Greenfaulds High School

Technical Department

CAD
&
Dimensioning

Curriculum for Excellence
National 4/5
Graphic Communication

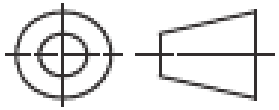
Page

Orthographics

Orthographic projection is used in engineering and architecture to show the 3 main views of an object, (Elevation, Plan, End elevation).

Third Angle Projection Symbol

The use of the third angle projection symbol informs the reader of the drawing it has been carried out in this projection. All ***orthographic*** drawings should show this symbol. This standard is recognised throughout the world.



Types of line used

Outlines

Continuous thick lines used for visible outlines and edges.

Construction Lines

Continuous thin lines used for projection and dimension leader lines.

Hidden detail

Dashed thin lines used to show hidden outlines and edges.

Chain Lines

There are two types and uses,

1. Used for centrelines and lines of symmetry
2. Chain lines with thickened ends used to show sectional cutting planes.

Fold Lines

Chain lines with a double dash used to show folds or bends.

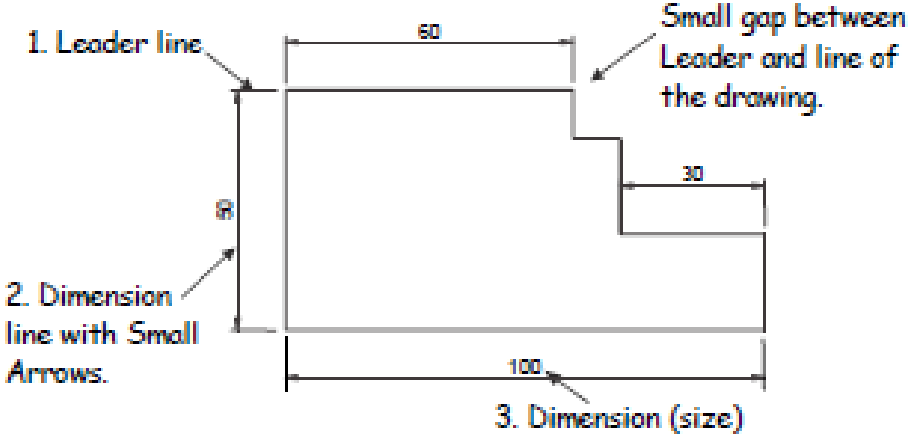
Hatching

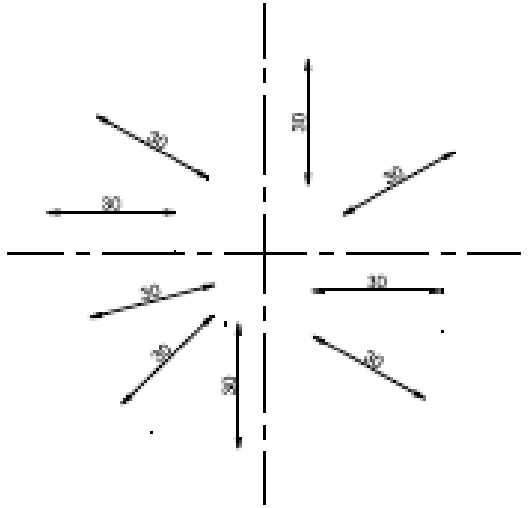
45° lines that show a part has been sectioned (cut through). ***See sectioning.***

Dimensioning Lines

There are three parts to dimensioning lines.

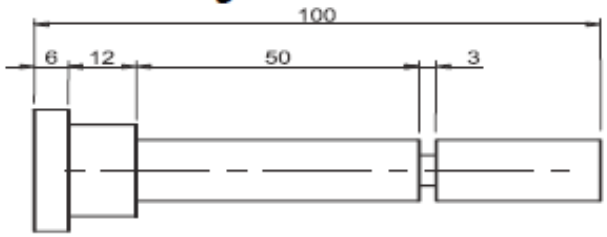
1. Leader Lines, showing the beginning and end of the measured area. They do not touch the measured part.
2. Dimension line, start and finish with arrows touching the ***leader lines.***
3. The Dimension. This is the measured size which sits on top of the ***dimension line*** in the centre.





Note the position of the dimensions on each of the lines is always on top and centred.

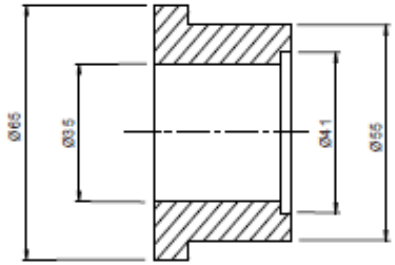
Dimensioning — Continued



All sizes in mm

Notice on the above drawing that the largest dimension is placed on the outside of the smaller dimensions. It is also important when dimensioning not to include the units of measurement. As can be seen from the drawing above, state on the drawing the unit of measurement. i.e. (All sizes in mm).

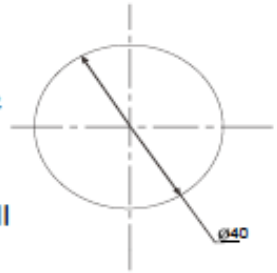
The sectioned drawing opposite is of a round item. It shows some possibilities for putting a diameter on a drawing.



If the item shown was ***Square***, then the following symbol would be used □65 replacing the diameter symbol.

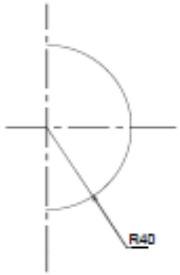
Diameter (dimensioning a circle)

Diameters should also be dimensioned by a dimension line that passes through, or is in line with, the centre of the circle. The dimension line should have two arrow heads, which touch the circle. The symbol Ø is placed in front of the dimension. Small circles may be dimensioned similar to a radii with one arrow head touching the outside of the circle.



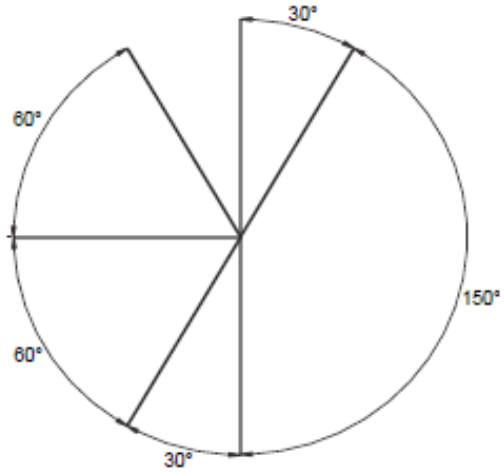
Radius (dimensioning an arc)

Radii should be dimensioned by a dimension line that passes through, or is in line with, the centre of the arc. The dimension lines should have one arrow head only, which touches the arc. The symbol R is placed in front of the dimension.



Angular Dimensions

Leader lines show the extent of the angle. The dimension line follows a curve with arrow heads touching the leader lines. The angular distance is placed outside of the dimension line.

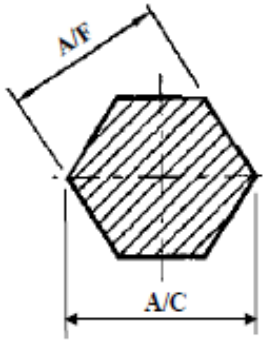


Across the Flats (A/F)

The distance across the flat sides of a hexag or an octagon.

Across the Corners (A/C)

The distance between the corners of a hexag or an octagon.



ASSY

An Abbreviation of the word Assembly.

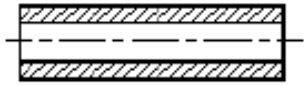
C_L or CL

An Abbreviation of Centre Line.

Sectioned views

BSI hatching sectioned or "cut" objects is always at 45° and evenly spaced (fig.1)

Fig.1



Hatching an object with more than one part is achieved by firstly changing the direction of the 45° lines (Fig.2) or if three or more parts are included the spacing between the 45° lines can be altered (fig.3).

Fig.2

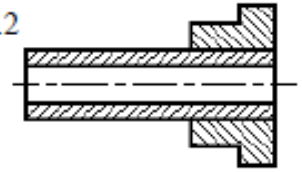
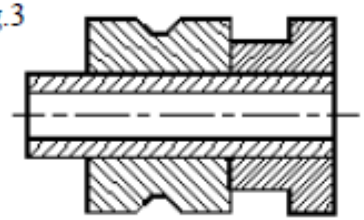


Fig.3



BSI conventions state that some specific engineering parts included on an assembly Do Not Show hatching detail.

Parts that should not be hatched are; Nuts & Bolts (fig.4), Studs, Screws, Shafts or Axles, Keys, Pins, Gear teeth, Roller bearings, Ball bearings, Webs (fig.5 & 6).

There are some exceptions to this rule. Nuts & Bolts, Studs, Screws, Shafts or Axles, Keys, Pins, Gear teeth, and Webs are hatched when cut across their axis. Fig.7 shows a strengthened boss with the web cut across its axis.

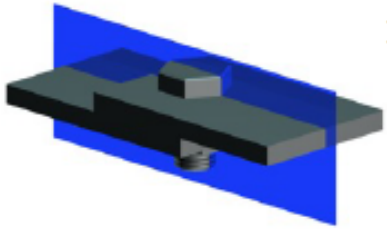
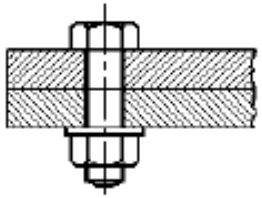


Fig.4



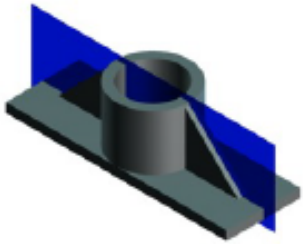


Fig.5 ✗

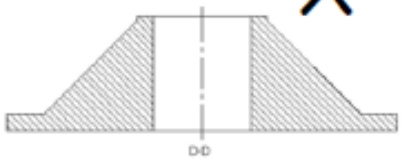
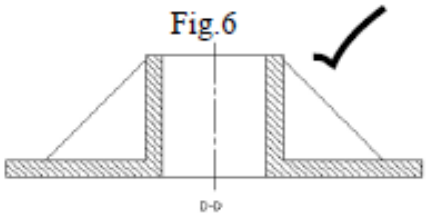


Fig.6 ✓



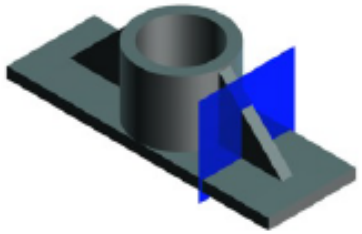
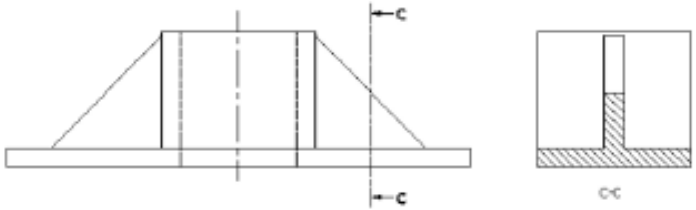


Fig.7



Scales

Scaling drawings allow us to draw exceptionally large objects such as houses on any size of paper available to us. To enable this to happen we have to scale every size (dimension) by the same factor.

i.e. taking the example of the house, every dimension would have to be divided by say 100. By doing this we are scaling **DOWN** the size of the house.

We can also draw exceptionally small objects larger, examples of which are, the minute electronic chips which are now part of our every day life. They are so small we could not draw them as they are so we **SCALE UP** the drawing to be able to draw them.

1:1 When we create a drawing using the actual dimensions, this is called 'full size', or the drawing has been drawn to a scale of 1:1 (the drawing is exactly the same size as the item).

1:2 Scaling down is when we create a drawing and reduce all the sizes by a factor. I.e. A scale of 1:2, all dimensions are divided by 2. This makes the drawing half the original size of the item. If we reduced the items dimensions by twenty the scale would be 1:20 (divide all sizes by 20).

2:1 We can also increase the size of an object on a page by any factor. The scale 2:1 is stating that for every 1mm actual size of the object, 2mm have been drawn (the drawing is twice the size of the item). If we increased the item by 10 the scale would be 10:1 (multiply all sizes by 10).

With respect to Engineering drawings, there are recommended scales for reduction and enlargement. These are as follows:-

Reduction:- 1:2, 1:5, 1:10, 1:20, 1:50, 1:100, 1:500, and 1:1000

Enlargement:- 2:1, 5:1, 10:1, 20:1, and 50:1.

Advantages of CAD over manual drawing

Drawings can be produced quicker and very accurately.
Drawings are easier to edit/change.
Repetitive elements, libraries of various parts can be created.
Convenience of use (Lap top, tablet etc..).
Standardisation. (see below)
Drawings can be easily scaled up or down.
Use of layers allows different parts to be drawn separately.
Easier to store drawings (paperless office)
Easier to send drawings to another location quickly.
New designs from existing designs.

Limitations of CAD over manual drawing

Overall cost of hardware.
Overall cost of software.
Continual need to upgrade systems to stay competitive.
Risk of catching computer viruses.
Staff training costs.
System faults/crashes.
Data loss security.

Advantages of computer aided modelling.

An Accurate 3D image which can be rotated 360° in any direction.
Allows the operator a view of an object from any angle.
Animation can show the designer how the parts interact and can highlight any problems.
Simulation programs are used in speciality areas such as pilot training.
Computer generated imagery is used in the TV and Video industry.

Advantages of Standardisation

Allows the creation of a library common parts recognised throughout an industry sector, such as BSI symbols.
Allows users to recognise the industry standard throughout the world, such as BSI or paper size (A4,A3 etc..).

Common Computer Terms

Animation

Animation means "Bring to life". A computer manipulates electronic images to create moving images. The computer is giving the illusion of moving parts. This technique can then be used to show parts move together, like a car engine or a folding chair. Computer animation is also used for films such as 'Toy Story' and CGI film technology.

Central Processing Unit (CPU)

At the heart of the computer, it controls all processes that the computer runs.

Hard Drive

The main storage device in the computer which is not portable. Memory capacity is measured in terms of: Megabites (MB), Gigabites (GB) and Terabites (TB).

Hardware

The physical parts of the computer. Example: the case, disc drives, motherboard, Monitor, Printer, etc.

Modem

This is the device that allows the computer to connect to other computers either through a local intranet (direct cable links within the same area/office) or through the internet (via a router).

Screen Dump / Screen Capture

When a screen image is sent to a printer to obtain a hard copy, the resulting copy is a screen dump. Using the 'print screen' option on the keyboard an image of what is being viewed is copied onto the clipboard. This can be pasted into another program and saved as a screen capture.

Simulation

This is very similar to animation but with simulation the graphics react to a persons input. i.e. A flight simulator, or a games consol.

Input Devices

Hardware that inputs information into the computer.

Digital Camera Inputs photographs either directly via a USB cable or by transferring the storage card into a card reader attached to the computer.

Digitiser / Graphics Tablet A flat-bed input device with a puck, stylus or light pen attached. Useful for 'tracing over' existing drawings to convert them into computer-stored versions, and for making free-hand sketches dimensionally accurate. With overlaid menus they can be used to input symbols from icons.

Joystick An input device which normally moves in two axes. The output from the joystick can be used to control the screen cursor movement.

Keyboard Used for input commands to the CPU and for inputing text into programs.

Light pen A light sensitive device which can be used as an input device. The light pen is used by pointing it at a raster-type display. Not commonly used in desk-top CAG applications.

Mouse A mobile hand-held interaction device for controlling the cursor position.

Scanner These are usually flat-bed input devices however there are also hand held scanners. Optical Scanning is a process in which documents are scanned and the incident light from their contents generates signals which are received by the scanning device and transmitted to the computer.

Touch Screen Touch sensitive screen used often on portable devices such as mobile phones and hand held computers.

Output Devices

Hardware that outputs information from the computer.

Printers An output device for obtaining hard copy of photographs, pictures, drawings and text.

- **Dot matrix printer** A contact printer that prints text characters and graphics images by using a series of dots to make up the text, lines and fills. Not suitable for documents which require good quality graphics such as pictures/photographs.

Cost - Low capital cost
Printing costs - Low for small batches, High for mass produced items.
Speed - Slow
Quality - Very poor graphics
Special Features - Printing triplicate forms

- **Ink-Jet Printer** A non-contact printing device that uses tiny droplets of ink. Slower and less expensive than a laser printer but with very similar quality results.

Cost - Low capital cost
Printing costs - Low for small batches, High for mass produced items.
Speed - Medium
Quality - Excellent
Special Features - Good home office applications when combined as a 3 in 1 unit (printer / scanner / photocopier)

- **Laser Printer** A non-contact printing device used mainly in DTP. Laser printers use a laser beam focused on an electrically charged drum which forces the ink to follow the light pattern and form the characters. It is a fast method of printing which also provides very clear images.

Cost - High capital cost
Printing costs - High for small batches, Low for mass produced items.
Speed - Very fast
Quality - Excellent
Special Features - Printing double sided items

- **3D printer** This printer 'builds up' a 3D model of an object using thin layers of plastic. Used mainly in model making at present and sometimes referred to as rapid prototyping.

Cost - High capital cost
Printing costs - Low for one off production, High for batches & mass produced items.
Speed - Slow
Special Features - Builds 3D models direct from CAD programs.

Plotters Modern day printers far exceed the capability of plotters and therefore make plotters redundant. However, they can still be used for printing any drawings which are made up of lines such as orthographic CAD and circuit diagrams.

- **Drum Plotter** A pen-type plotter in which the paper is rotated on a drum under the pen while the pen also moves across the drum.
- **Flat bed plotter** takes up more desk space than the drum plotter. The pens only move in horizontal and vertical directions (X and Y axis).

Speakers These output any sound via the computers internal sound card. Modern multi-media computers are designed with powerful sound cards can output digital surround sound.

VDU / Monitor Visual Display Units (VDU) are mostly flat screen Liquid Crystal Display (LCD) monitors. The latest generation of VDUs are touch sensitive and also act as input devices.

CAM (Computer Aided Manufacture) This refers to machines directly linked to CAD programs and controlled by computer. A CAD drawing can be sent directly for manufacture to machines such as; 3D printer for model making, Laser cutters for developments/shapes, Machine Lathes & Milling machines for engineering components.

Portable Storage Devices

These devices can be connected to any computer and carried around. Floppy discs and Zip discs are now very rare, however they may still be in use.

- **Floppy Disc** Only holds 1.44 MB of data. Can be used in most computer systems. Easily damaged.
- **Zip Disc** Similar to floppy disc. Greater storage capacity (100 to 250 MB). Needs a Zip drive attached to the computer.
- **CD** High capacity storage (800MB). Needs a CD writer.
- **USB Key (memory stick)** High capacity storage (1GB to 12GB).
- **DVD** High capacity portable storage (4.7GB or 8.5GB). Needs a DVD writer.
- **External HD (Hard Drive)** High capacity storage (50GB to 2TB). Expensive.

Common CAD and computer 2D Sketching commands

Library Items need only be drawn once, saved to a library file, then retrieved and positioned each time they are required on a drawing. This saves time and effort.

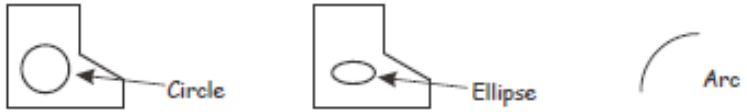
Layering This allows different types of information to be kept separate on a drawing for easier editing and printing.

Grid This gives an on screen grid to make it easier to construct Orthographic or Isometric drawings and position objects.

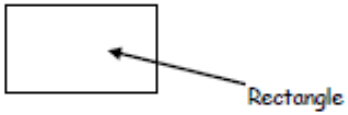
Snap Allows the user to restrict the start & stop points of lines etc to a predefined grid. Allows the accurate positioning of objects on a CAD, CAG or DTP document.

Line Allows the user to draw a line from one point to another.

Circle / Ellipse / Arc Allows the user to draw a circle or an arc.



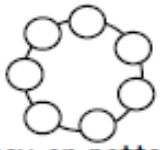
Square / Rectangle / Box Allows the user to draw a quick shape rectangle or square.



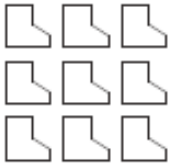
Scale Allows a user to accurately increase or decrease the size of an object keeping all parts in proportion.

Move means to move an object to a new position on the page.

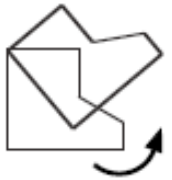
Circular / Ring / Polar Array or pattern This allows the user to draw a circular pattern of shapes or objects.



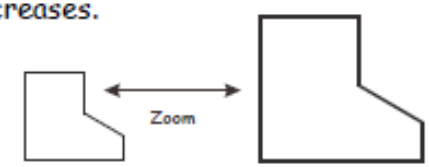
Box / Rectangular Array or pattern This allows the user to draw a pattern of shapes or objects in columns & rows.



Rotate Allows the user to rotate / turn an object about a specified point.



Zoom Allows a user to increase or decrease the screen view so that they can see more detail. All dimensions remain the same only the view increases or decreases.



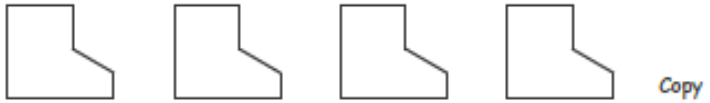
Text Allows the user to add text onto a drawing.

This is Text

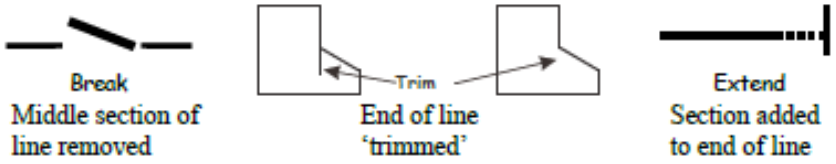
Hatching Allows the user to hatch a surface/area that has been 'cut'.

Mirror Image This flips an object about the horizontal or vertical axis.

Copy Allows the user to copy and position objects or parts of a drawing without having to redraw them.



Break / Trim / Extend Allows the user to remove a section of an object using break / trim or, extend a line so that it meets another object.



Fillet Fillet puts a radius on a corner (rounded).

Chamfer Chamfer cuts off a corner.

Constraint A constraint prevents an object or line from moving. This is used to ensure parallel or perpendicular (90°) lines in 2D computer sketching. It is also used to place parts in a 3D assembly model. Also see ***Snap***

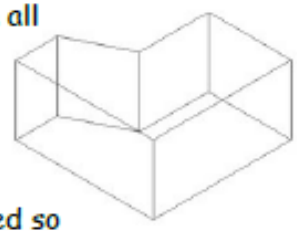
Erase Means removing part of a drawing.

Undo Means to reverse the last command.

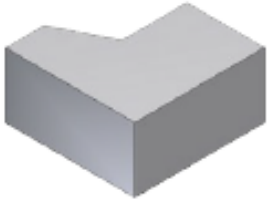
Common CAD and computer 3D modelling commands

There are 3 types of computer generated 3D model.

Wire-frame model A three-dimensional image made up as a series of connected lines between all edges and line end-points.



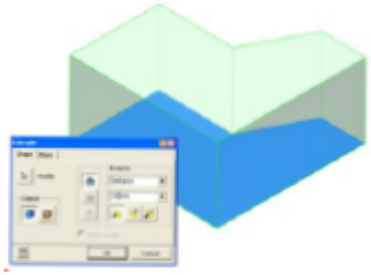
Solid model The wire-frame model is coloured so that it looks 'solid'. This is sometimes called base material and is usually a uniform brown or grey colour with no shadows or highlights.



Rendered model The solid model is fully rendered to show material colour with highlights and shadows. This type of model should look like the real item.

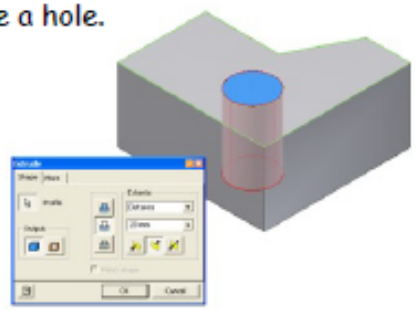
Extrusion

From drawing a 2D sketch, extrusion converts this into a 3D form.



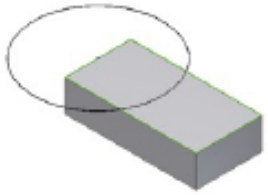
Subtraction

The sketched shape is 'cut away' from the object. In the example a circle has been subtracted to create a hole.

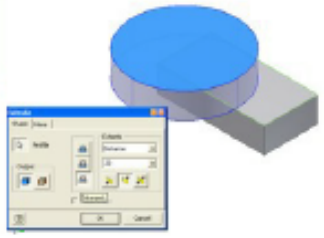


Union

When two overlapping 2D sketches can be used to create a 3D form of the overlapped area.



The rectangle has been *extruded*.

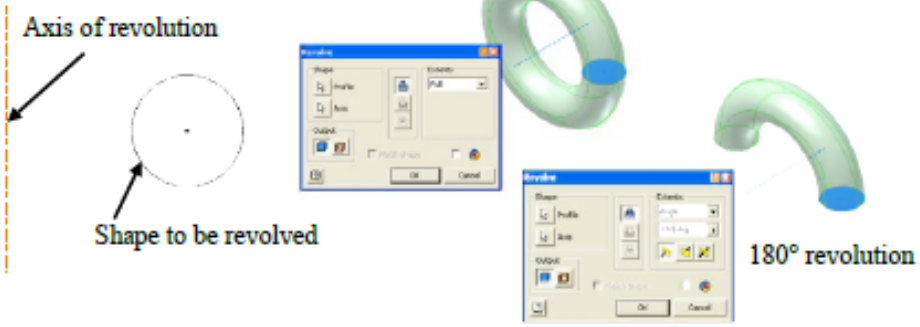


Next the circle is selected and *union* is chosen

A 3D form the shape of the overlapping area.

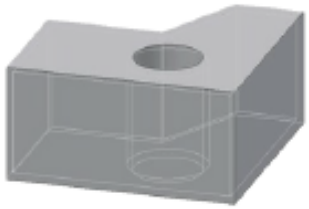
Revolve / Revolution

A Shape is revolved around an axis of revolution. In the example shown a circle is revolved around an axis to create a 'Taurus' (sometimes referred to as a ring or donut). The angle of revolution can also be set.



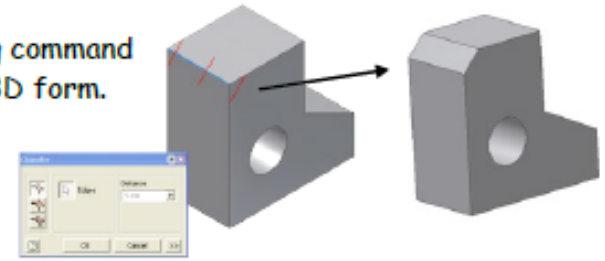
Shell

This alters the 3D form to make it hollow.



Chamfer

Similar to the 2D sketching command this cuts a corner off the 3D form.



Fillet

Similar to the 2D sketching command this rounds a corner on the 3D form.