Fortrose Academy

Higher Graphics Course Notes

2D CAD

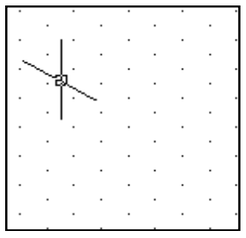
2D CAD can basically be considered as being a computer version of a manual drawing board and is used extensively in the architectural, engineering and construction industries. It also forms the basis for producing 3D models. By applying on-screen commands the user can quickly, easily and accurately produce high-quality 2D drawings of the required format.

2D CAD packages bring several advantages to the process. In addition to increased **SPEED** and **ACCURACY** of production, the drawings can be easily **EDITED, STORED** and **TRANSFERRED** immediately around the world via the internet. 2D CAD also provides the user with several fea tures which are unique to this medium:

Grid

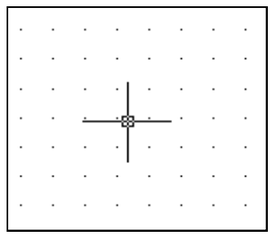
By applying a grid template to the drawing, the user can 'Snap to grid' - this means that each point and line on the drawing is joined to a pre-determined format. The size and style of the grid can be set before drawing and this allows greater accuracy and speed of production. It can be compared with the drawing instruments used with the manual drawing board such as the rule, set squares and T-squares.

Isometric



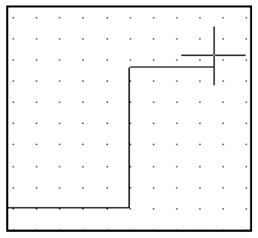
Displays a 30' grid on screen which makes isometric drawing easi er and more accurate.

Ortho grid



Displays a grid on the screen to any desired spacing. This makes or thographic drawing easi er and more accurate.

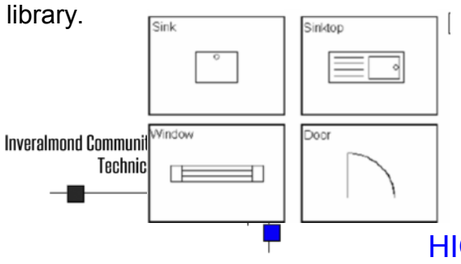
Ortho



Restricts the movement of the cursor to horizon tal and vertical move ment only. This makes orthographic projection

Library of parts

This allows the user to insert previously drawn and saved parts into a new drawing. The advantage of this feature is that each part is **UNIFORM** (BSI symbols, etc.) and does not have to be redrawn each time it is required. The library feature allows newly drawn parts to be saved for future use and multiple users can add to and access the library.



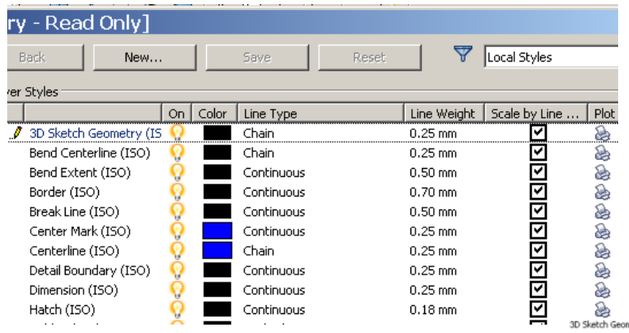
Some disadvantages with CAD...

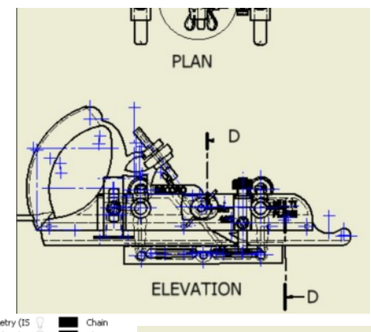
Using CAD as a software package involves some of the risks associated with any computer systems, such as:

- The initial cost of a computer system is high, as is the cost of retraining staff that are used to pro ducing drawings by traditional methods.
- It takes time to convert existing paper drawings over to an electronic format, although **scanners** can help with this.
- Loss of material can occur due to computer viruses and power failures.
- Possible theft of materials is more common with a CAD system.

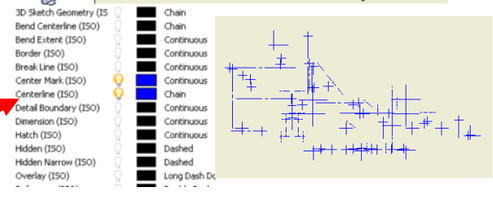
Layers

A CAD drawing is made up of individual 'layers', with each layer providing a different line type or 'element' of the drawing. This allows that layer to be isolated and edited/ applied to the drawing. For example, within a large floor plan the electrical, plumbing or heating systems can be displayed individually so allowing that information to be easily available to the individual required without the drawing becoming 'cluttered' with ex cess detail.





All the layers in the CAD drawing have now been turned off, apart the centre lines. This can be done with any layer in the drawing.

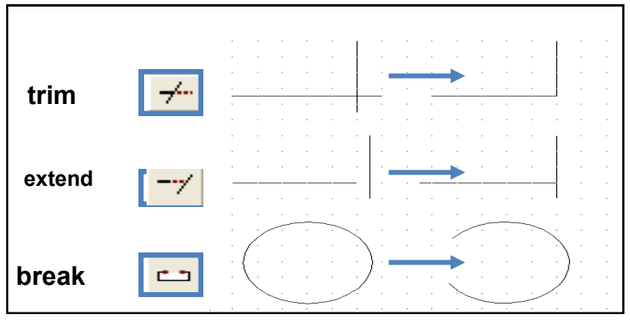


2D CAD (2)

The main CAD comands

These CAD commands are taken from 2D Auto CAD, but all can be used within the **sketching** mode of 3D Modelling packages, including Inven tor. They are all designed to make the drawing of material as easy and efficient as possible for the user.

Trim, extend and break

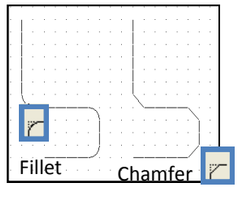


Trims the end off a line

Makes a line longer

Removes a section from the middle of a line

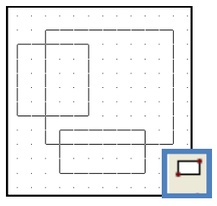
Fillet and chamfer



Rounds (fillets) cor ners;

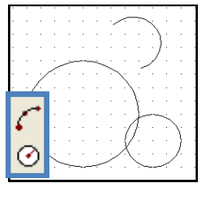
Angles (chamfers) corners

Rectangle/box



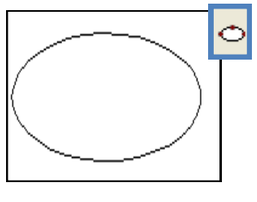
Draws squares and rectangles accu rately and quickly

Circle and arc



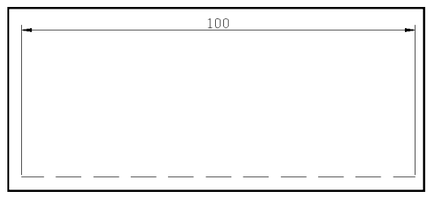
Draws circles and arcs accurately and quickly

Ellipse



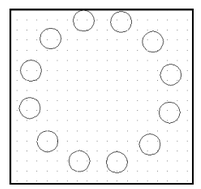
Draws circles and arcs accurately and quickly

Dimension



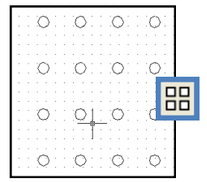
Automatically measures then dimensions chosen parts of a drawing.

Ring Array



Creates a circular arrangement from copied objects.

Box Array

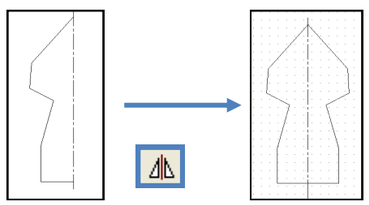


Creates a rec tangular ar rangement from copied objects.

Text

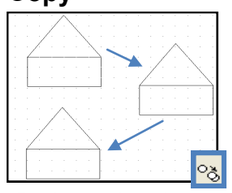
Allows text to be en tered in a va riety of fonts and sizes

Mirror



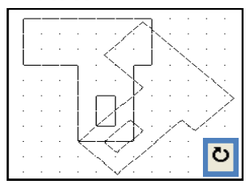
Creates a mirror image copy of an object

Copy



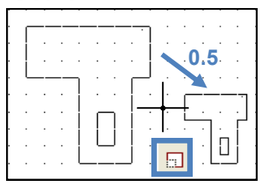
Copies and posi tions without having

Rotate



Turns an object to any angle required.

Scale



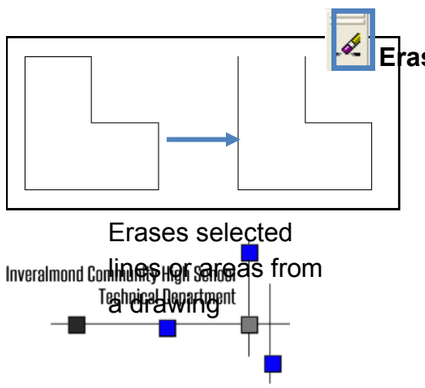
This changes the sizes of objects.

Line types

Linetype	Appearance	Description
ByLayer	———	
ByBlock	———	
CENTER2	—·—·—	Center (.5x)
Continuous	———	Continuous
HIDDEN2	— — —	Hidden (.5x)

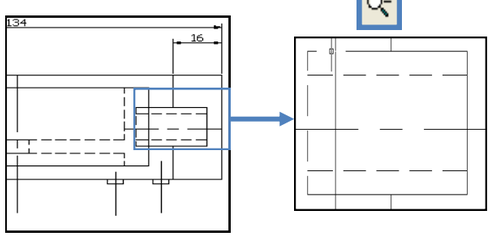
Allows any BSI line types to be used in the drawing.

Erase



Erases selected lines or areas from a drawing

Zoom



Enlarges view so that small details appear bigger and are easier to work on.

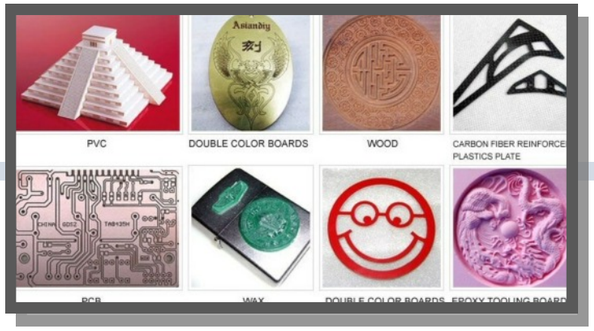
Layers

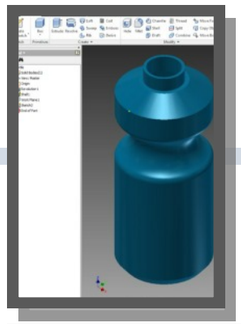
Name	On	Freeze...	L...	Color	Linetype	Lineweight
0				250	Continuous	Default
Centre Line				250	CENTER2	0.15 mm
Defpoints				250	Continuous	Default
Dimension				250	Continuous	0.15 mm
Hidden Line				250	HIDDEN2	0.15 mm
SMART-Redline				250	Continuous	0.15 mm

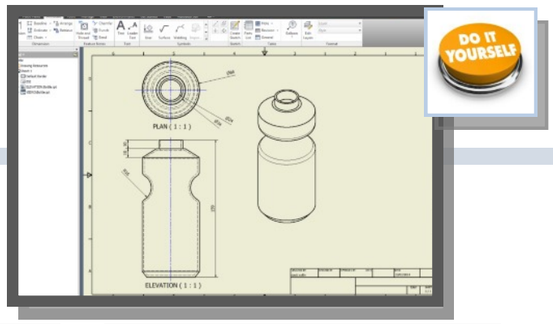
Allows a complex drawing to be built up in several layers to make it easier to work on.

3D CAD

3D CAD—also known as 3D modelling - allows the user to produce virtual models based on sketches produced within the package or im ported 2D CAD drawings. 3D modelling has several uses within indus try:







Manufacturing

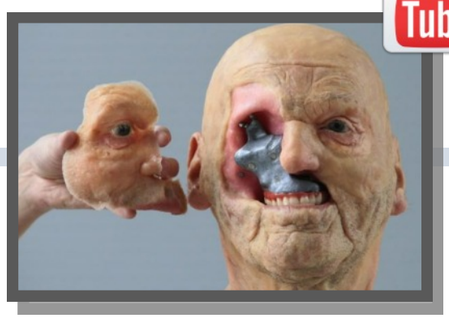
Prototype ‘models’ of a design can be produced on the software and ‘tested’ via features in the program. This can be to simulate different areas of stress on the de sign or how it would react in various real-life situations. Computer Aided Manufac ture (CAM) allows Computer Numerically Controlled (CNC) machines to produce physical parts. A result of this development over the years has been the replace ment of many human workers with this automated system.

Production Drawings

2D CAD production drawings can be very quickly and accurately obtained from the 3D model. This can make it easier to produce these drawings than using manual methods or 2D CAD. Alterations to the model automatically update the 2D produc tion drawing.

3D Printing

The 3D models can be exported as standard tessellation language (STL) files to 3D printers and produced as physical prototypes. This allows basic models to be produced to provide a hand-held, tangible version of the design from the computer. The advantages of this are that the designer or customer can get a ‘feel’ of how the design shall exist in real-life, in a way that the computer version cannot do, no mat ter how sophisticated the software is.



Simulation

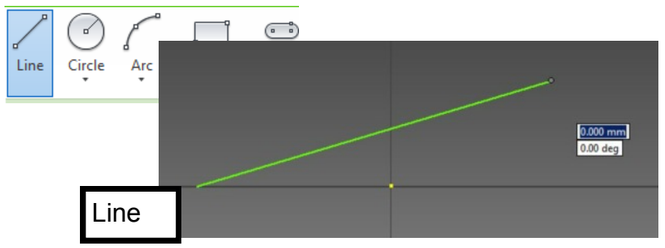
This allows the creation of required situations for training, testing design/ materials and predicting future events. This is generally cheaper than ‘real-life’ and safer too.

3D Illustration

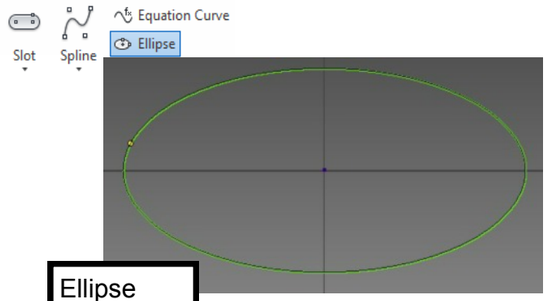
This improves the visual appearance of a 3D model, and some packages allow the user to interact and animate with the design. Most CAD packages have illustration features imbedded within them—ie Inventor Studio—but there are ‘stand alone’ products available which are solely devoted to the task.

Drawing tools

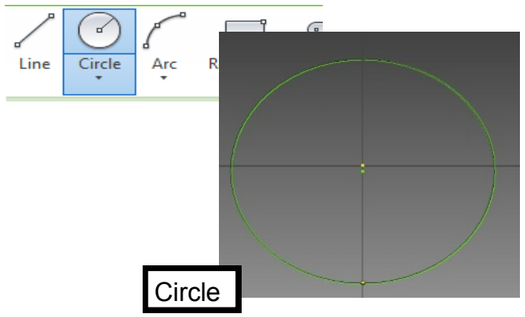
These are the tool you use within **SKETCH MODE** to produce the initial component before it becomes a **MODEL.**



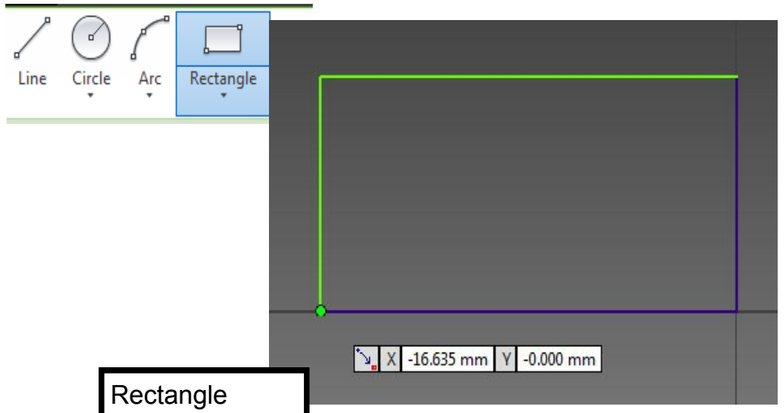
Line



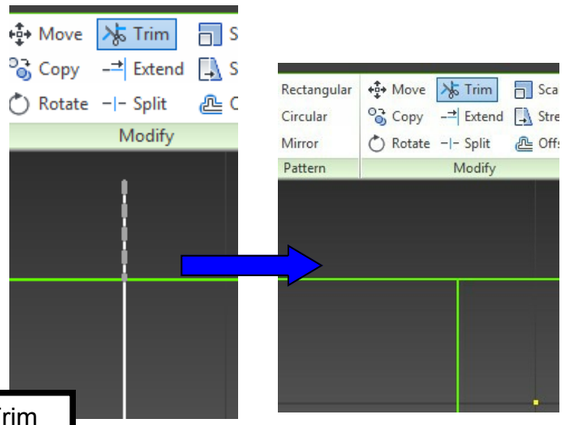
Ellipse



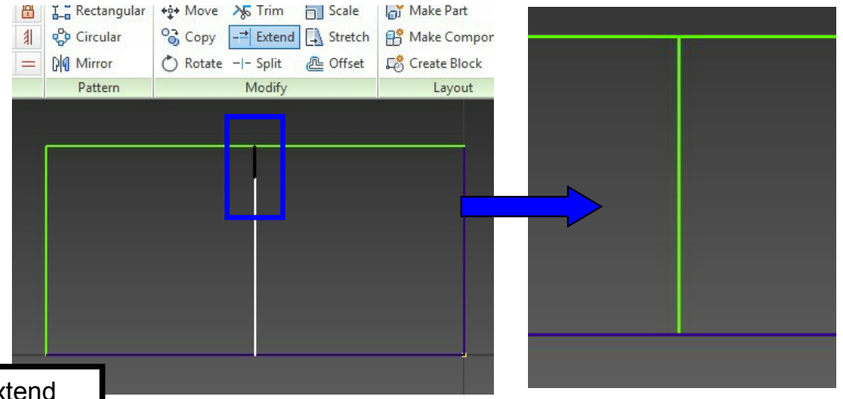
Circle



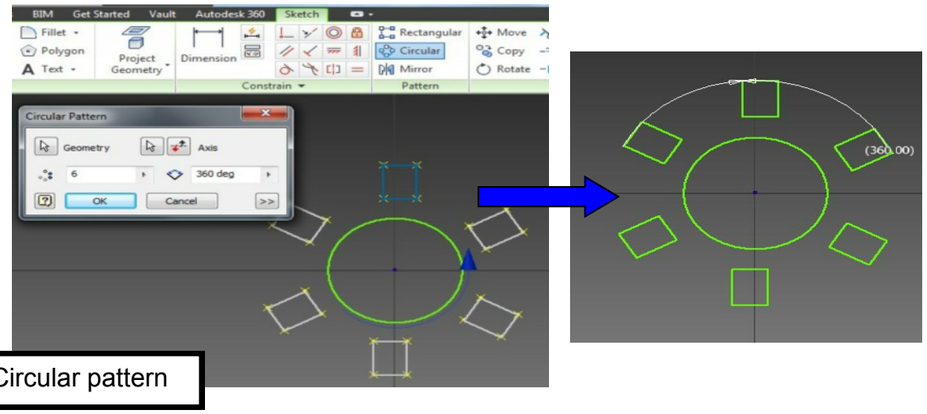
Rectangle



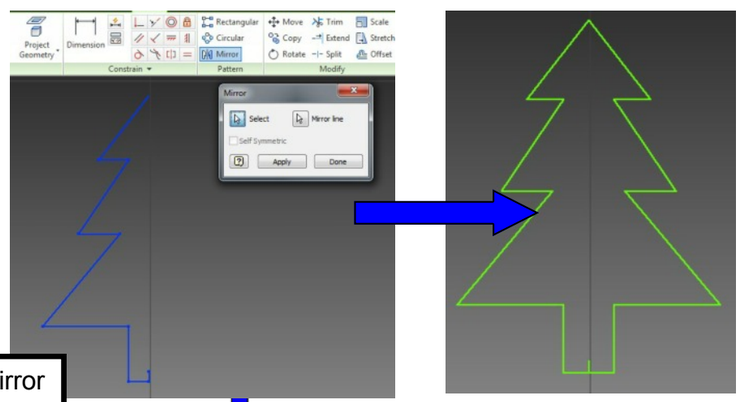
Trim



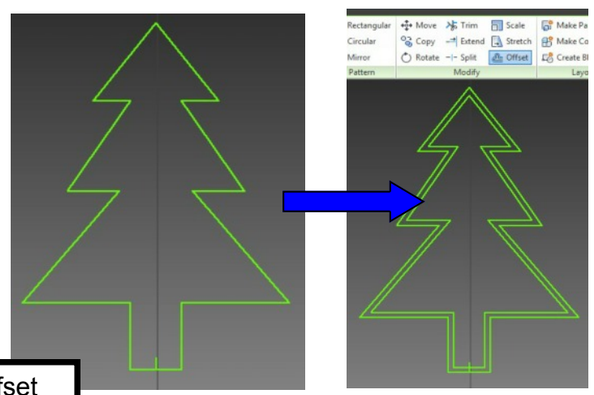
Extend



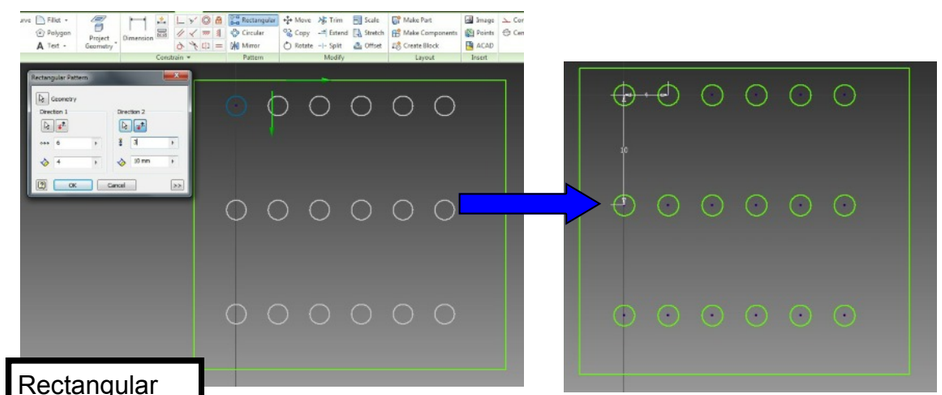
Circular pattern



Mirror



Offset

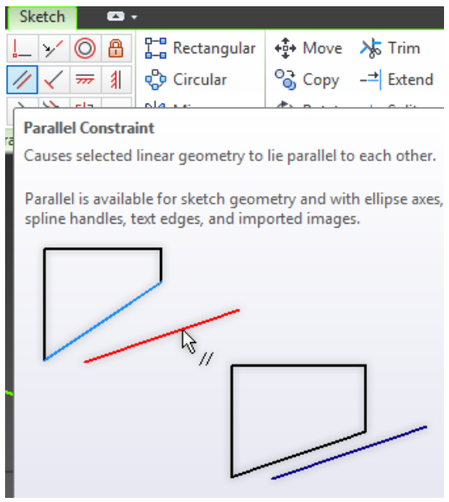


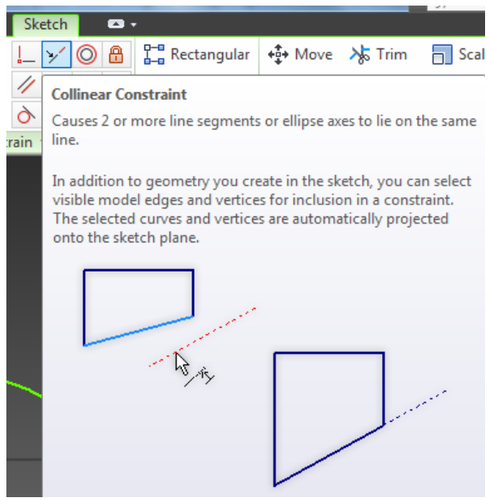
Rectangular pattern

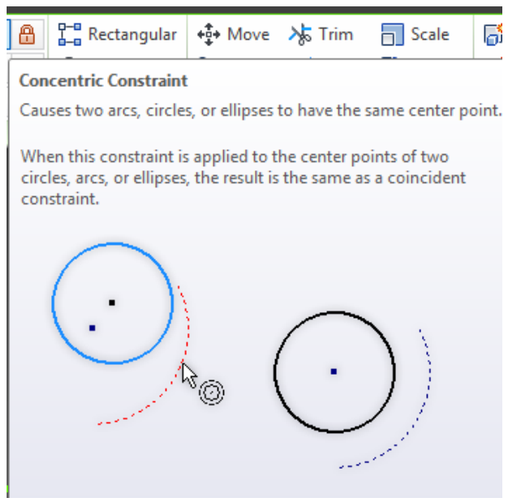
Inveralmond Community High School
Technical Department

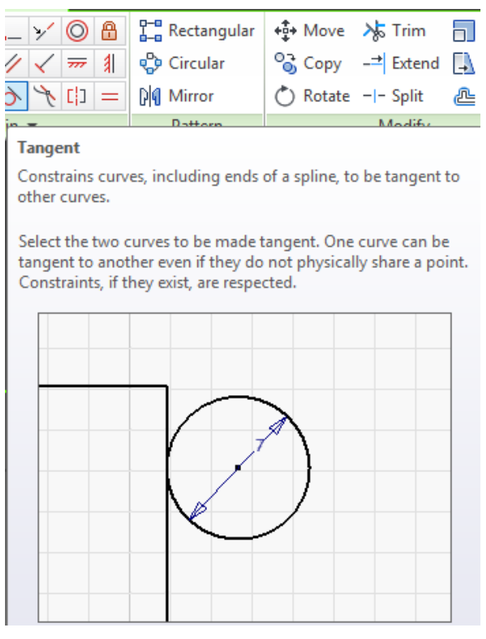
Sketching constraints

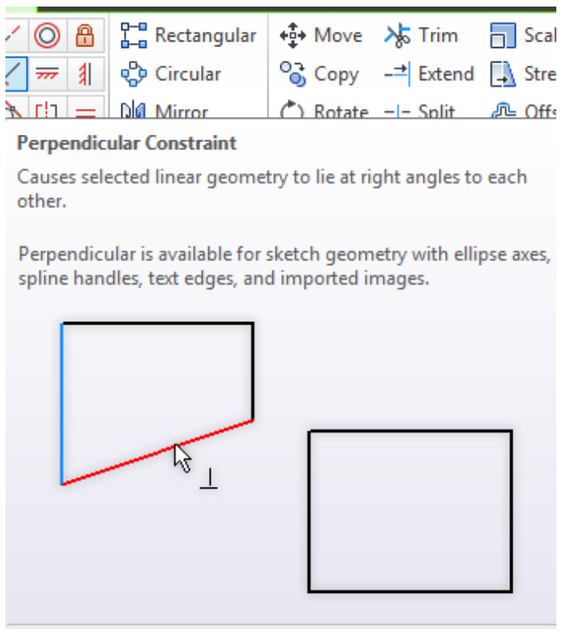
Constraints are intended to make the initial sketch quicker and easier to pro duce.

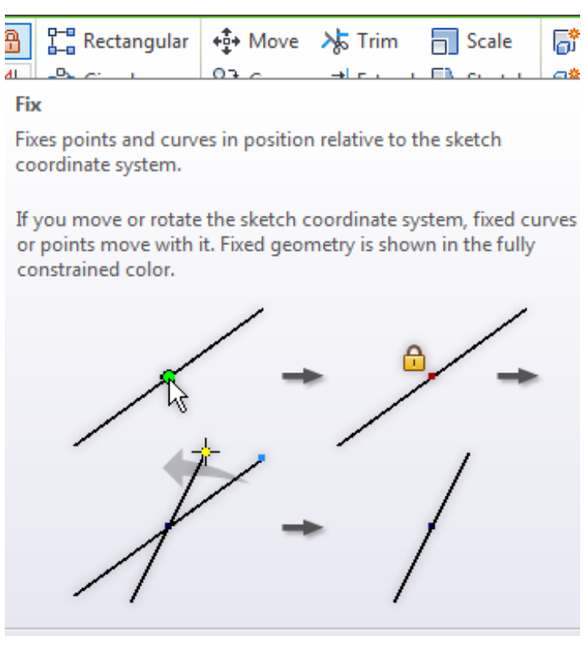








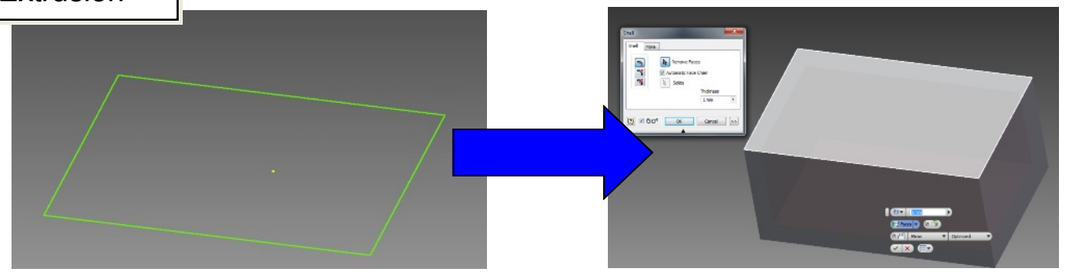




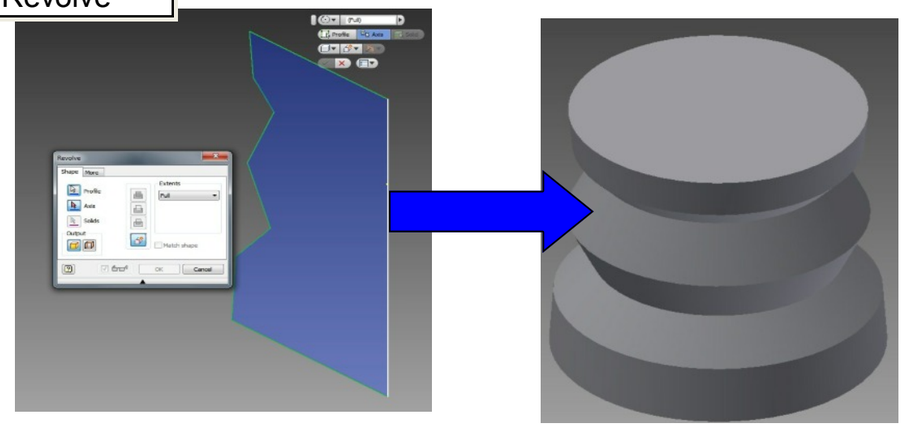
Modelling features:

These are the functions which transform the sketch into the 3D model.

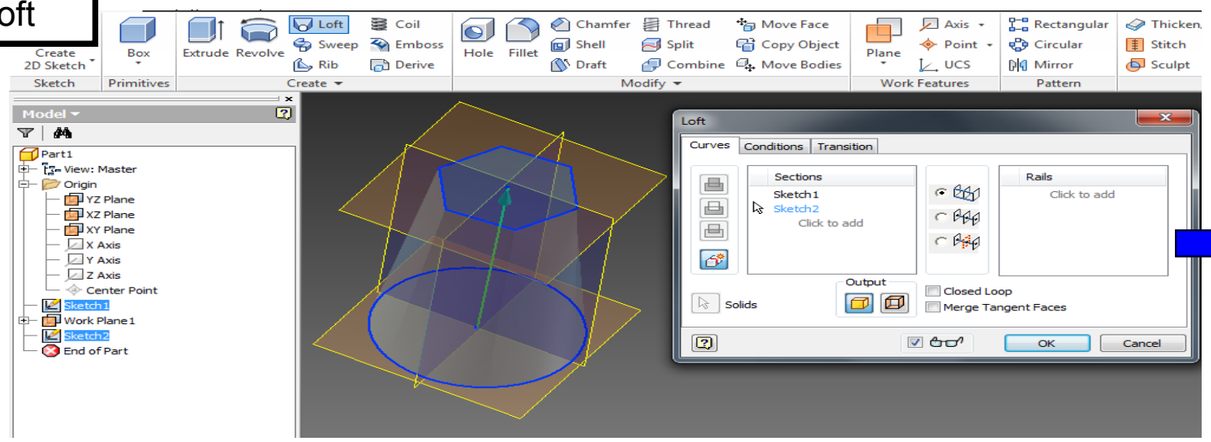
Extrusion

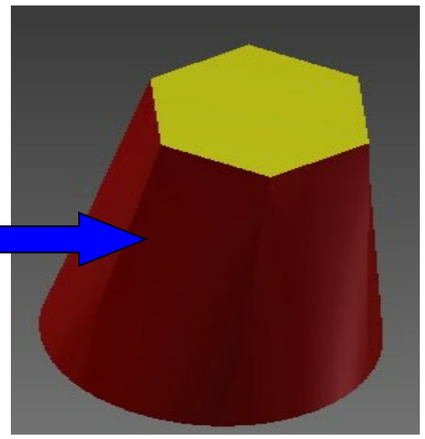


Revolve

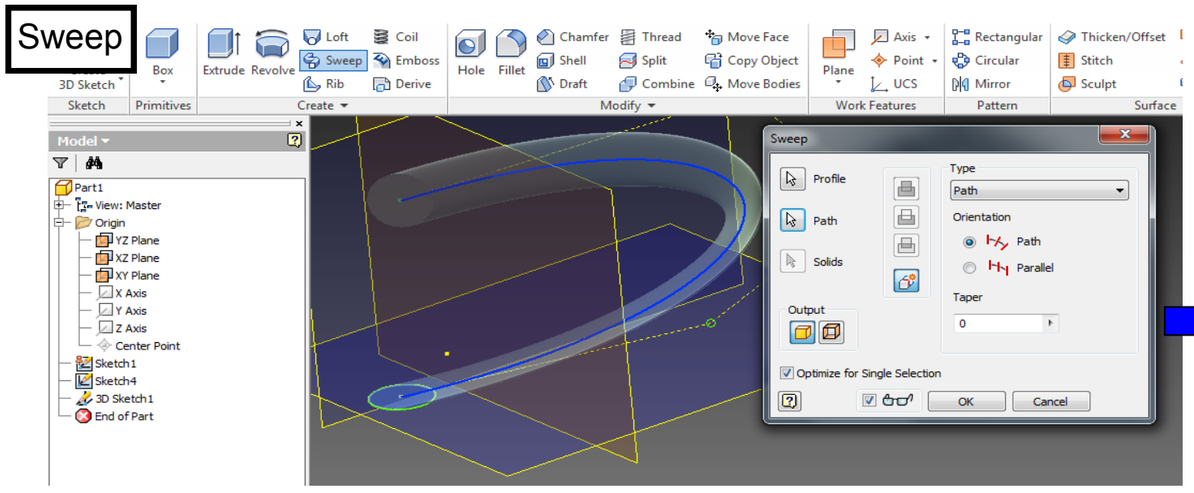


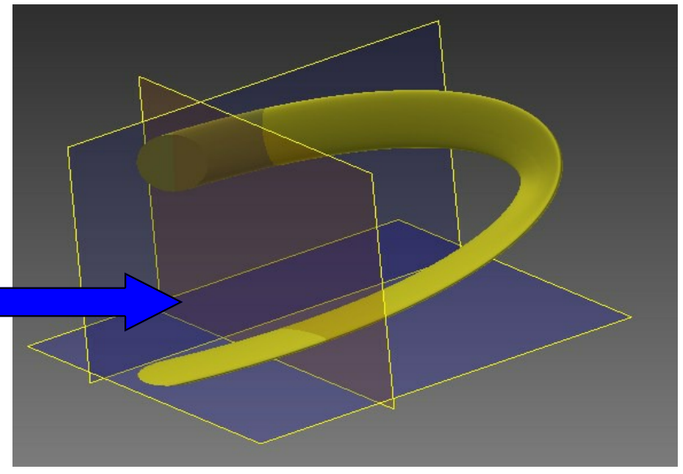
Loft





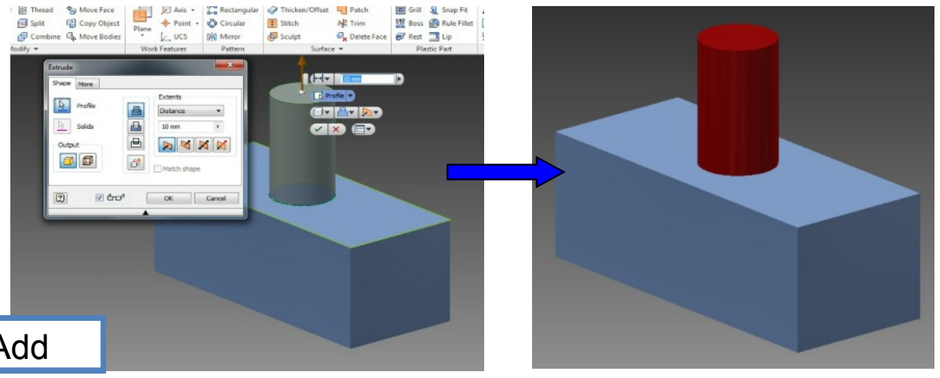
Sweep



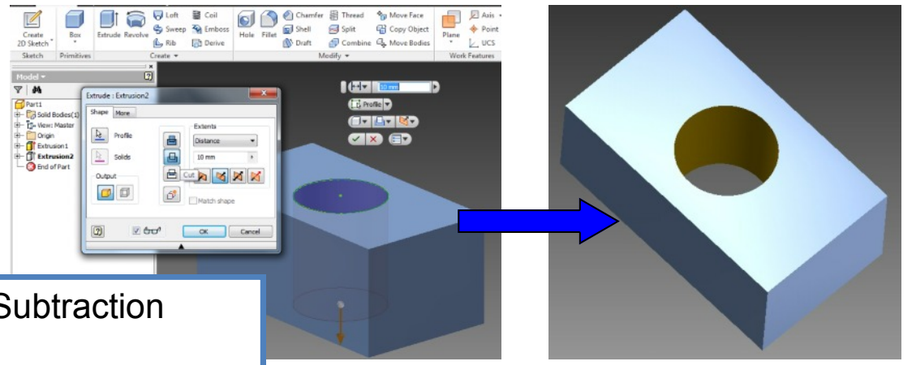


Modelling edits:

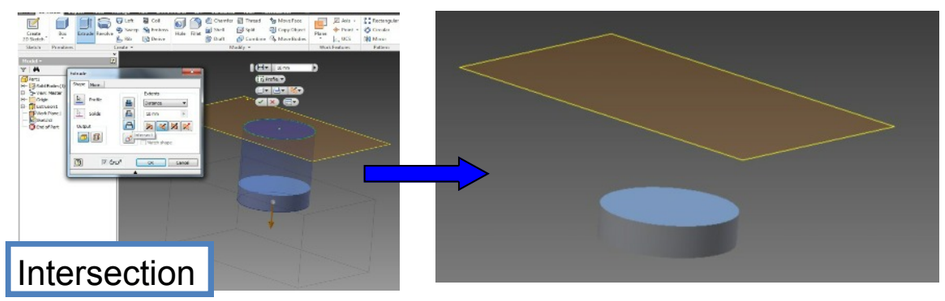
These three edits are known as BOOLEAN functions, and are a basic way to change a model and build others.



Add

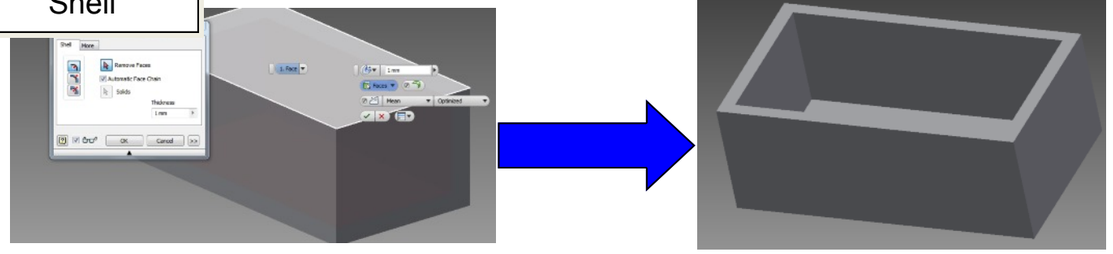


Subtraction

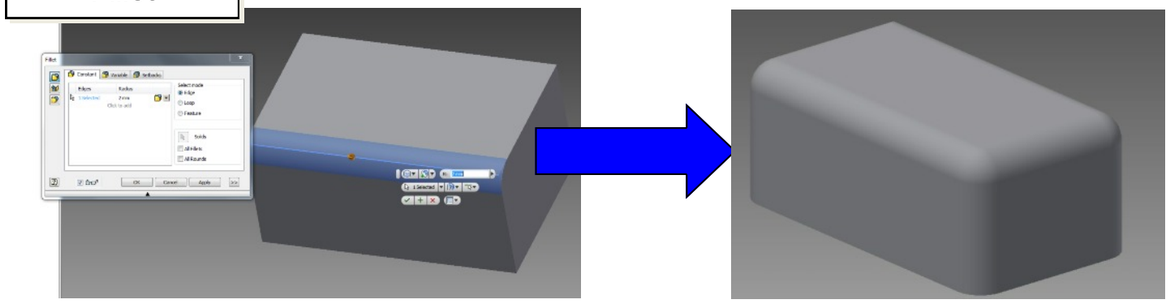


Intersection

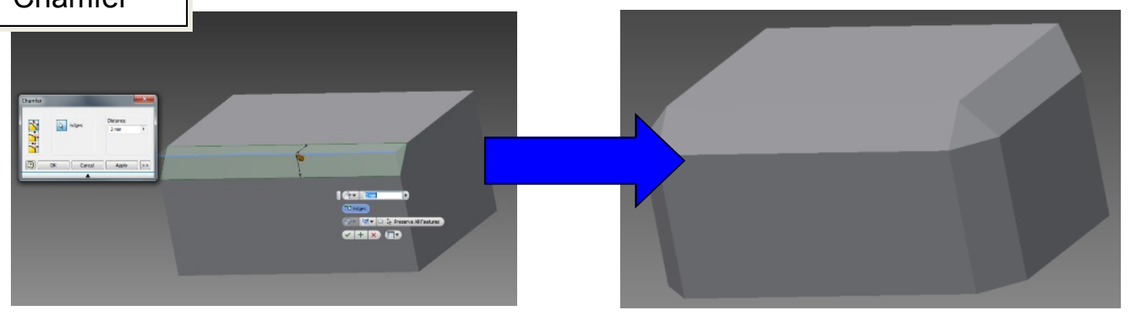
Shell



Fillet

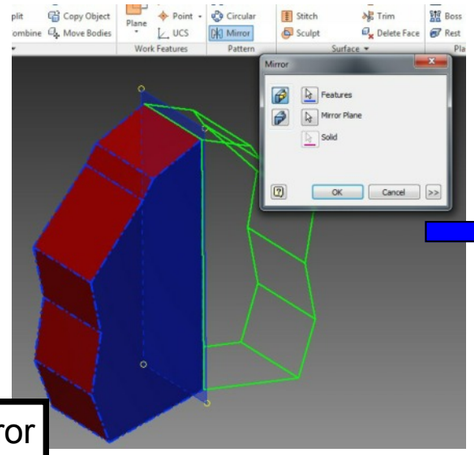


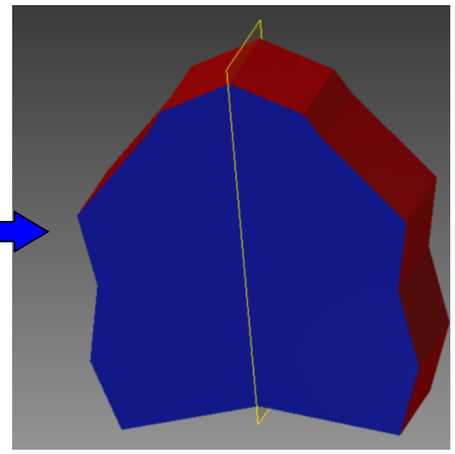
Chamfer



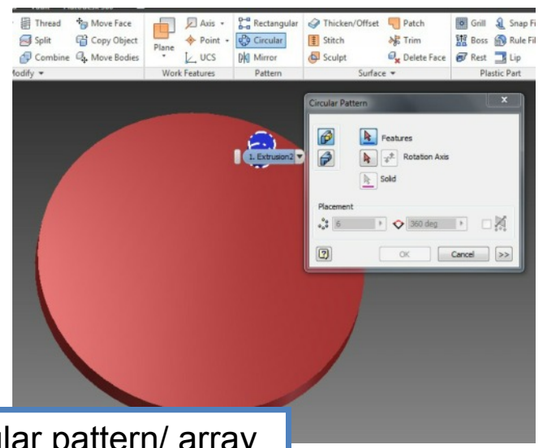
Modelling edits:

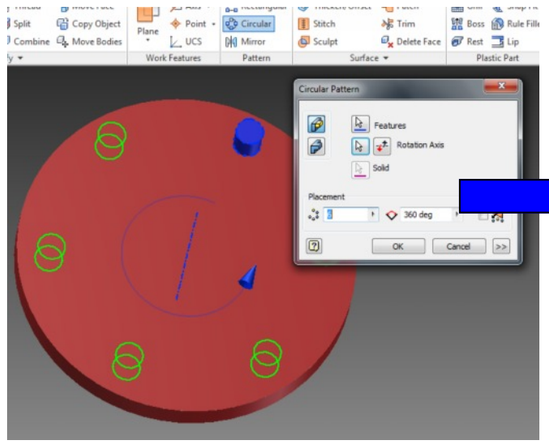
These edits are used to quickly change an existing model's features into more complex forms.

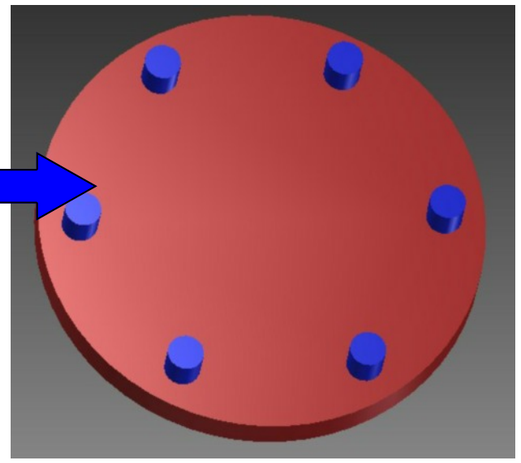




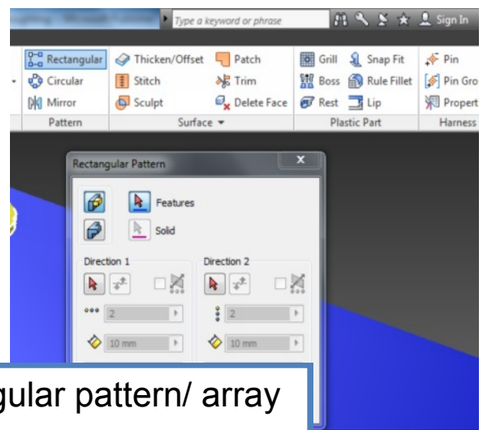
Mirror

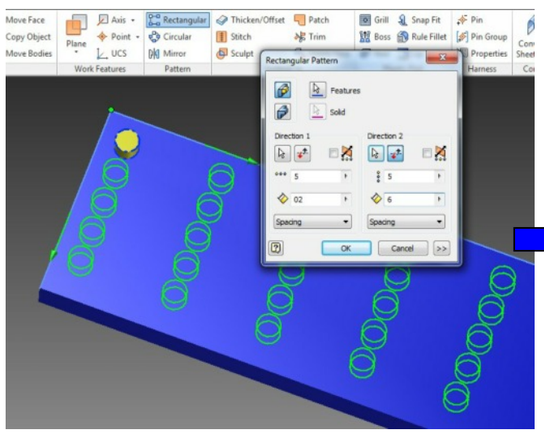


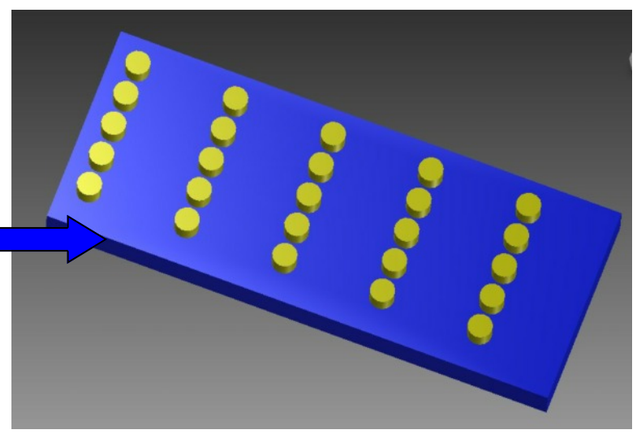




Circular pattern/ array



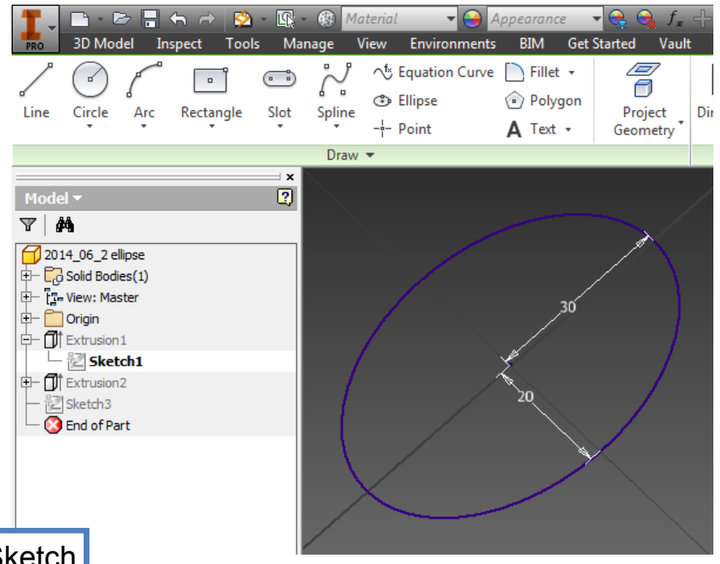




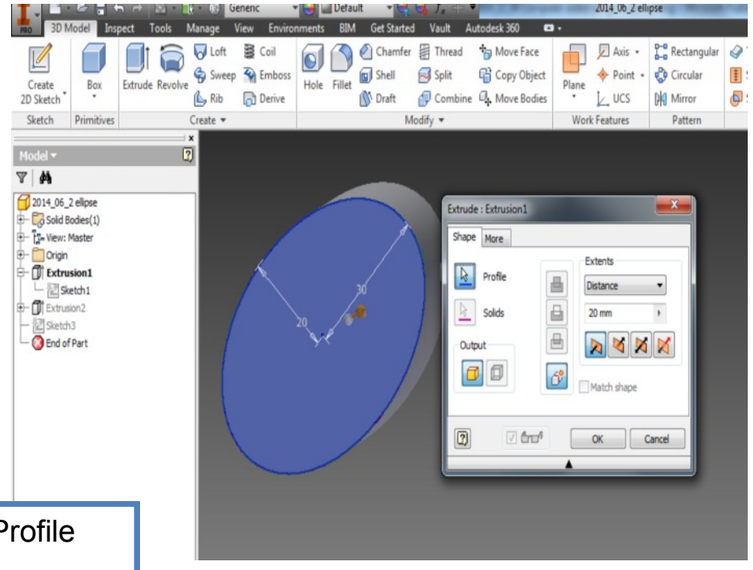
Rectangular pattern/ array

Technical Department

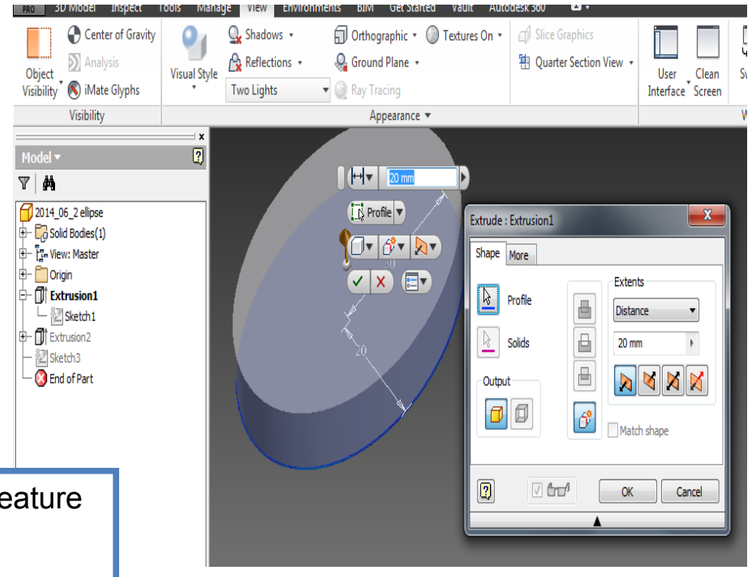
Modelling terminolgy



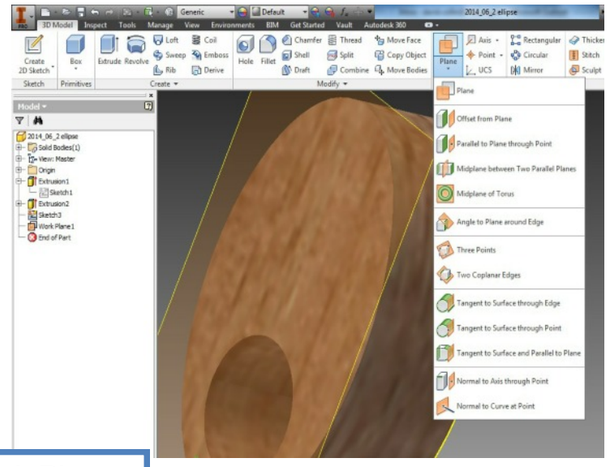
Sketch



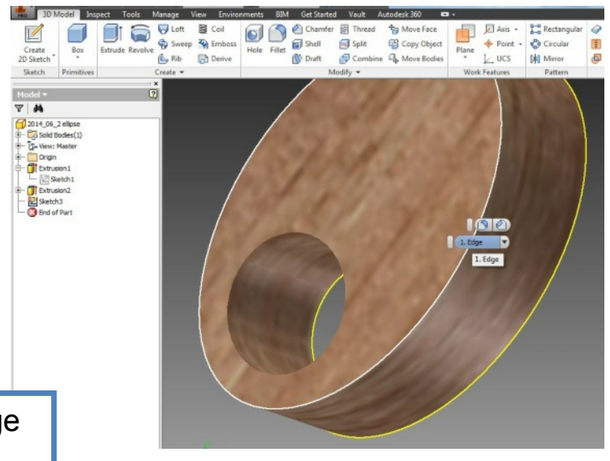
Profile



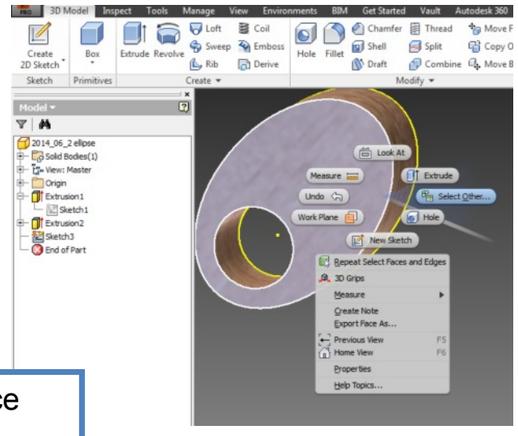
Feature



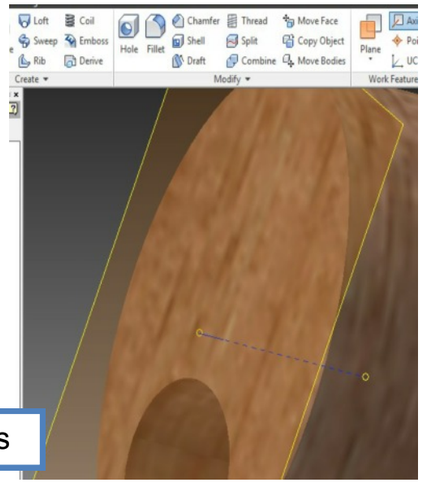
Work Plane



Edge



Face



Axis

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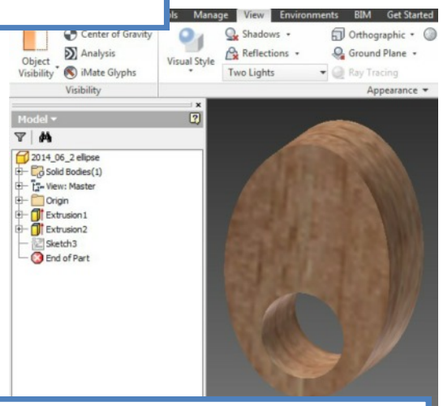
Technical Department

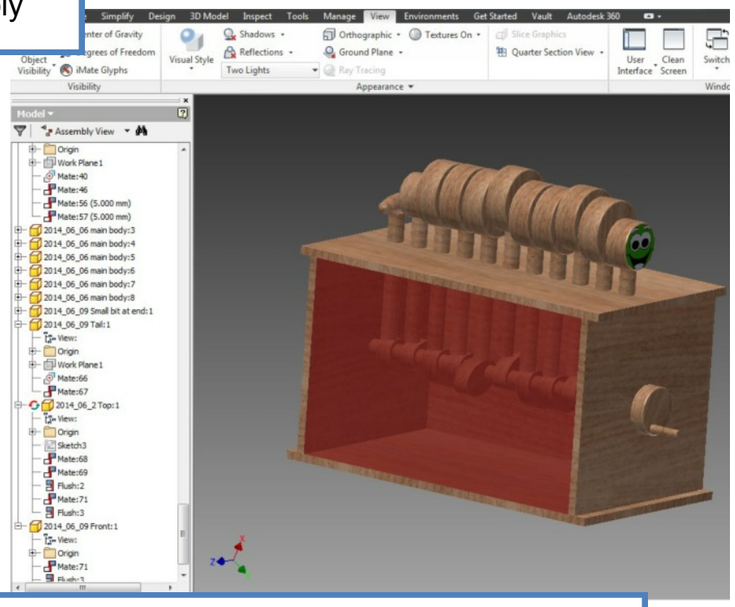
Modelling terminolgy

Component



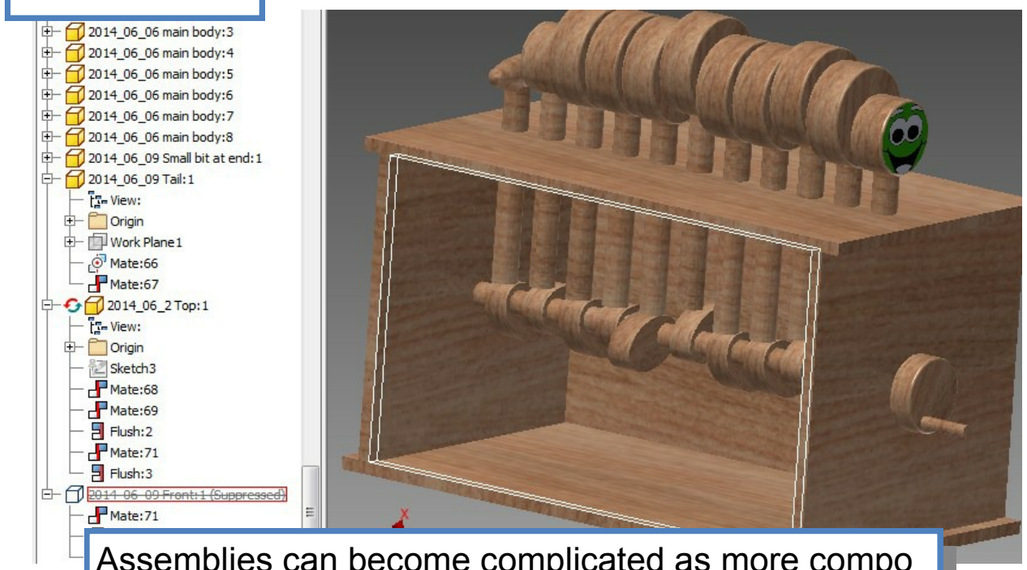
This is a single part, either within an assembly or on its own.

Assembly



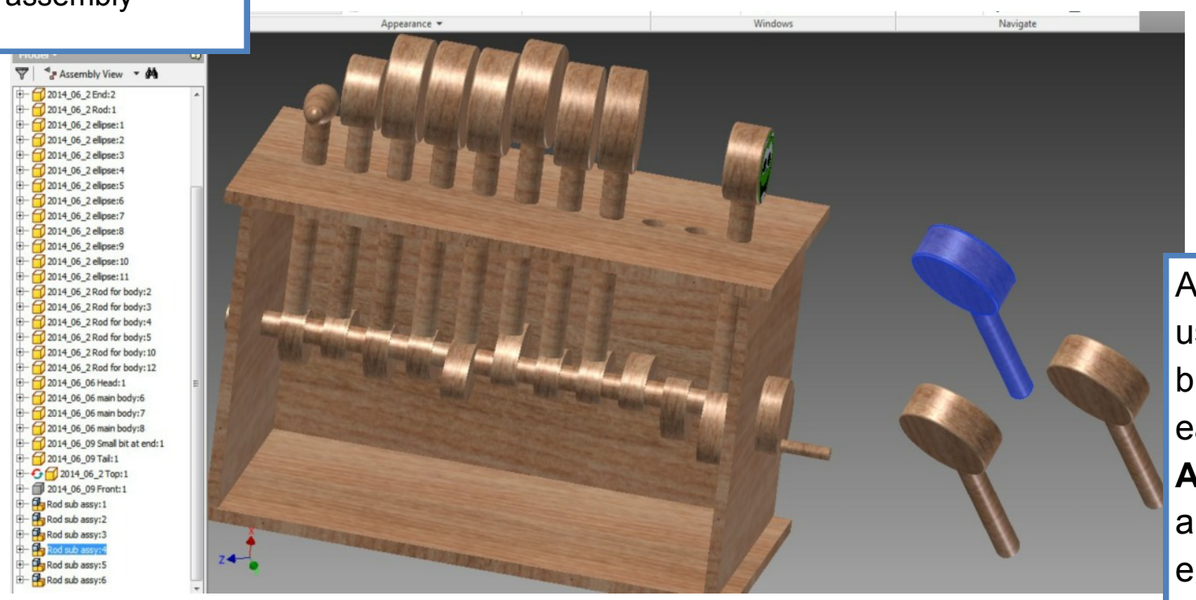
This is when 2 or more components are joined together to form a larger overall body.

Suppress



Assemblies can become complicated as more compo nents are added. The **SUPPRESS** function can toggle a component's visibility on/ off to enable other compo nents to be seen more effectively. In the image above, the red plastic front of the caterpillar toy has been suppressed to enable the interior to be inspected.

Sub– assembly



Assemblies may consist of a lot of frequently used components which are themselves assem bled together. To make the overall assembly easier and quicker to work with, **SUB-ASSEMBLIES** may be adopted. In this example, a sub-assembly of the vertical rods and the cat erpillar body parts has been put into the overall toy assembly.

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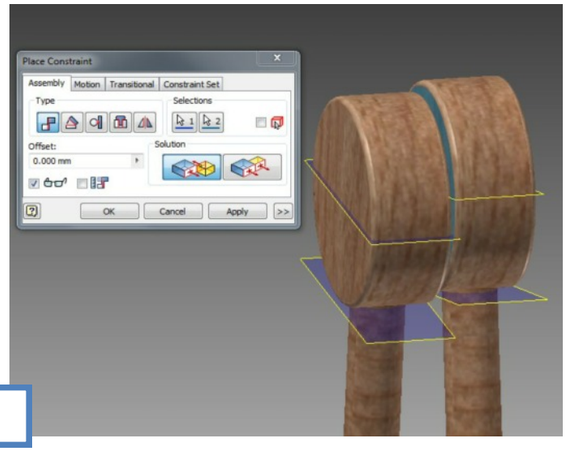
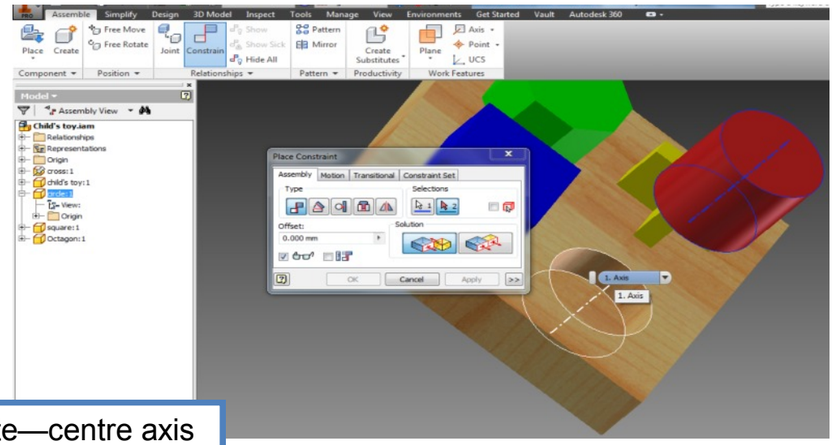
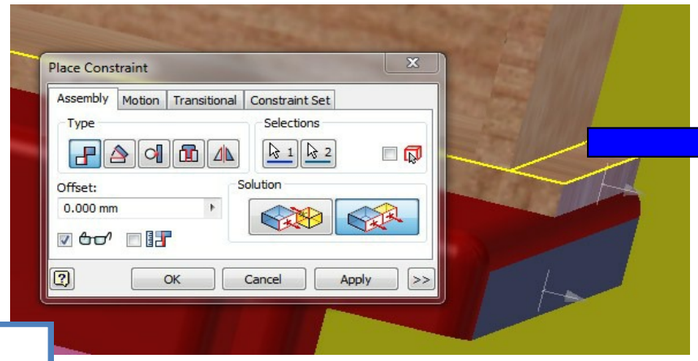
Assembly



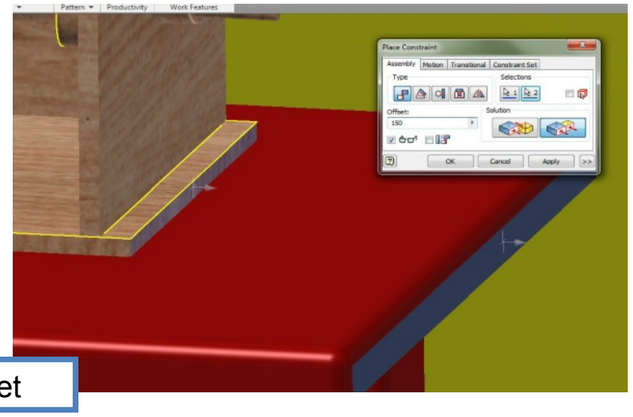
Mate



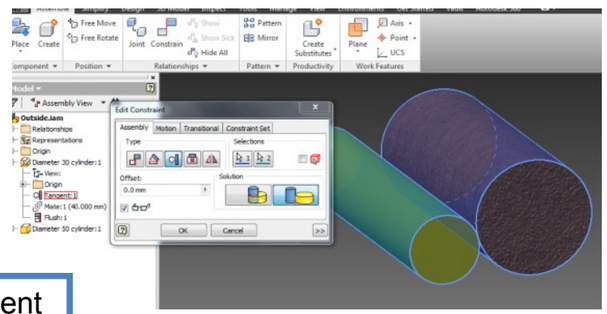
Mate—centre axis

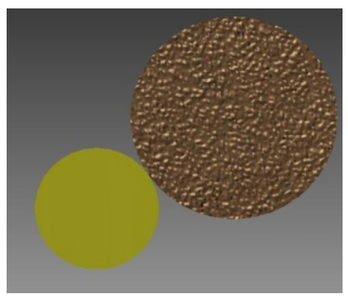


Align

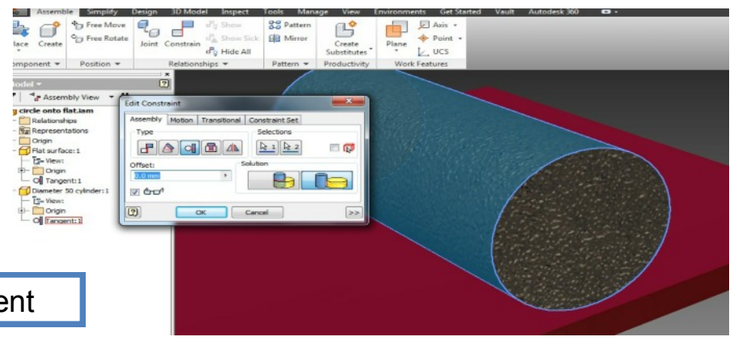


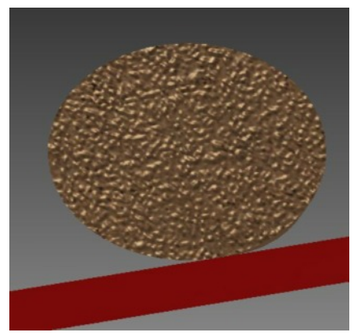
Offset





Tangent

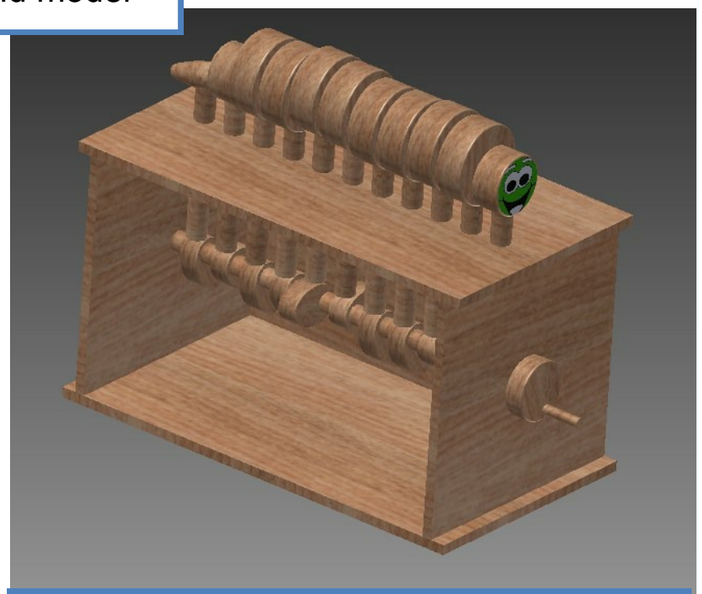




Tangent

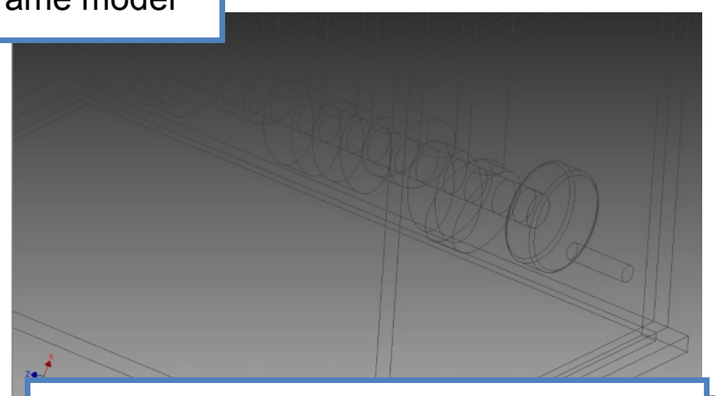
Modelling terminolgy

Solid model

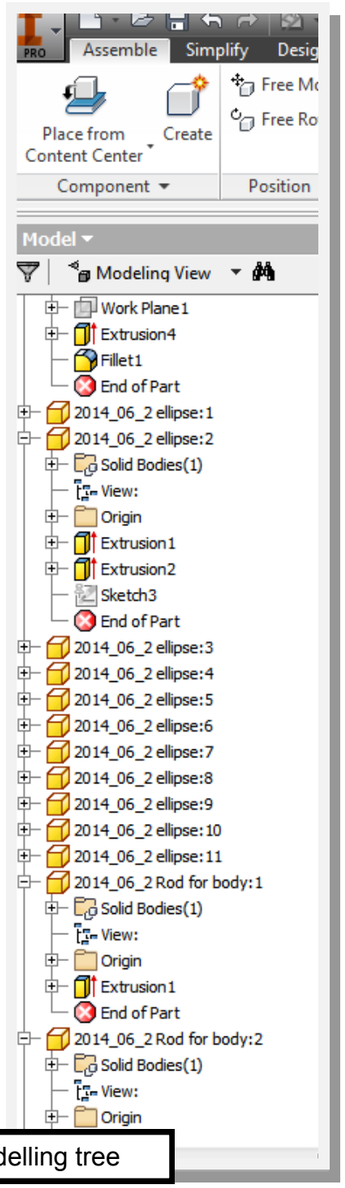


This is the most commonly used view for modelling and enables surface textures and material to be applied.

Wire frame model

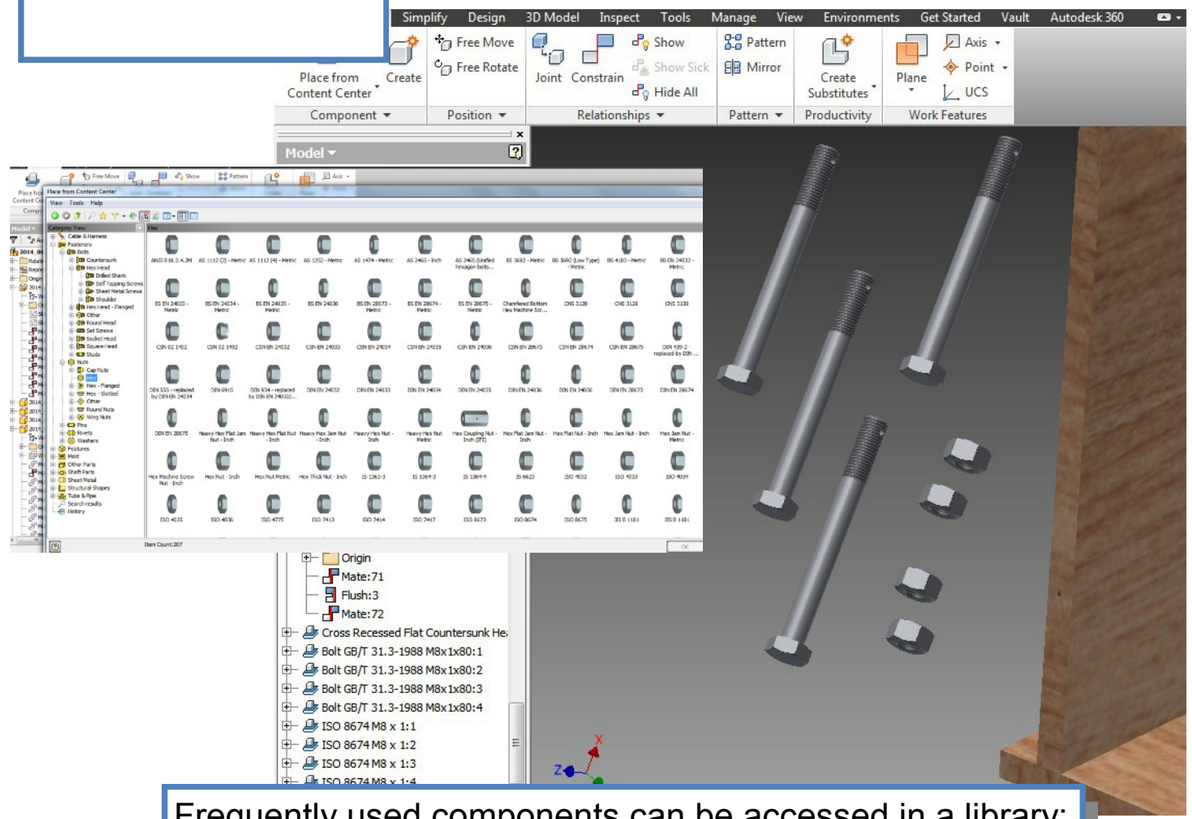


This modelling view only shows the edges of the model and can be useful to show the internal features of an assembly.



Modelling tree

Library of components



Frequently used components can be accessed in a library; this saves time and ensures that all components are of the same standard. This may be within the user's local system or from the internet

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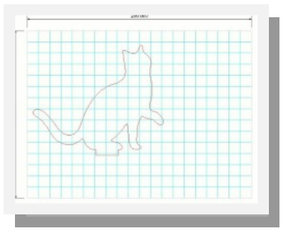
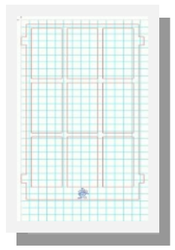
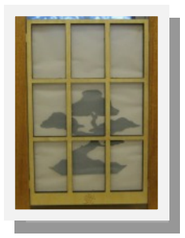
File types:

AutoCAD DXF (Drawing Interchange Format, o Drawing Exchange Format) is a CAD data file format developed by Autodesk[for enabling data interoperability between AutoCAD and other pro grams. The image here shows an AutoCAD drawing which has been converted to DXF to be input into a laser cutter to produce the physical model.



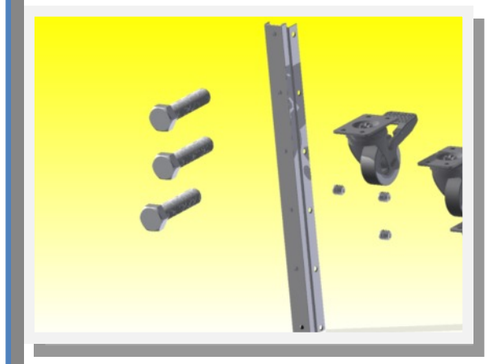
©R. McCluskey

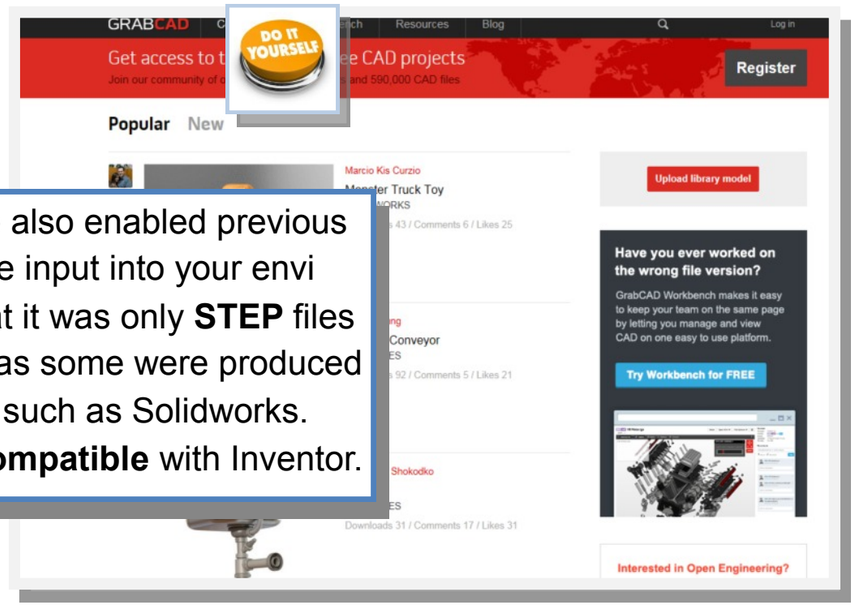




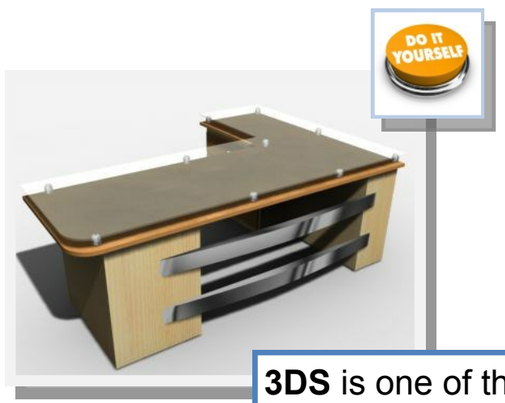
A **STEP** file enables 3D Models produced in one program—such as SOLIDWORKS—to be used in another (i.e. Inventor). Usually a model produced in one would be INCOMPATIBLE with another program, but saving it as a STEP file ensures COMPATIBILITY.

The image here shows STEP files which you were required to use for your Higher Assign ments.





The **GRABCAD** website also enabled previous ly produced models to be input into your envi ronment. Remember that it was only **STEP** files which could be utilised, as some were produced on other CAD programs such as Solidworks. Solidworks files are **incompatible** with Inventor.

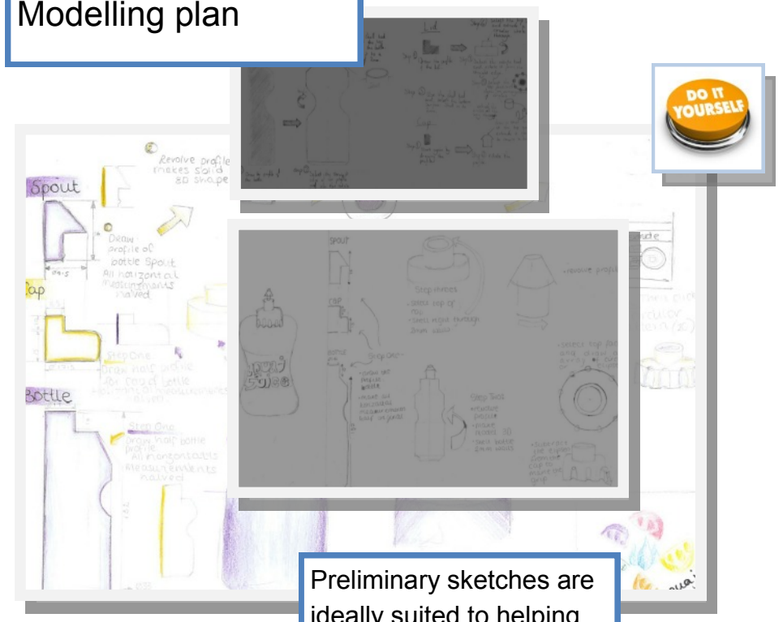


3DS is one of the file formats used by the Autodesk 3ds Max 3D modelling, animation and rendering software.

This enables files to be transferred be

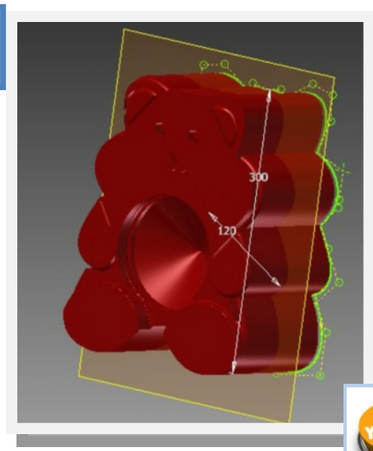
Modelling concepts

Modelling plan

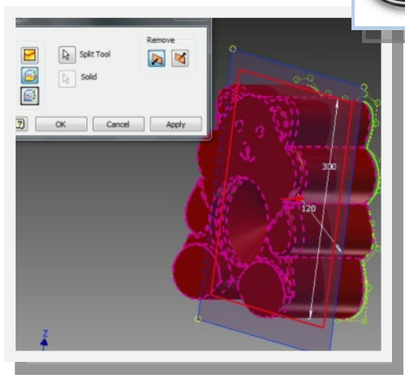


Preliminary sketches are ideally suited to helping plan out complex 3D modelling operations.

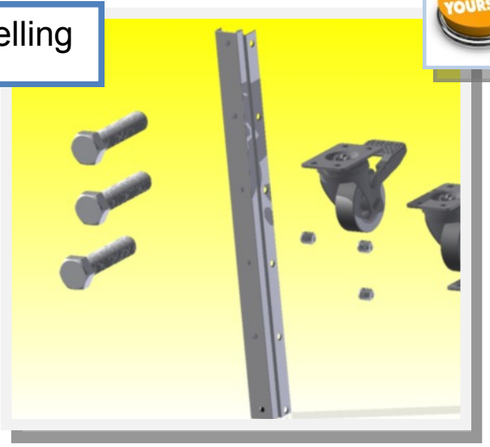
Top down modelling



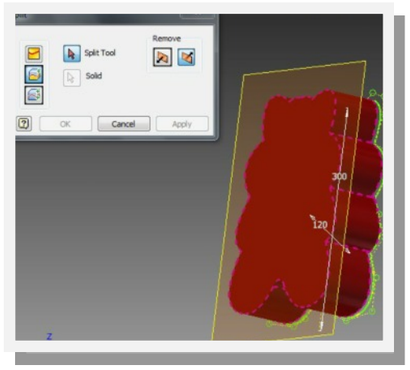
This is when two separate entities are produced from an existing, initial model. The advantages to this are that the two parts fit together exactly, and time is saved as just one model is required to be produced initially rather than two separate halves. This image illustrates two separate parts of a speaker case which have been produced from the initial whole

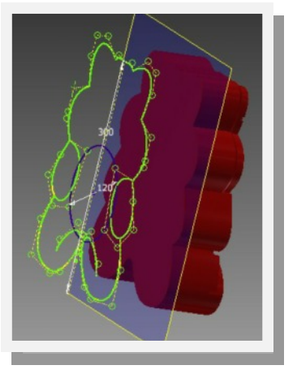


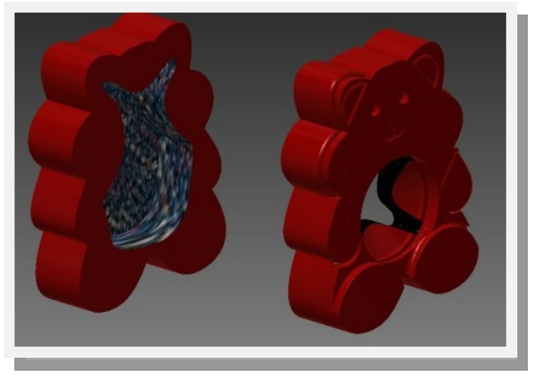
Bottom up modelling



Your Higher assignments were produced using **bottom up** modelling, whether it was the drawer runner, castor wheel or knock down fittings. This allows more complex models to be produced from an initial, rela tively simple parts. Sub assemblies are often used within bottom-up modelling.







3D illustration

With the rapid development of 3D modelling, great advantages have been provided to engi neers, architects and designer. Basic models can be effectively ‘brought to life’ by a range of features within the software. Most 3D modelling programs have an in-built package to enable illustration—i.e. Inventor Studio—but there are many ‘dedicated’ packages which can provide even greater depth to illustration. Several core features are applied to a basic model or scene to make it attractive and realistic:

- **Materials:** metals, plastic and wood effects can be added to the model to give it different appearances.
- **Lights:** there are two basic types of light used to illuminate a model or scene. **Global il lumination** lights up the whole scene, **Focused illumination** involves individual lights pointing at specific parts of the display—like spotlights.
- **Reflections:** these are used to add further realism to the illustration, and bounce light and surface details to other parts of the model or scene.
- **Shadows:** usually a ‘follow on’ effect from applying light to the display, it adds further re alism to the illustration. The more focused illumination involved, the more shadows.
- **Texture:** added to material to give it further life-like qualities. It could involve characteris tics such as a ‘rough’ look for example knurled metal.