

Working with Blender for 3D Printing

Blender is a very powerful open source graphics package primarily designed for modeling to produce rendered still images and animations. It also allows users to produce accurately dimensioned models for 3D printing. The Blender development community has recognised this and the latest editions now include a suite of tools for checking the models produced to ensure they are print-ready.

Where to get Blender

Blender is free to download and can be obtained from the website below.
<http://www.blender.org/>

On the CD you have been provided with you will find versions 2.71 and 2.72 for 32 bit Windows and Linux. If you would like Mac versions or 64bit versions you will need to go to the Blender website to download them. The Windows versions are either zipped-up self-contained installations which do not need to be installed, or as a self-installing .exe.

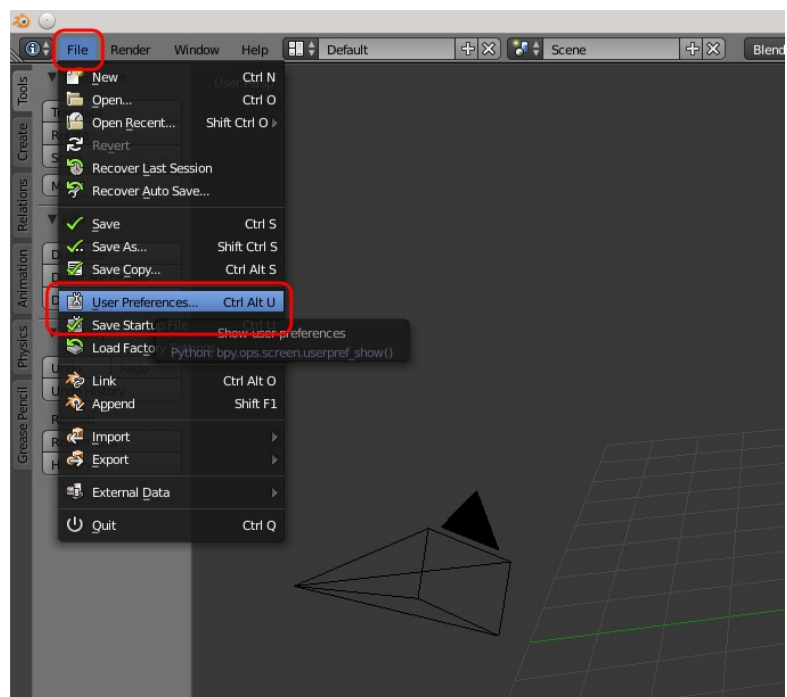
A Special Thing to Remember When using Blender

A word of warning about Blender: Blender will NOT ask you if you want to save before it shuts down. Make sure you save your work before shutting down the application. The latest version does ask you if you are sure you want to quit so this does allow for second thoughts.

Setting up Blender

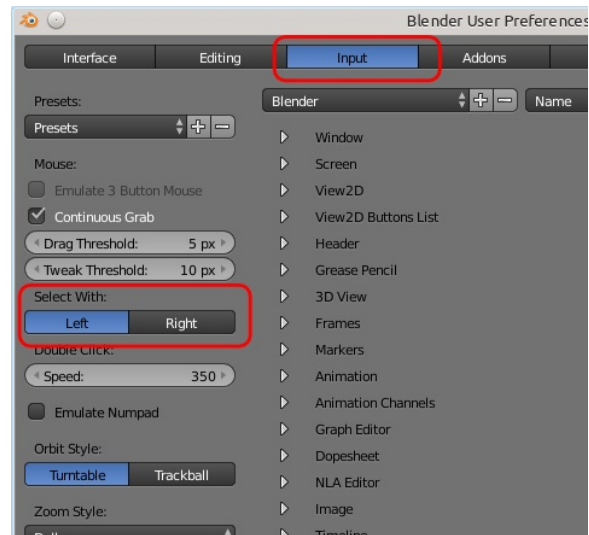
Blender's default settings are slightly unhelpful for 3D modeling, particularly if you are used to other modeling packages. The installations we are using for the workshop have already been set up; but, should you wish to set up an installation at home, here are the suggested changes:

Open the “**User Preferences**” window by clicking on the **File Menu** at the top of the Blender Window and selecting the **User Preferences** option.



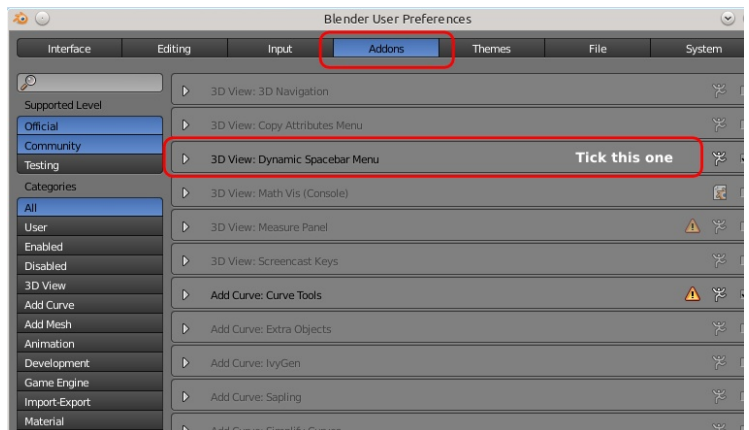
Select the “**Input**” tab and click on the “**Left**” button under the “**Select With:**” option. This means that to select an object, vertex, edge, or face, you will use the left mouse button.

This will make the method for selecting items consistent with most other 3D modeling and animation packages.



Select the “**Addons**” tab and scroll down until you find the “**3D View: Dynamic SpaceBar Menu**”. Tick the box to the right. While this is not necessary to enable you to build objects in Blender, it is a useful addition.

Now when you hit the **Space Bar** when the cursor is in the 3D View, a menu will pop up that allows you to add objects, manipulate them and do a whole host of other things.

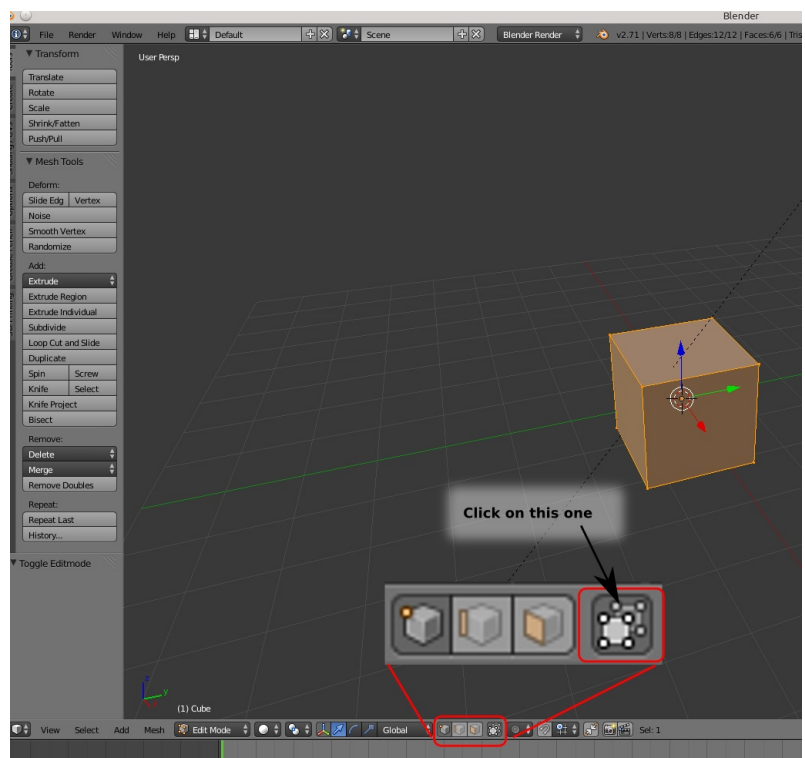


Down at the bottom of the **User Preferences** window you will find a “**Save User Settings**” button. Click on this to save the modifications you have made so that these will be your settings when you next run Blender.

As a default, Blender only allows you to select the vertices on the surfaces of an object that are facing you when in the **Edit Mode**. This is not particularly helpful if you are trying to select the whole top surface of a cylinder from a side view for instance. To change this, do the following:

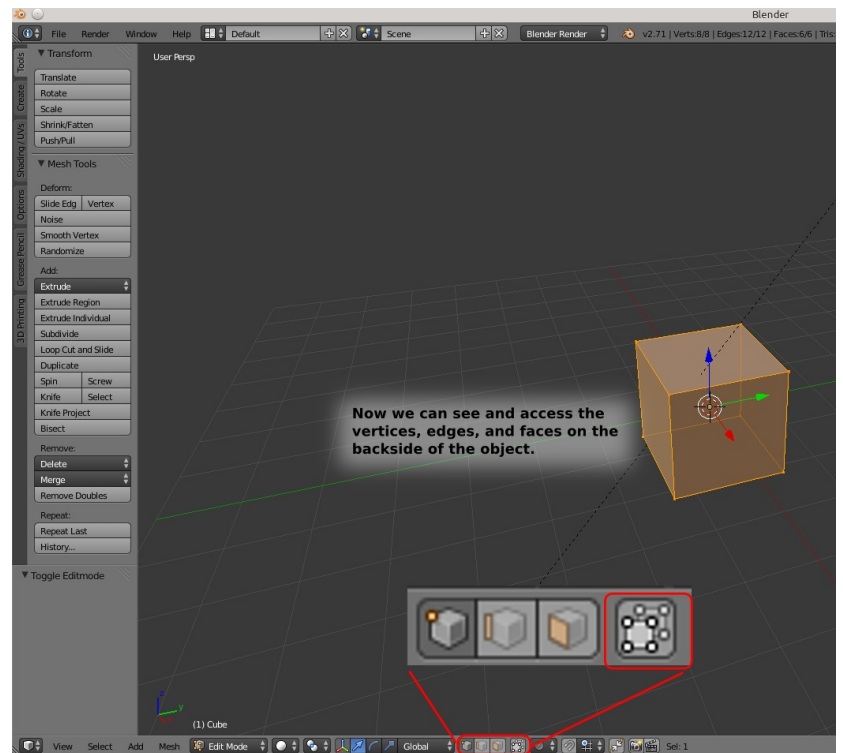
With the default cube selected, hit the **Tab** button to enter **Edit Mode**.

At the bottom of the 3D window you will find a picture of a cube with big vertices on one of the buttons. It will have a dark background as shown in the image to the right. Click on this button to deactivate it.



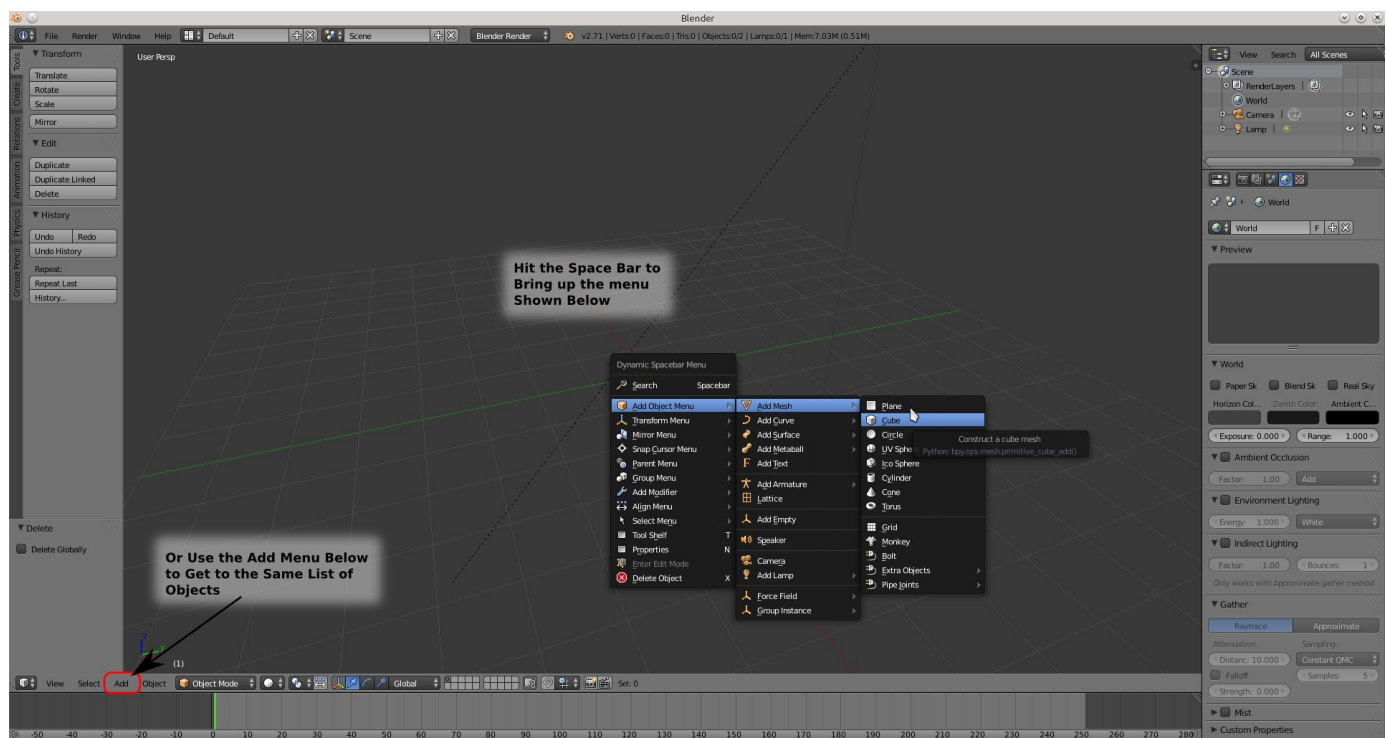
It should now have a light grey background as shown in the image to the right. The default cube in your scene should now have the vertices on the back corners visible.

Go to the File menu at the top of the screen and select “**Save Startup File**”. Once you have done this, the settings we have just set will be automatically loaded each time you start Blender.

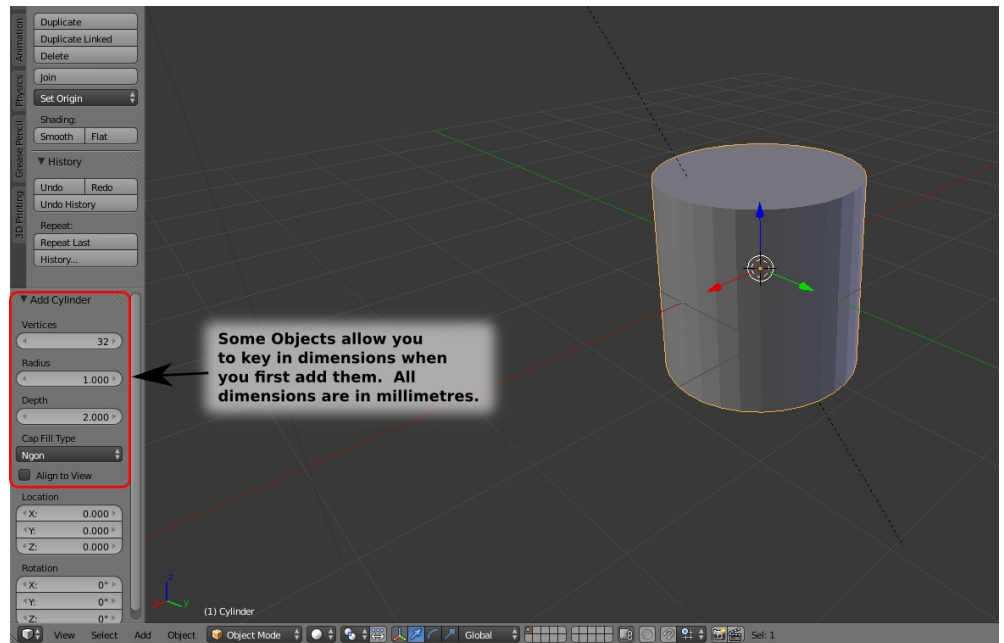


Adding Things

Generally all Blender 3D printing models start from a handful of basic shapes such as cubes, cylinders, and occasionally curves. There are two main routes for adding an object to your model. Use the **space bar** pop up menu, or the “**Add**” menu at the bottom of the 3D window. If you want the shape to be added to an existing shape, then you can add them when you have the original shape open in **Edit Mode**.



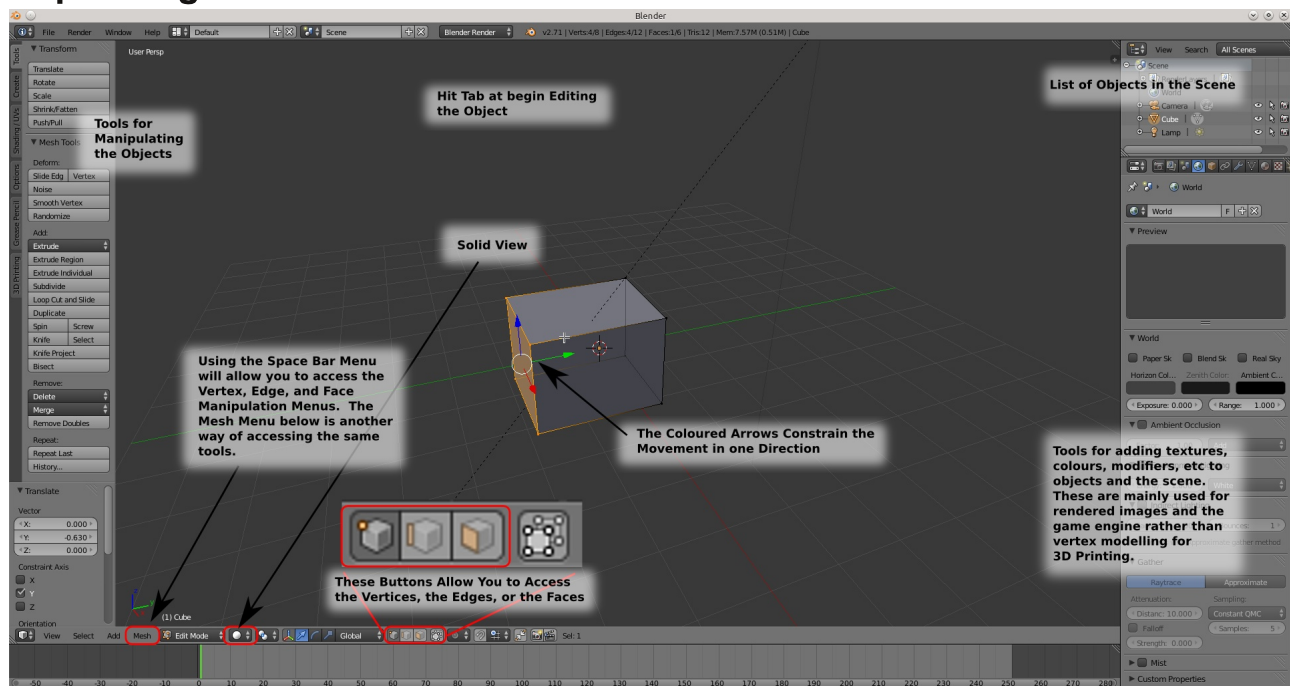
Some shapes have the option of setting the basic dimensions when you add them. The dialogue in the left hand panel is where you will find this. All dimensions in Blender are in mm. This is really handy for exporting the models for printing as it allows us to define the exact sizes we are after.



Modifying Things

Once you have a basic shape in the 3D workspace, you can modify it in many ways to achieve the shape you are after. These include; moving, rotating, scaling, deleting, filling, and extruding shapes, vertices, edges and faces. Subdividing edges and faces and merging vertices are also useful tools. You can also add, subtract, and intersect objects but this can lead to some odd artifacts appearing in your mesh that will need cleaning up before it can be printed reliably.

Manipulating faces and vertices



Click on the vertex, edge or face you want to change. If you want to select more than one face or vertex, hold the shift key and select each additional one by clicking on them, or use the box select by hitting the "b" key and drawing a box around the items you wish to select.

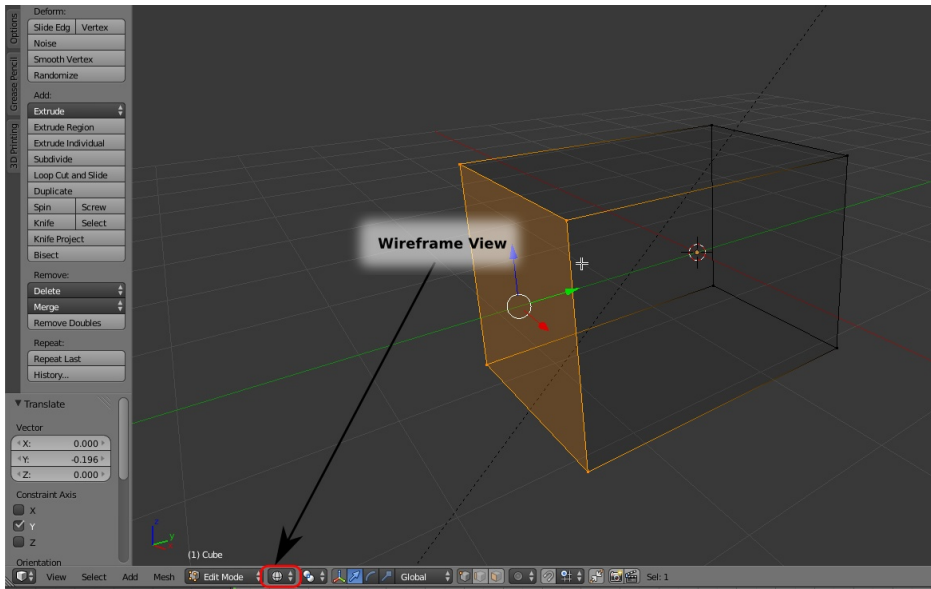
Say you wanted to move a vertex, the following method using keyboard shortcuts is one method to achieve this:

- Hit "g" and drag the item in the direction you want to go.
- If you wish to move it only in the X, Y, or Z direction just key in "gz" to constrain the movement in the z-direction, or "gx" for the x-direction.
- If you wish to move it a specific distance just key in the direction shortcut and the number of millimeters you wish to move it. For instance, the shortcut "gz5.2" will move the item 5.2mm in the z-direction.

The same applies for scale and rotation.

- For a scaling operation you would key in something like “s4” to make something four times the size or “sy0.5” to scale something 50% in the y-direction.
- For rotations, “rx45” will rotate the selected item 45° around the x-axis.

If you do not wish to use the shortcuts, you can use the buttons in the top of the left hand panel, or the three buttons in the middle of the small panel immediately below the 3D window next to where it says “Global”. Using these buttons will change the *handles* on the object to indicate the type of action. In the image below the handles are the blue, green, and red arrows in the centre of the selected face. Clicking and dragging these handles will move the object.



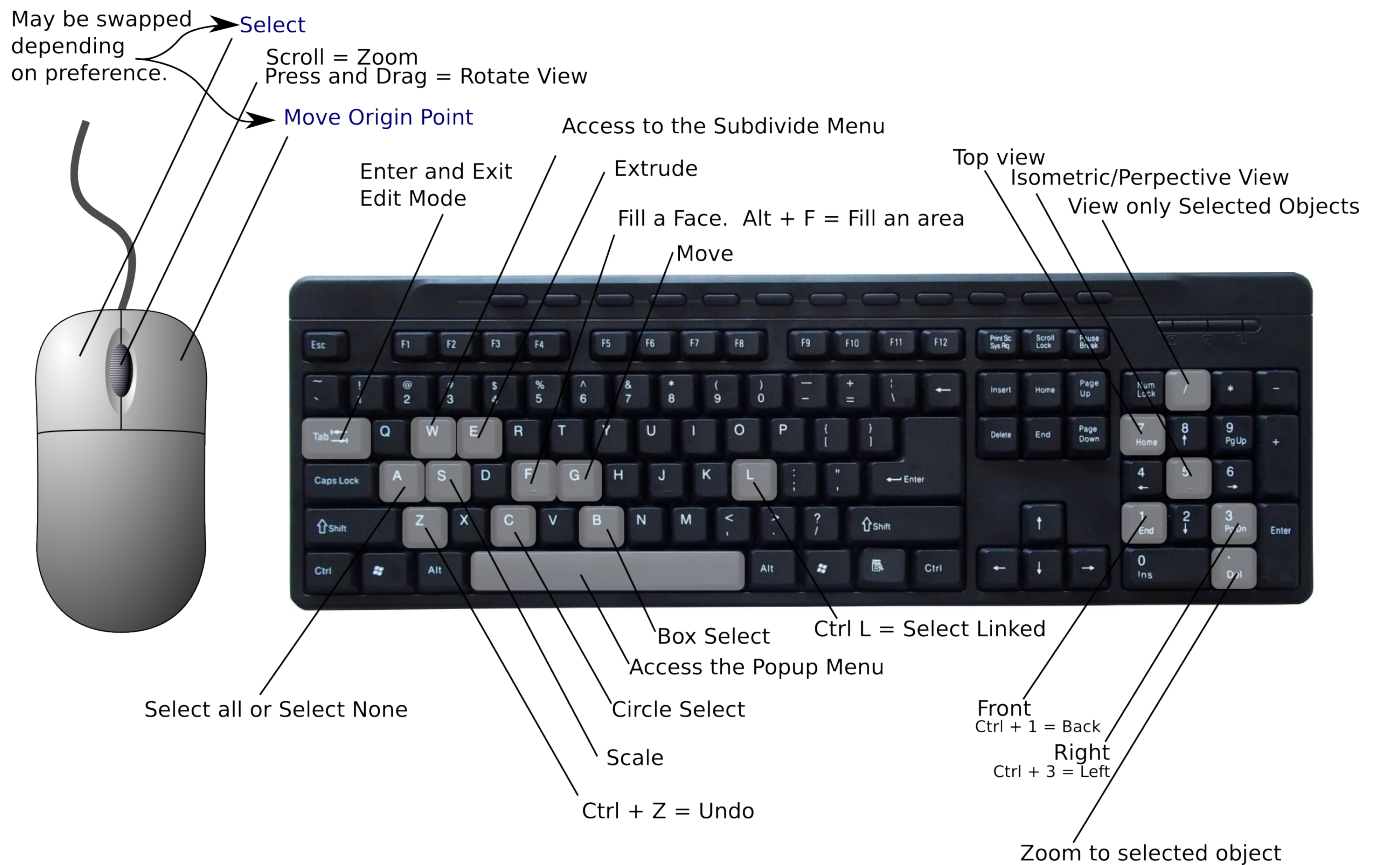
A wireframe view can be useful for viewing complex shapes and how they might be fitting together.

Filling areas

If you wish to join two vertices or fill the space between three or four vertices, select them and hit the “f” key. If you have an empty area bounded by edges, select all of the surrounding edges (sometimes selecting an **Edge Loop** from the “**Select**” menu at the bottom of the 3D Window will allow you to easily select all of the edges), and then hit **Alt+f** to fill the area.

Handy Keyboard Shortcuts

Here is a diagram of the most useful shortcut keys. Having a full keyboard makes life a lot easier for view control.



Tutorials on Blender

There are a large number of tutorials on using Blender. Unfortunately most of the pdf tutorials are for older versions of Blender, you will most likely have to use video tutorials for the latest versions. Generally a tutorial for blender versions 2.5 or greater will be valid for what you are using at the moment.

Hutt City Libraries also have free access to lynda.com where you can find a number of Blender tutorials.

Glossary

Artifacts

Sometimes a digital model is of a poor quality and when “sliced” to produce the “gcode” it can produce unwanted features, layers, and other random “scribbles”. These errors are called “artifacts”.

ABS

Acrylnitrile-Butadien-Styrene – A particularly tough plastic commonly used in children’s toys and Lego. It has a relatively high melting point compared to the more common PLA (see below) and because of its tendency to shrink as it cools can be quite challenging to print.

Arduino

An Open-Source microcontroller that is the heart of most 3D printers that are on the market at present. It is a programmable device capable of taking measurements with a range of sensors, controlling motors, and interfacing with a computer.

Engine

In the software context this is a dedicated piece of software or code that does the hard mathematical work calculating out something like the tool paths that the 3D printer extruder will need to follow to create the desired shape.

Extruder

The part of a 3D Printer that produces the line of molten plastic as the Printer builds the object. Typically the extruder is a fine nozzle with a heater and a device to force the filament into the heater and nozzle.

Extrusion Printer

These are the most common type of 3D Printer available for the home or small workshop. These printers use an extruder to lay down layers of molten plastic to produce the object.

Filament

All 3D Printers on the market for home and small workshop use a spool of plastic filament as the “raw material” from which the objects are built. The filament is passed into the extruder which melts it and exudes it as a fine stream of molten plastic into the object being made. The filament looks a bit like a spool of weed-eater nylon (and people have used weed-eater nylon as 3D Printer filament).

Fill

The fill is an expression for the amount of material used to fill the interior of an object. A 15% fill means that the interior of the object is 15% plastic and all the rest is air.

Fill Pattern

In order to achieve the desired density of fill the user can define a type of pattern to use; this might be “hexagonal” to give a honeycomb fill pattern, or “rectilinear” to give a cross hatch fill pattern.

gcode

When a model is “Sliced” the program works out what movements the 3D Printer extruder must do in order to create the shape for that layer. It writes these instructions into a gcode file. The gcode file could conceivably be read by a person because it is just a series of directions and measurements.

Handles

When working in graphics programs such as Blender, you may find a series of three coloured arrows appear whenever something is selected. These are called “Handles” and dragging on them will change the selected item(s) in some way in the direction of the handle you have dragged on.

Handworking Techniques

Working the old fashion way with hands and tools.

Laser cutting

Laser cutting and CNC milling are both complementary technologies to 3D printing where a laser or a router are guided around a shape to cut it out of a sheet of wood, plastic or metal.

Mesh

In the context of 3D modeling a “mesh” is the digital shape created within a 3D modeling computer package. The name derives from the fact that a mesh is a series of points joined by lines to describe the object’s surface.

Microcontroller

An electronic device that can be programmed to do a variety of sophisticated tasks. They are not as complex as a computer but are able to interface with computers and with hardware such as motors, relays, etc.

Moderated

In the context of 3D Model websites this means that the models submitted are not checked by the website owners and operators.

OBJ

A common 3D Model format. Most 3D printer software can handle this format. It appears to be becoming the standard for multiple extruder printers because the OBJ format can carry colour information.

Open Source

Open Source means that the underlying code and intellectual property is available to be picked up by anyone wanting to develop it further, improve it. This means it cannot be patented and depending on the nature of the license it must only be distributed for free. Obviously there is a lot more to it than that and I would encourage you to look it up on the web as well as look at the Creative Commons License which is strongly associated with it.

PET

Polyethylene-Terephthalate. This is the same plastic in 1.5L soft drink bottles.

PLA

Polylactic Acid. A starch based bioplastic. This is the same plastic in supermarket bags and is the most common 3D Printing filament. It is a well behaved plastic with good 3D printing characteristics and moderately good strength.

Plugin

In the software context a plugin is a small bit of extra software you can add to some existing software to extend its functionality.

Reprap

The Reprap is the open source 3D Printer that is the original “parent” of most of the home and small workshop type printers available on the market at present. There are quite a few different variations. You can find all the instructions and files to build your own on the www.reprap.org website.

Slicer

A program for analysing 3D Digital models to develop the gcode that will guide the 3D printer as it creates the object.

Slicing

The term used to describe the process that a Slicer goes through to analyse a 3D digital model by considering it as a series of slices with a perimeter and the interior of the shape defined by the perimeter filled with a pattern that the program determines based on the amount of “fill” it has been told to achieve.

STL

This is the common format used for 3D Models and the 3D Printer software. This format does not carry any colour information.

Tool path

This is the line, and shapes that a printer extruder will follow in order to create the object. The gcode describes every step in the tool path.

Wireframe

In 3D modeling packages it is sometimes useful to make the faces on the model invisible. The view of the object then looks a little bit like it was made out of bits of wire describing the surface of the object – thus wireframe model. As it is just a way of viewing the model doing this does not affect the model itself and the view can be changed to show the faces again.



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