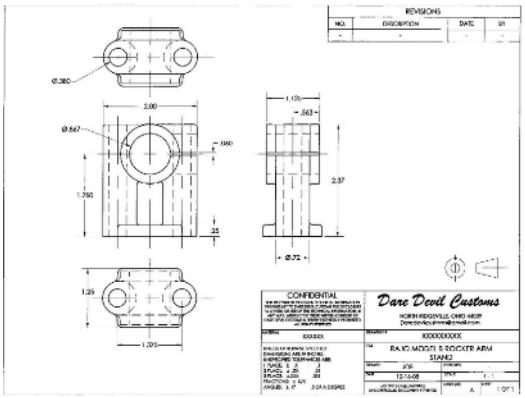
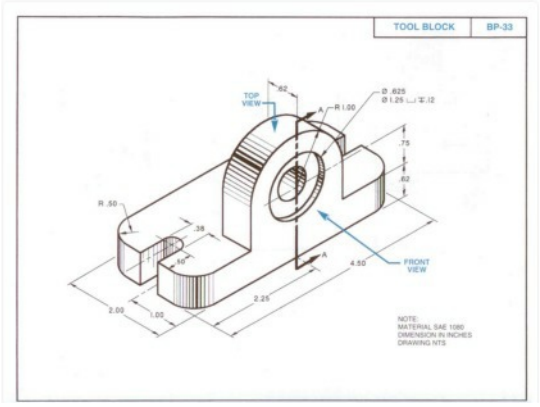
Computer Aided Design Software

Computer Aided Design (CAD) was developed so that architects and engineers, who had previously produced drawings on paper, could produce the same kind of drawings on computers. This has revolutionised the graphics and engineering industries. Nowadays computers have largely replaced drawing boards in industry and commerce. There are two types of CAD you need to know about: **2D** and **3D.**

1. 2D Software such as AutoCAD allows graphic designers to produce orthographic and pictorial drawings using a system of lines, shapes and 2D CAD commands. These drawings are always 2D in nature but can then be turned into 3D models if necessary.



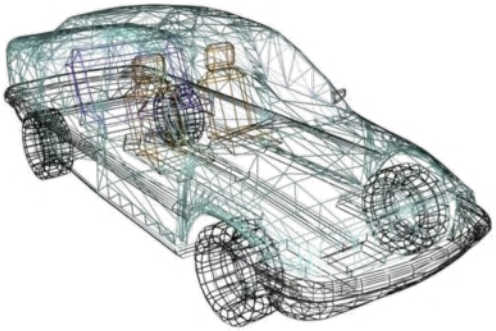


2D CAD software eventually led to the development of **3D modelling software**. This software unlike 2D CAD, allows the graphic designer to instantly build 3D models without the need to draw 2D orthographic or pictorial views first. This is done using 3D CAD commands that instantly allow the designer to transform 2D shapes into 3D models.

The difference here is that 3D models can be rotated to see all sides of an object where as 2D CAD is similar to drawing board work and only provides the designer with an orthographic view or 3D representation = 2D pictorial i.e. isometric.

Types of 3D Modelling

There are 3 types of 3D computer models:



1. **Wireframe model** - The model is built up using a series of connected lines/curves. This creates a wireframe allowing you to see the external shape and internal workings of a model.

2. **Surface model** - The 3D model is built up by drawing the surface of an object normally extruding or revolving the wall of a line or shape. These models replicate products made from thin sheet materials

3. **Solid model** - The 3D model is built up using simple solid geometric shapes such as cones and cylinders and then cutting away the sections that aren't required for holes etc. This type of model can be rotated on screen to be viewed from any angle.

CAD Software - Animation and Simulation

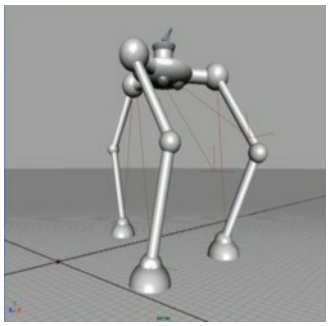
Further types of 3D modelling are **Animation** and **Simulation**. These can be used to run tests on designs and demonstrate the functionality of products that have been designed on the computer. Ultimately, these allow the designer to display their model and bring it to life. These are both outlined as follows:

COMPUTER ANIMATION

In the past all animations were created by drawing thousands of still images by hand, to complete a full moving image. With advances in technology we now have animation software that allows us to create on-screen movement by moving graphic images along a plotted path. This is much **quicker, smoother** and **realistic.** Animation is used to create visual impact i.e. a lift in a building can be shown, moving up and down as it would do in real life. Architects can also use this to take a client on a 3D "walk-through" of their building design.

ADVANTAGES:

- Improves realism and quality.
- On screen movement grabs the user/clients attention.
- It enables the creation of animated stunts or movements.
- Cheaper than building real-life prototypes.
- Industries like cinema and film can use animations rather real actors to save costs and bring ideas to life.
- Quicker to produce than manual animations.

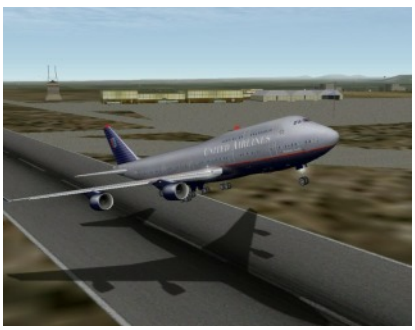




COMPUTER SIMULATION

The use of computer simulators to re-create real life situations that would otherwise be too difficult or dangerous to create elsewhere. It is made realistic by using simulated real life environments. Its main purpose is for training and testing. For example, pilots use training simulators to learn how to cope in dangerous situations that may occur whilst flying. Car engineers test wind resistance etc. on a car before even building a prototype.

ADVANTAGES:

- Dangerous events or tests can be carried out safely e.g. training pilots to fly planes.
- Realistic training programmes can be used to train people.
- It is much cheaper than the "real" event because no real materials are being used.
- It allows accurate predictions to be made which improves design quality in the final product.
- Full product testing can be carried out to analyse a product.


Advantages/Limitations of CAD vs Manual

Computers have largely replaced drawing boards in industry and commerce. A CAD system of drawing has many advantages over the traditional drawing board method but it also has it's limitations and it is important to be aware of both.

Advantages

- **Storage of drawings/models—**A completed drawing/model can be stored on a hard drive, external hard drive or USB flash drive. This means that less storage space is required and drawings can be printed many times with no loss of quality and models can be used again and again. Previously in manual methods drawings would have been stored using filing cabinets taking up lots of space.

- **Drawing speed**—Although it can take a considerable length of time to train CAD/CAG operators, drawing production is generally much faster. This will save the company time and money in the long term.

- **Ease of modification**—Drawings/models and publications can be easily changed which saves time and money. In manual methods, mistakes can lead to the drawing or model being started all over again.

- **Accuracy**—Drawings/models can be enlarged or reduced with no loss of detail. Extremely fine, detailed work can be produced using the **zoom** command. Also, by using sized grids and grid snap features in CAD software, the graphic designer can be much more accurate in the production of drawings/models.

- **Templates** - Templates set to British standards drawing conventions can be set up to save time when producing drawings. In manual drawing the designer would have to draw accurate hidden lines, centre lines etc. every time they needed them, where as a computer can add this exactly the same every time using a set template/layer without error.

- Use of a **CAD library**—Drawings/3D models can contain a number of repetitive elements such as windows, doors, nuts and bolts etc. It is useful to have these items stored in a library file which can be retrieved and positioned on a drawing when required. If doing this manually you would have to redraw/remodel each of these items again and again.

- **Layers**—Drawings can be 'built up' using a series of layers. These layers can be switched on and off or edited individually which can simplify complex drawings, making it easier to understand. For example, in a complex 2D CAD orthographic the designers could turn off the construction lines layer, centre lines layer and hidden detail layer to show only the outlined views. In manual drawing, what you have drawn is fixed and can't be removed.

- **Communication** - Electronic work can be sent via email without loss of detail, speeding up communication and creating instant dialogue. In manual drawing, drawings would have to posted or faxed taking time and losing important detail.

Disadvantages

- **Data Theft/Viruses** - With the vast increase of computers across the world it is now easier than ever for people to access information about companies and each other. Hackers can exploit computers to steal private and important information or destroy systems using viruses.

- **Power/System Failures** - If there is a power cut or a computer system crashes it can stop all production and cause data loss.

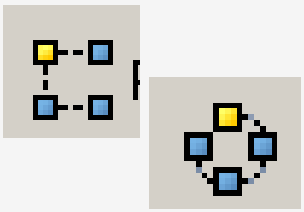
- **Expensive** - Set up costs for a company can be extremely high.

- **Training** - Staff unfamiliar with CAD will need training, leading to costs and loss of time.

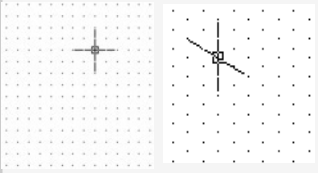
- ***Social Factors* -** CAD/CAM (Computer Aided Manufacture) has reduced the need for a great number of skilled workers. Jobs which were traditionally done by skilled manual workers are now being overseen by fewer workers who operate computer controlled machines and robots which perform the manual work. This leads to the loss of skilled tradesman.

C.A.D. Commands

You will have used most of these editing commands while producing C.A.D. items for your portfolio . For the Knowledge & Interpretation part of the exam, these commands should be learned. The exam may refer to 2D and 3D draughting commands from software such as Autodesk AutoCAD and Autodesk Inventor.

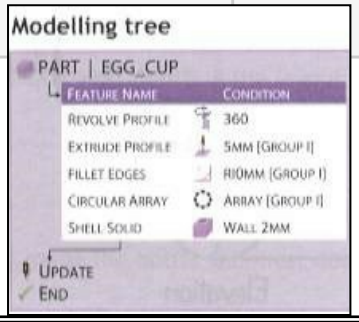
TOOL	DESCRIPTION	IMAGE	2D or 3D
CHAMFER	Used to angle corners.		2D & 3D
FILLET	Used to round corners.		2D & 3D
ARRAY RING and BOX DO NOT REFER TO THESE AS PATTERN	Creates circular or rectangular arrangements of copied objects.		2D & 3D
ZOOM	Allows you to zoom in and out of graphical item.		2D & 3D
SCALE	Enlarges or reduces the original size of an object.		2D
DIMENSION	Adds sizes to a drawing.		2D
COPY	Copies and positions objects without having to redraw them each time.		2D
BREAK	Removes a section from the middle of a line.		2D
TRIM	Cut or remove part of line that		2D
EXTEND	Makes a line longer.		2D
ROTATE	Turns an object to any angle around a selected point.	 	2D & 3D
MIRROR	Creates a mirror image copy of an object.		2D & 3D
PAN	Allows you to drag the page around your screen.		2D & 3D

C.A.D. Commands

MOVE	Allows you to move parts of your drawing to a specific point on your page.		2D & 3D
TEXT	Add writing to a drawing.		2D
ORTHO	Restricts cursor to horizontal and vertical movement only.		2D
SNAP	Restricts the position of the start and end points of lines. (improves accuracy).		2D
LAYERS	A complex drawing can be built up in layers making it easier to work on. Each layer can be turned on or off and can be printed out separately.		2D
GRID	Displays a grid, orthographic or isometric, of any given spacing.		2D
LINE	Draw a line.		2D
RECTANGLE	Draw a rectangle/square normally around two corner points		2D
CIRCLE	Draw a circle		2D
ARC	Draws an arc usually around 3 points = start, end and middle		2D
ELLIPSE	Draw an ellipse (oval shape).		2D
POLYLINE	A a series of straight that stay connected to make an unusual shape		2D
SPLINE	Special line. Control nodes on the line to allow you to make a series of smooth compound curves.		2D
EXTRUDE	Allows you take a simple 2D shape and pull it out into a 3D object. I.e. a 2D square extrudes into a 3D cube.		3D
REVOLVE	Allows to revolve half of a profile/shape around a central axis, making it into a cylindrical feature. I.e. a 2D semi-circle becomes a 3D sphere		3D
SHELL	Hollows out a solid 3D model to create a shell.		3D
WOKPLANES	Set planes where you can draw 2D sketches that allow you to build your model from the ground up, side to side, or front to back.		3D

CAD MODELLING TREE:

A CAD modelling tree almost tells the story of how you have created your model. Its lists each of the 3D features you have carried out and stores within them, the 2D sketches used to build the 3D feature. It also allows you to go back into any 3D feature or 2D sketch and edit it to update your model.



3D C.A.D. Commands

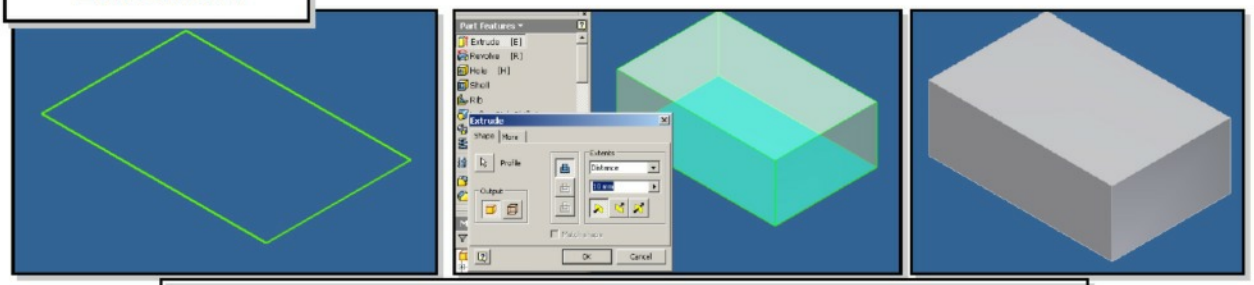
As well as the commands shown on the pages previously, you will need to know 3D commands in more depth. You will often be asked to describe how a graphic designer could build a given example of a 3D model. You will also need to know the order these commands are used in.

The 3D CAD process:

1. Start by building individual components.
2. To do this, select a work plane on which to build your model.
3. Draw a 2D sketch of your model using the commands listed on the previous page.
4. Create your model using the 3D command features such as extrude etc.
5. Assemble your individual components to create a complete model.
6. Illustrate your model to deliver realism.

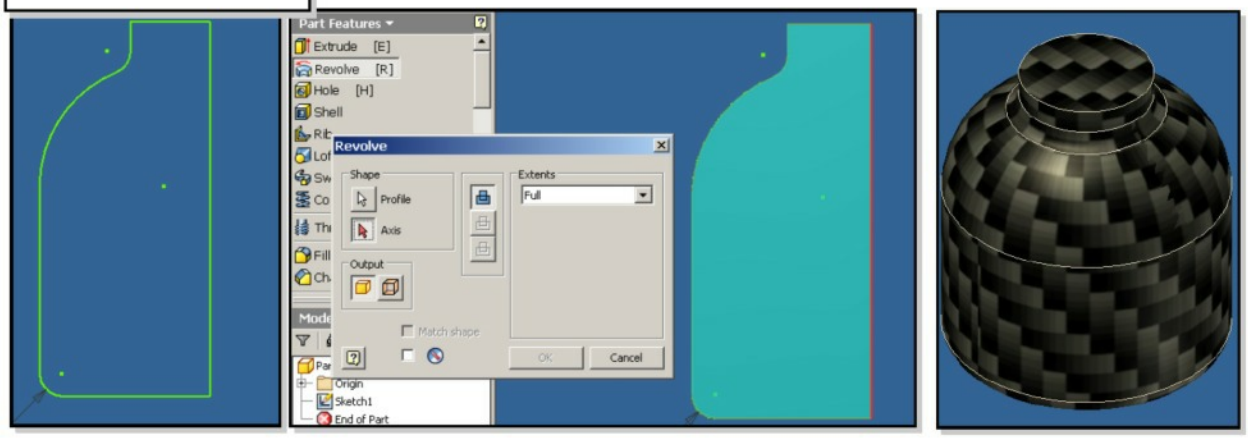
3D CAD features/commands explained further:

Extrusion



Extrusion is the most common feature used, and allows the construction of a 3D model with **VERTICAL SIDES.**

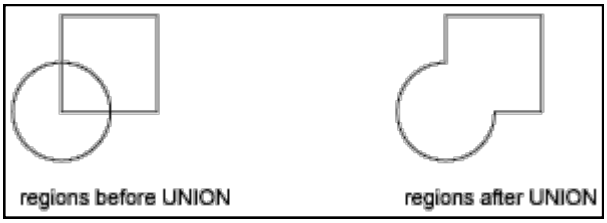
Revolve

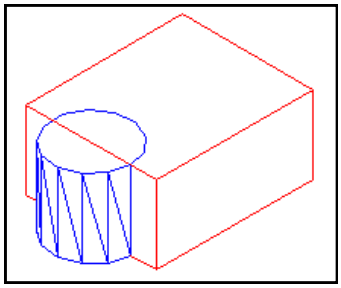


Revolve is a feature which is used to construct models which have more complex **PROFILES** such as curves, diagonals, etc.

3D C.A.D. Commands

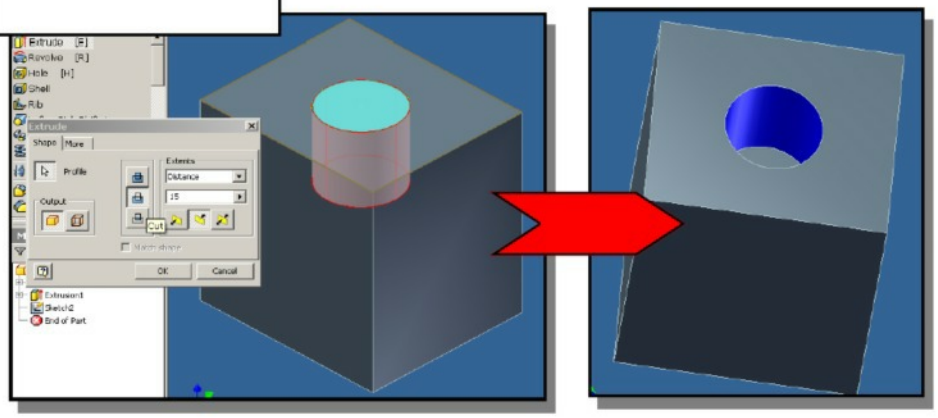
Union





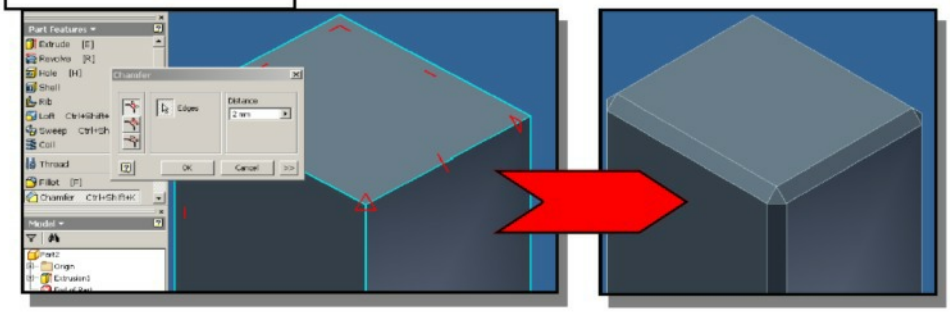
UNION
Allows two 2D sketches to be combined to create a solid shape or for material to be added in a 3D model to create a 3D shape.

Subtraction



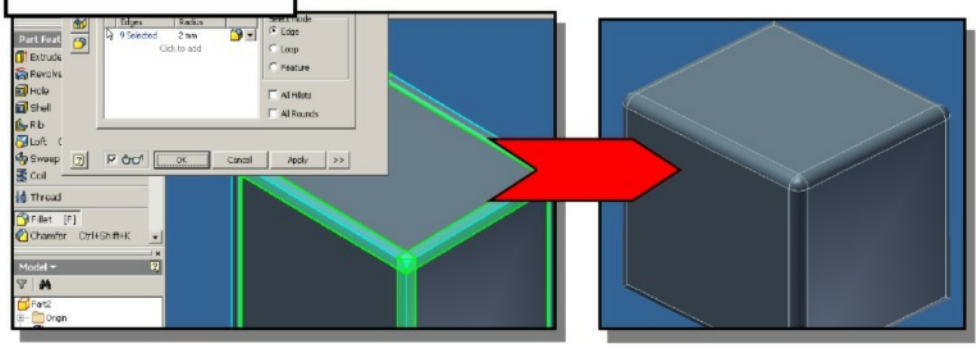
SUBTRACTION allows a section of the solid to be **removed**; the shape of the profile and depth of the removal is determined by the user.

Chamfer



CHAMFER applies an **angled edge**; the size and angle can be varied.

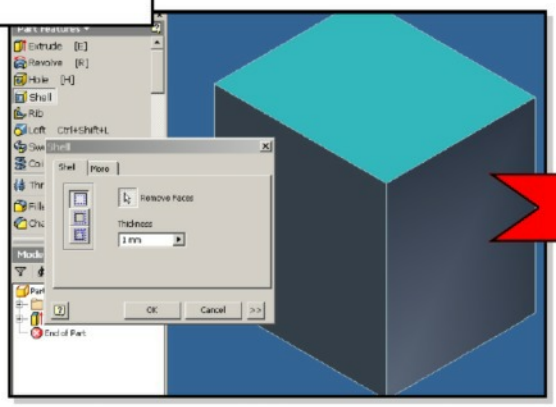
Fillet

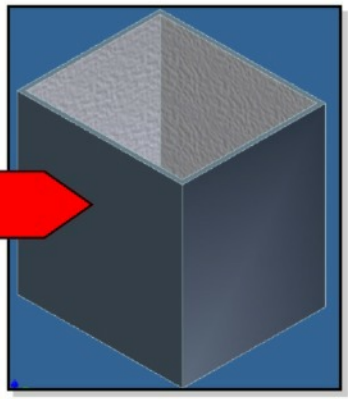


FILLET applies a **rounded edge** to the object; the size and style of the fillet can be varied.

3D C.A.D. Commands

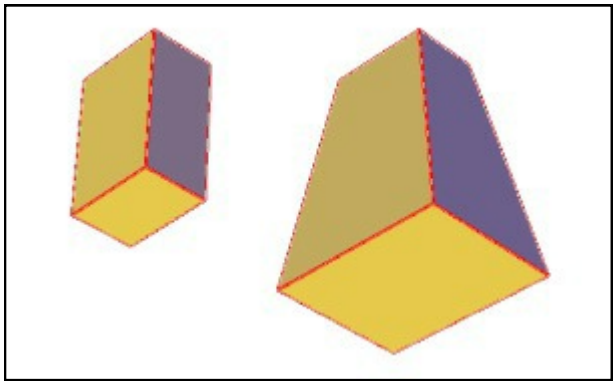
Shell

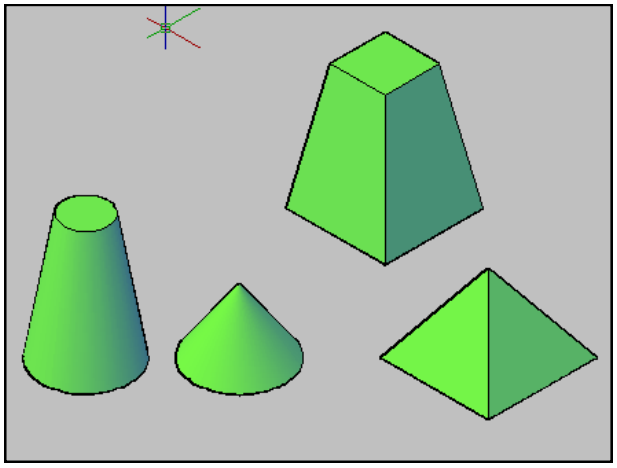




SHELL allows a solid object to be 'hollowed out'; the thickness of the walls being determined by the user.

Taper





TAPER

Allows you to slope the surface of a 3D model without using the chamfer or loft commands. The taper is controlled by setting an angle when using the extrude command. This turns a regular shape i.e. a box into a sloped shape e.g. a box becomes a pyramid.

3D CAD Assembly and Illustration

Assembly:

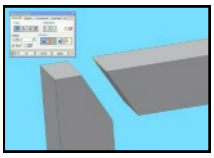
This is the name given to completed 3D models and involves pulling individual 3D components models together to create a final assembly.

3D models are assembled using constraints. Constraints basically act like glue and allow the designer to lock one component to another.

There are six main constraints you should know:

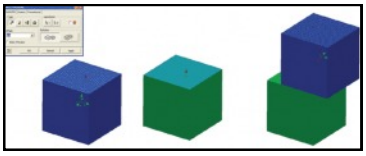
Align *(Flush):* Forces the face of one object to be aligned with the face of another object.

Offset: Used in co-ordination with other constraints, the offset tool allows you to create a special distance between the components you are trying to assemble.

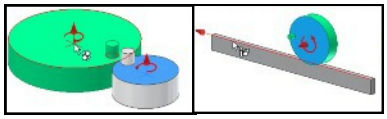


Orientate: This allows you to constrain component at angles to one another. The face or edge of a component can be angled to the face or angle of another component.

Mate: The mate command joins two faces together.



Tangent: Locks the round face of a cylinder to the round face of another cylinder of flat face of a prism.



Computer Illustration (rendering):

Computer illustration, sometimes called computer-generated imagery (CGI), is the technology used to create visually appealing or realistic-looking graphics.

Computer illustration has surpassed manual methods of illustration in most industries because of the many advantages that it offers.

Computer illustrated images do not rely on the designer having traditional manual skills with artistic tools. These skills are replaced by the imagination and creativity to produce images that have special impact.

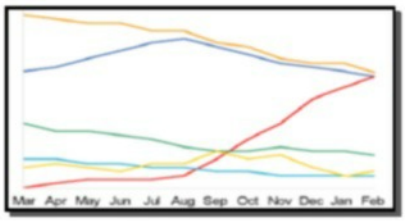
New technologies, from the internet and phone applications to video games and architecture, rely on illustrators to create the graphics and images that will appeal to the target audience.

Graphs and Charts

Statistical information often means little when laid out in a simple list or table. The true meaning of the statistics can be brought out much more clearly by the use of the right graph type accompanied by the right graphic.

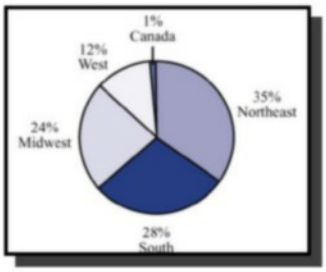
Knowing what type of graph to use for any given situation is a skill you should try to develop and a brief explanation is given here:

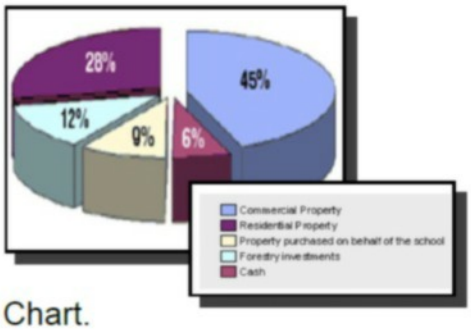
Line Graphs are used to show how values change over a period of time.



- The first example here describes six different values changing over the course of a year.
- The second example uses a graphic to enhance the graph. The graphic is relevant to the topic and therefore works well.

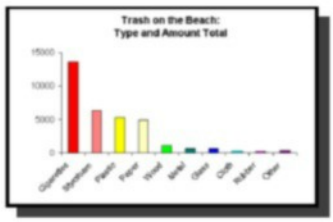
Pie Charts are used to show how values compare to some whole number.

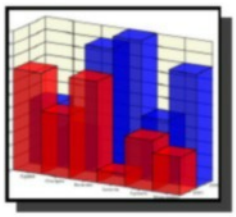


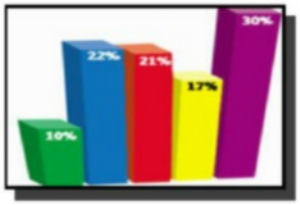


- The first example here shows a basic 2D Pie Chart.
- In the second, the Pie Chart is a bit more complex because it has been shown exploded.
- The third example is the clearest because it has been shown exploded and is 3D. This makes it the easiest to read.

Bar Charts are used to show how values compare directly against other values.







- The first example here shows how a series of values compare with each other and uses a simple 2D layout.
- In the second, the graph is a bit more complex because it compares the five different values and shows them as 3D blocks of different colour
- The third example overlays one year's values against another as well as using a 3D coloured layout.