Engineering Drawings: Dimensioning

A short series of lectures on Engineering Drawing as Part of ENGG1960
By Paul Briozzo
Dimensioning: Why is it Important?

- Define item and how to manufacture
- Minimum practical information on drawing
- Easily overviewed
- Systematically arranged
- Standard Presentation
Minimisation of Views

SIDE ELEVATION

SOME POSSIBLE END ELEVATIONS

MORE THAN ONE VIEW NEEDED

ONLY ONE VIEW NEEDED

ϕ 10

45

ϕ 20

25
**FIGURE 2.1 Use of projection and dimensioning lines**

- **Arrowheads** are drawn open or solid about 3 mm long and 1 mm wide.
- **Dimension lines** are thin lines.
- **Projection lines** are thin lines and may cross over when necessary.
- **2 mm past dimension line**
- **1 mm gap**
- **Arrowheads should touch projection lines at extremities of the dimension.**
- **Spacing between dimension lines and outline should be equal and about 12 to 15 mm.**
- **Dimension line is drawn parallel to direction of measurement and placed outside the view where possible.**
- **Figure is normally placed above the line in the direction of the arrowheads and readable from bottom or right-hand side.**
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DRAWING CALLOUT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td><img src="image" alt="Diameter Symbol" /></td>
<td>The symbol is placed in front of the dimension and indicates that it refers to the diameter of a circle, hole, cylinder or other circular feature (Fig. 2.7).</td>
</tr>
<tr>
<td>Radius</td>
<td><img src="image" alt="Radius Symbol" /></td>
<td>The symbol is placed in front of the dimension and indicates that it refers to the radius of part of a circle (Fig. 2.8).</td>
</tr>
<tr>
<td>Square</td>
<td><img src="image" alt="Square Symbol" /></td>
<td>The symbol is placed in front of the dimension and indicates that it refers to the width across the flats of a square section (Fig. 2.11).</td>
</tr>
<tr>
<td>Taper</td>
<td><img src="image" alt="Taper Symbol" /></td>
<td>The symbol is placed in front of the slope ratio of the taper and indicates a taper and its direction. The center line of the symbol is parallel to the axis or plane of symmetry of the tapered feature.</td>
</tr>
<tr>
<td>Slope</td>
<td><img src="image" alt="Slope Symbol" /></td>
<td>The symbol is placed in front of the ratio of the slope and indicates the slope direction. The base of the symbol is parallel to the datum plane.</td>
</tr>
<tr>
<td>Centre line</td>
<td><img src="image" alt="Centre Line Symbol" /></td>
<td>The symbol is placed adjacent to or on the center line and indicates the center line of a part, feature or group of features. It is not normally used when the center line is obvious.</td>
</tr>
<tr>
<td>Countersink or spotfaced</td>
<td><img src="image" alt="Countersink Symbol" /></td>
<td>The symbol is placed after the hole diameter and before the spotfaced diameter. If a depth symbol follows the second diameter a countersink is indicated to the depth specified (Figs 2.16 and 2.17).</td>
</tr>
<tr>
<td>Depth</td>
<td><img src="image" alt="Depth Symbol" /></td>
<td>The symbol is placed in front of the dimension.</td>
</tr>
<tr>
<td>Countersink</td>
<td><img src="image" alt="Countersink Symbol" /></td>
<td>The symbol is placed after the hole dimension and indicates that the hole has to be countersunk out to the diameter immediately following the symbol and at the angle stated (Fig. 2.15).</td>
</tr>
</tbody>
</table>
### TABLE 2.1 Dimensioning symbols (continued)

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>DRAWING CALLOUT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Curved surface or arc length" /></td>
<td><img src="image" alt="Circumferential" /> <img src="image" alt="Chordal" /></td>
<td>The symbol is placed above the dimension and is used in conjunction with a curved dimension line drawn parallel to the curved surface. Dimension end lines indicate the extent of the dimension as well as the surface being dimensioned. Chordal dimensioning uses a straight line parallel to the chord length, in this case on the top surface joining the hole centres.</td>
</tr>
<tr>
<td><img src="image" alt="Spherical diameter" /></td>
<td>Sφ 20</td>
<td>The symbol is placed in front of the dimension and indicates the diameter of a spherical surface (Fig. 2.10(a)).</td>
</tr>
<tr>
<td><img src="image" alt="Spherical radius" /></td>
<td>SR 20</td>
<td>The symbol is placed in front of the dimension and indicates the radius of a spherical surface (Fig. 2.10(b)).</td>
</tr>
</tbody>
</table>
| ![Surface texture](image) | ![Line representing the surface](image) ![a](image) ![b](image) ![c](image) | (a) is the basic texture symbol, and means that the surface may be produced by any production process  
(b) is a modified symbol which indicates that the surface must be produced by a machining process  
(c) is a modified symbol which indicates that the surface must be left in the state resulting from a preceding manufacturing process. |
| ![Third angle projection](image) | 3RD ANGLE PROJECTION | Either the symbol or the drawing callout “3RD ANGLE PROJECTION” may be displayed prominently on each drawing sheet. |
Correct and Incorrect Usage of Dimensions

**FIGURE 2.2** Use of centre and projection lines in dimensioning

(a) correct

(b) incorrect
EXAMPLES OF POOR DIMENSIONING
LINEAR DIMENSIONS
These should preferably be expressed in millimetres. It is not necessary to write the symbol ‘mm’ after every dimension. A general note such as ‘all dimensions are in millimetres’ in the title block is sufficient.

FIGURE 2.3 Methods of dimensioning

METHODS OF DIMENSIONING
Two methods of indicating dimensions are in common use:
1. Unidirectional, where the dimensions are drawn parallel to the bottom of the drawing, that is, horizontal.
2. Aligned, where the dimensions are drawn parallel to the related dimension line and are readable from the bottom or right-hand side of the drawing.
Dimensions and notes indicated by leaders should use the unidirectional method as illustrated in Figure 2.3.

STAGGERED DIMENSIONS
Where a number of parallel dimensions are close together they should be staggered to ensure clear reading, as shown in Figure 2.4.

FIGURE 2.4 Use of staggered dimensions

FUNCTIONAL DIMENSIONS
Some dimensions are essential for the proper operation or function of a component. These are called functional dimensions and are always inserted on the component detail drawing. Functional dimensions may also be tolerated if necessary to ensure a proper working relationship with mating parts on assembly.

OVERALL DIMENSIONS
When a length consists of a number of dimensions, an overall dimension may be shown outside the dimensions concerned (see Fig. 2.5 on page 24). The end projection lines are extended to allow this. When an overall dimension is shown, however, one or more of the dimensions that make up the overall length is omitted. This is done to allow for variations in sizes that may occur...
AUXILIARY DIMENSIONS
When all the dimensions that add up to give an overall length are functional and/or convenient for manufacture, the overall dimension may be added as an auxiliary dimension. This is indicated by enclosing the dimension in brackets.

FIGURE 2.5 Use of overall dimensions

 Auxiliary dimensions are never tolerated and are in no way binding as far as machining operations are concerned. Figure 2.6 illustrates the use of an auxiliary dimension, namely (100).

 If the overall length dimension is important, then one of the intermediate dimensions is redundant, for example the dimension 42 from the left-hand end (Fig. 2.6). This dimension may be inserted as an auxiliary.

DIMENSIONS NOT TO SCALE
When it is desirable to indicate that a dimension is not drawn to scale, the dimension is undefined with a continuous, thick type A line, for example:

FIGURE 2.6 Use of auxiliary dimensions

DIMENSIONS NOT COMPLETE
Where a dimension is defining a feature that cannot be completely inserted on a drawing (for example, for a large distance or diameter) the free end is terminated in a double arrowhead pointing in the direction the dimension would take if it could be completed.

2.2 Dimensioning common features

DIAMETERS
End view
The symbol Ø shall be used to precede the dimension indicating a hole or cylinder. See Figure 2.7(a) for methods which are used on circles ranging from small to large diameters.

Side view
This may be indicated, as shown in Figure 2.7(b), by the use of the symbol Ø preceding the dimension or by the use of leaders which are at right angles to the outline in conjunction with the symbol Ø.

RADII
Figure 2.8 illustrates methods of dimensioning these features. A radius dimension is preceded by the letter R. Leaders should pass through or be in line with the centres of arcs to which they refer.
SMALL SPACES

Figure 2.9 illustrates methods of dimensioning small spaces which are too small to be dimensioned by normal methods.

FIGURE 2.9 Dimensioning small spaces

SQUARES

AS 1100 recommends the representation of squares by the symbol preceding and separated from the dimension by a single space, indicating the size 'across flats' of a shaft or hole as shown in Figure 2.11(a) and (b). The symbol used on the hole dimension indicates the Envelope Principle described on page 97.

Some practitioners advise dimensioning of a square shaft by the 'across-comers' method together with an additional and view, Figure 2.11(c), claiming there is less chance of error when reading this drawing representation to determine the diameter to be turned preparatory to machining the flats of the square shaft.

SPHERICAL SURFACES

These are dimensioned as shown in Figure 2.10. Note the distinction made between spherical diameters (Fig. 2.10(a)) and spherical radii (Fig. 2.10(b)).

FIGURE 2.10 Methods of dimensioning spherical surfaces

FIGURE 2.11 Methods of dimensioning squares
HOLES
Holes either go right through a material or to a certain depth, and this must be specified as well as the diameter. If no indication is given, a hole is taken as going right through. Figure 2.12 illustrates methods of dimensioning holes using both end and side views.

FIGURE 2.12 Methods of dimensioning holes

POSITIONING HOLES
Holes may be positioned by specifying the diameter of pitch circles as shown in Figure 2.13 or by specifying rectangular coordinates of centre distances as shown in Figure 2.14.

FIGURE 2.13 Positioning holes by angular dimensions
(a) holes equally spaced
(b) holes unequally spaced

FIGURE 2.14 Positioning holes by co-ordinate dimensions
(a) co-ordinates of holes on a pitch circle
(b) symmetrical holes
(c) holes positioned by co-ordinate dimensions
(d) holes positioned relative to an edge
COUNTERSINKS
These may be dimensioned by one of the methods shown in Figure 2.15.

COUNTERBORES
These may be dimensioned by one of the methods shown in Figure 2.16.

SPOTFACES
These may be dimensioned by one of the methods shown in Figure 2.17.

CHAMFMERS
These may be dimensioned by one of the methods shown in Figure 2.18.

FIGURE 2.16 Methods of dimensioning countersinks

FIGURE 2.16 Methods of dimensioning counterbores

FIGURE 2.17 Methods of dimensioning spotfaces
KEYWAYS—SQUARE AND RECTANGULAR

Methods of dimensioning keyways in shafts and hubs, both parallel and tapered, are shown in Figure 2.19, together with suitable proportions for drawing rectangular keys. Enlarged details of key and keyways are shown in Figures 2.20 and 2.21.

Note: Tables 2.2 and 2.3 overleaf give dimensions and tolerances for square and rectangular parallel keyways.
2.3 Screw threads

GENERAL REPRESENTATION

The methods shown in Figure 2.24 are recommended for right-hand or left-hand representation of screw threads. The diameter (D or Dia) of a thread is the nominal size of the thread, for example for a 12 mm thread, M12, see Figures 2.24(a) and (b), Dia = 12 mm.

**FIGURE 2.24** Methods of representing screw threads

![Diagram of screw threads]

**FIGURE 2.25** Methods of representing assembled and special threads

![Diagram of assembled and special threads]
DIMENSIONING FULL AND RUNOUT THREADS

When full and runout threads have to be distinguished, the methods of dimensioning shown in Figure 2.26 are recommended. Where there is no design requirement, the runout threads need not be dimensioned.

DIMENSIONING METRIC THREADS IN HOLES

Figure 2.27 (below) shows various methods used to dimension threaded holes. The diameter of the thread is always preceded by the capital letter M, which indicates metric threads.

FIGURE 2.26 Methods of dimensioning threaded members

FIGURE 2.27 Methods of dimensioning threads in holes