drawing

Note that general tolerances are always shown as part of, or next to, the title-block. Tolerances which only apply to one dimension will be shown as part of the dimension.

3.6 Special annotations:

3.6.1 Surface texture:

Sometimes this is referred to as surface finish: it defines surface parameters such as roughness, direction of cut and waviness.

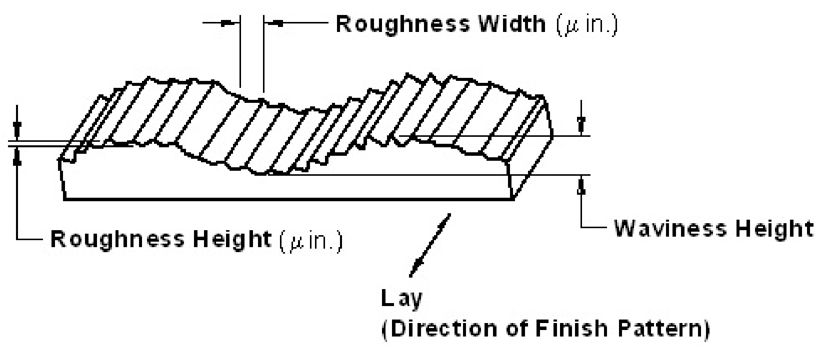

Figure 3.6.1: Surface Texture Terminology

Note that roughness height and roughness width are measured in micro-inches or micro-metres and must not be compared to dimensional tolerances which are typically in the range of 0.00x" or 0.0x [mm].

Symbols used to specify surface texture:

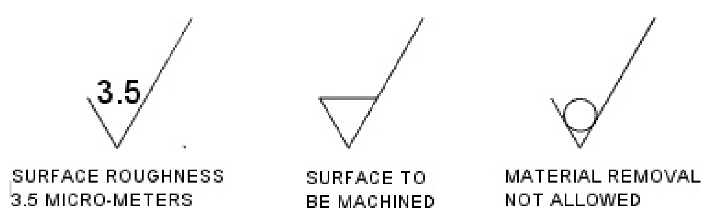

Figure 3.6.2: Surface Texture Symbols

Surface texture symbols can be much more complex and define many more parameters:

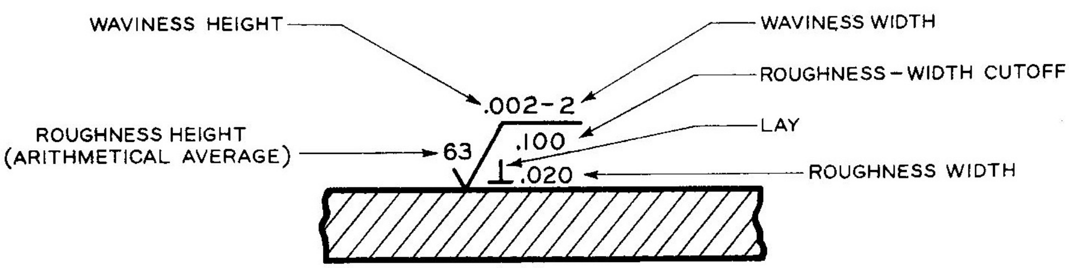

Figure 3.6.3: Theoretical Surface Texture Call-out

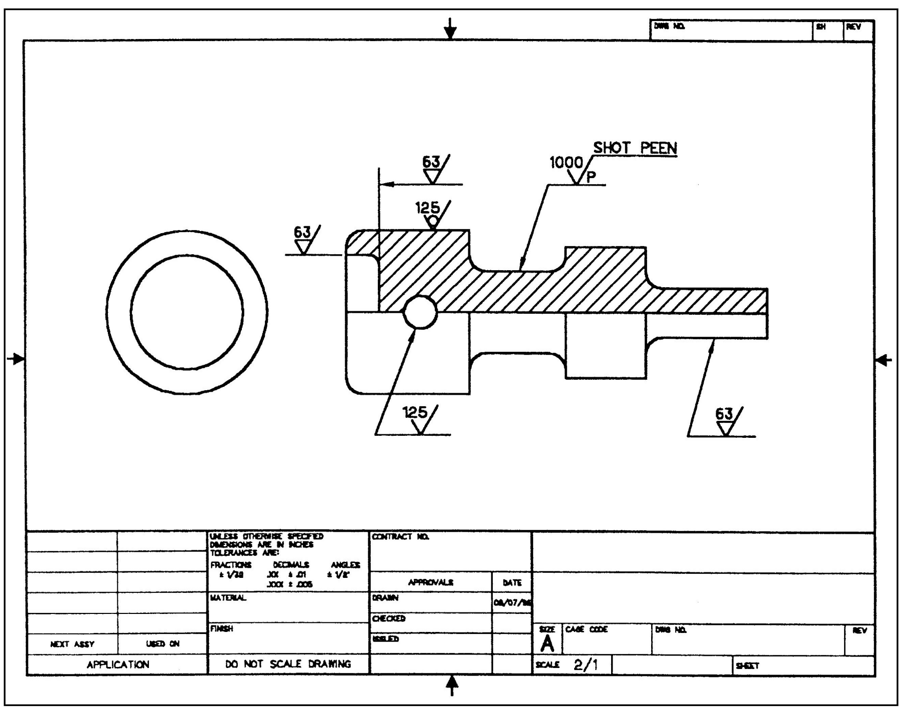

Figure 3.6.4: Conventional Surface Texture Call-outs

The specified roughness height influences the type of fabrication process(es) which must be chosen to achieve the specification.

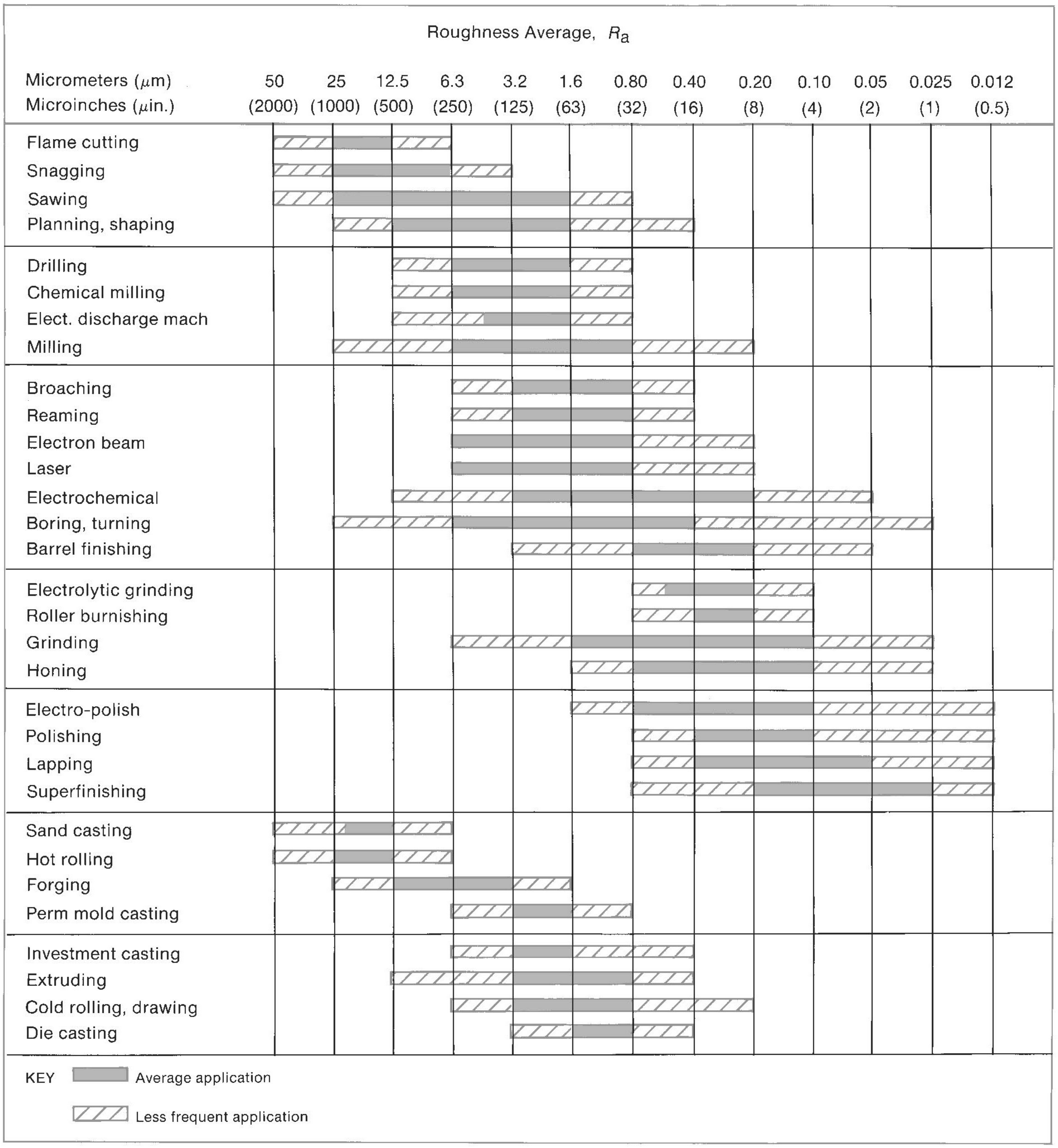

Figure 3.6.5: Surface Roughness Values for Machining Processes