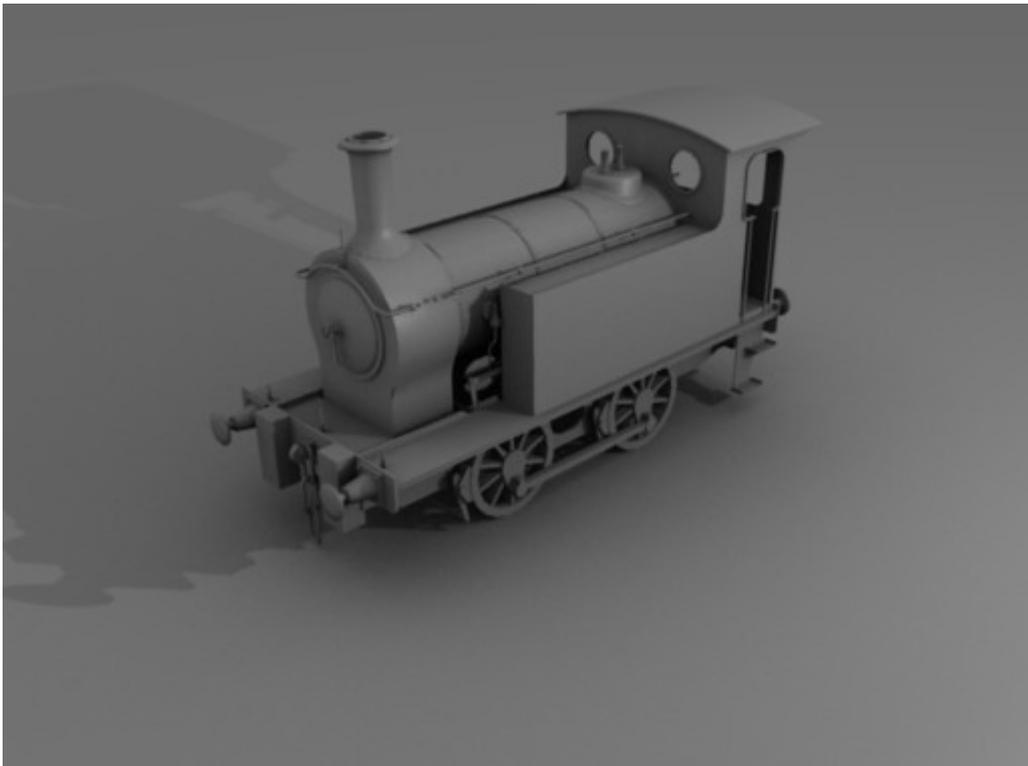


# A Blender Tutorial

## Building a Simple Loco

### Part 1 The Mesh

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## Why Blender?

Well, it's free, fast and stable. It can also be used for very complex models – it's much more suitable than GMax for example when working with large and highly detailed models – and it includes everything you might need to make mapping and texturing easier in one package. It can render and also 'bake' the results into the texture which means that highlights and shadows can be automatically generated, saving hours of work.

Additionally an exporter for Trainz is available, there are numerous tutorials on the Internet and the program is being actively developed.

You can get Blender here: <http://www.blender.org> . I recommend the version without an installer as you can simply copy the whole Blender application anywhere you want without installing it, for example onto a USB stick. It's only about 30Mb in size and very fast so it works well from a stick.

Versions are available for Windows, Linux and Macs (and it doesn't have any problems running under Vista unlike GMax).

## Disadvantages

The user interface is different to anything else you have ever seen before . Stick at it though, as once you are used to it you can work very fast and effectively. A minor disadvantage is that **Blender doesn't keep track of whether you have changed the file or not when you close it**, it expects you to know that (at least in v2.48a). Click on the the close icon and the changes are gone, never to be seen again.

## About this Tutorial

This tutorial will attempt to guide you through the steps necessary to create your own 3D models which can be used in the Trainz Railway Simulator or any other program for which you can find an exporter. I won't attempt to explain all of the possibilities that Blender offers as firstly I haven't found out myself yet, and secondly a lot of the more advanced stuff just isn't needed.

You'll need to bring a certain amount of patience and perseverance with you, learning a new 3D application is a bit like learning a new language – you have to work at it.

Once mastered you can create any model that you desire though, so it is worth it. I couldn't use Blender either until I tried.

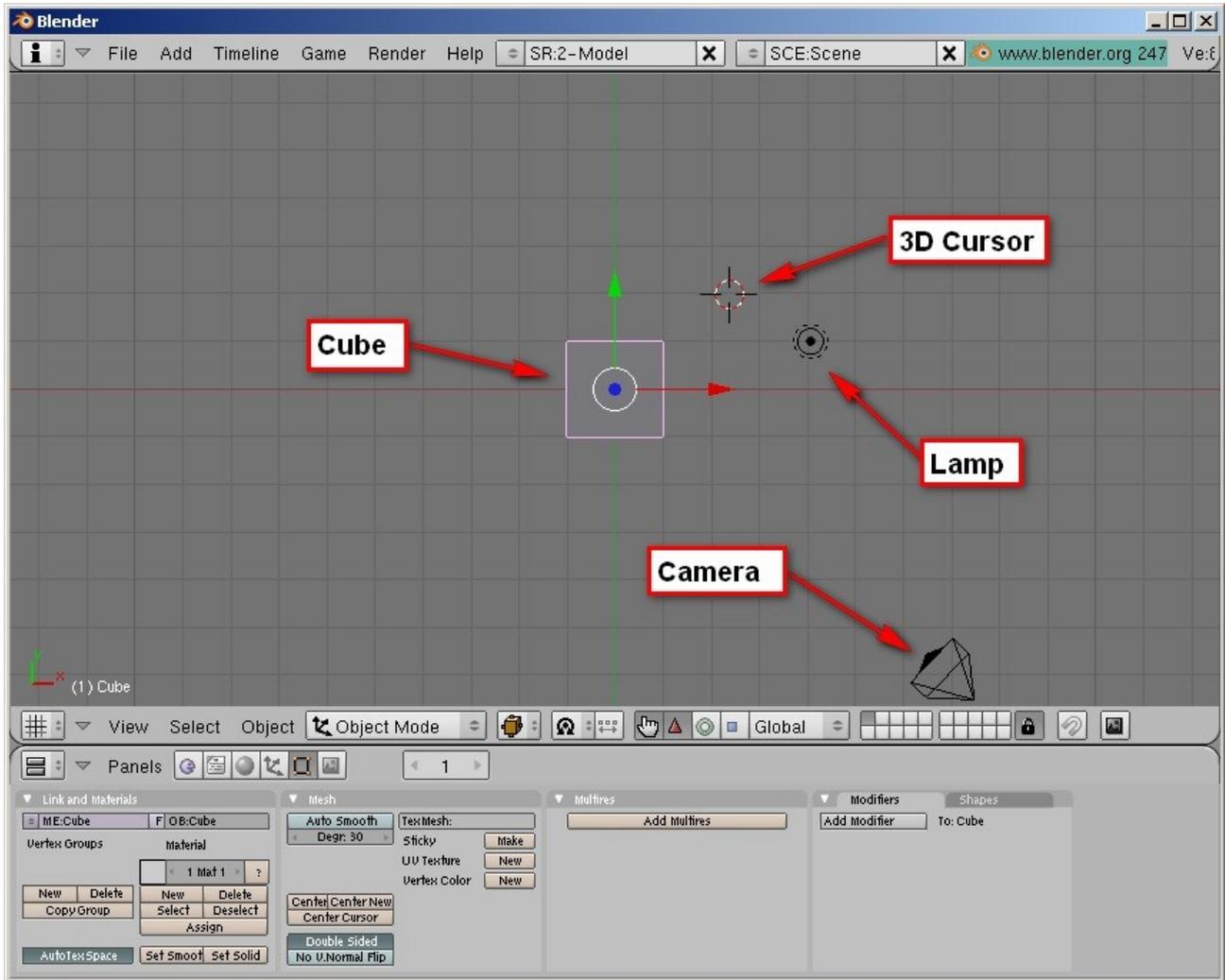
If you get stuck there are many, many other tutorials as PDFs or videos available on the Internet, but most of them use earlier versions of Blender. As Blender develops some major changes have been made to the interface which render the earlier tutorials out of date, so check to make sure that they are still relevant.

Hopefully this tutorial will concentrate on the bits of Blender that are important for creating Trainz models, filtering out the less relevant parts.

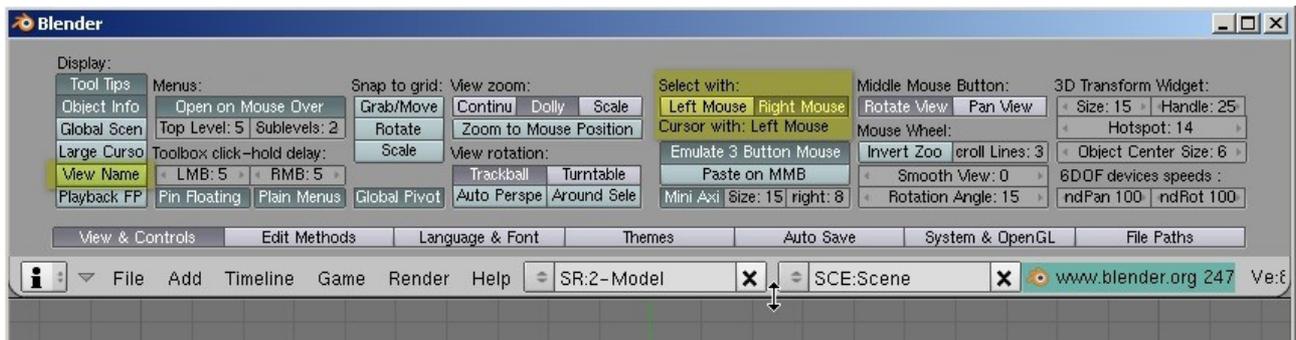
A useful resource is the Trainz WikiBook at [http://en.wikibooks.org/wiki/Trainz/Tutorial\\_for\\_Blender](http://en.wikibooks.org/wiki/Trainz/Tutorial_for_Blender) which covers texturing, mapping and animation. It also has links to videos and other tutorials.

# The Interface

Once Blender starts you are presented with the following screen:



The 3D Cursor is the point at which new objects will be inserted, but it also has other uses which we'll come to later. It's position is set by a left mouse button click, so you'll have to get out of the habit of left clicking to select something, although this can be changed which is a good way to introduce the options window. This is cunningly hidden at the top of the screen, it's part of the 'info' window (the bar with the big 'I' in it). Drag the window border down to reveal the options:



Highlighted are a couple of useful settings, the mouse button to use to select things ('Select with') and 'View Name' to display the name of the view in the view port. To make things more like GMax or Max select 'Left Mouse'. This will mean that the 3D Cursor will be positioned by the right mouse button, and elements will be selected with the left button.

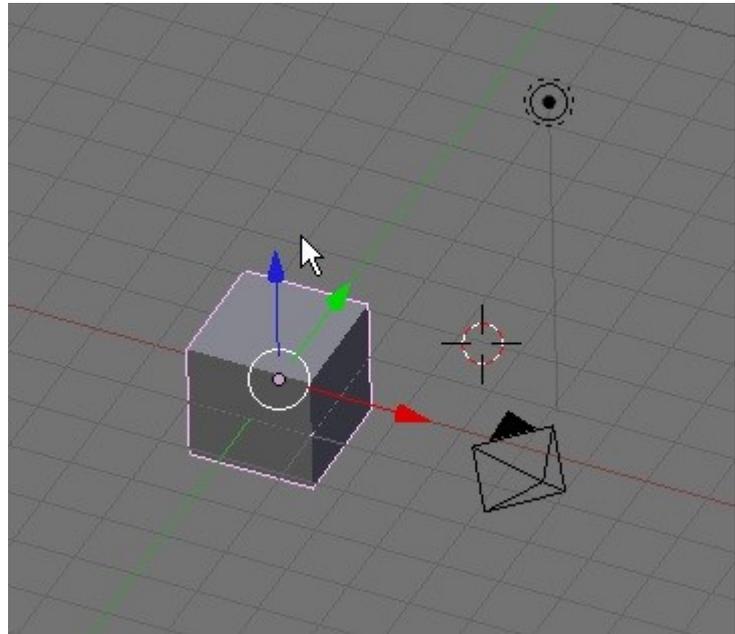
**I recommend though that you don't change this, as all the tutorials assume the standard setting.**

Incidentally the cube is outlined in pink which denotes that it is currently selected.

OK, now with the mouse cursor over the main graphic window hold down the middle mouse button and move the mouse. The scene will rotate to show it from a different angle.

As you can now see, the cube is a 3D object. When Blender starts it loads a default scene which includes a cube – which is not a bad thing as you can edit the cube to look like anything you like.

You can move the cube around by left clicking and dragging on one of the axis arrows.



Also note the yellowish dot at the centre of the cube, this is the local origin point of the object (the pivot point in the GMax context) which among other things is useful when mirroring objects.

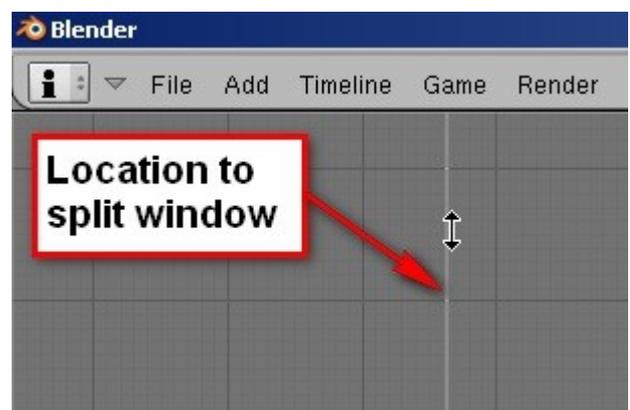
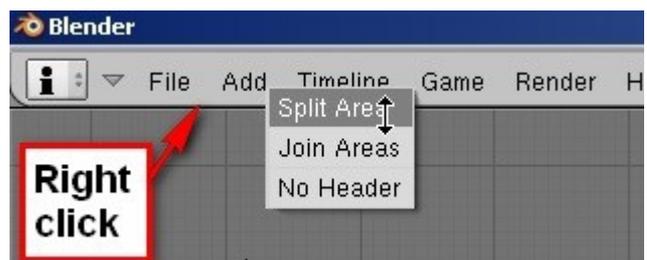
**Panning the view is achieved by dragging with the middle mouse button and SHIFT, zooming with the middle mouse button and CTRL.**

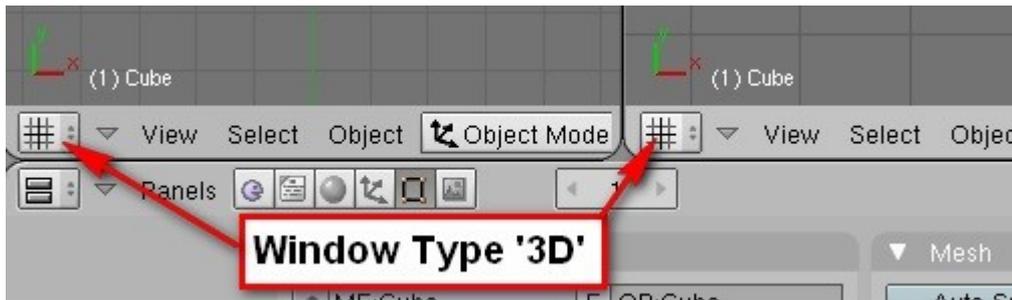
If you get lost SHIFT and C will zoom the view to show everything and also centre the 3D cursor at 0,0,0 (handy when you accidentally left click).

You'll find it useful to create extra views on the model you are making, this is in fact pretty much essential when you are working with background images (plans for example). To create a new window place the cursor on the window border and right click. From the menu that appears select 'Split area'.

A line will be shown on the screen to denote the edge of the new window – click the left mouse button to split the window.

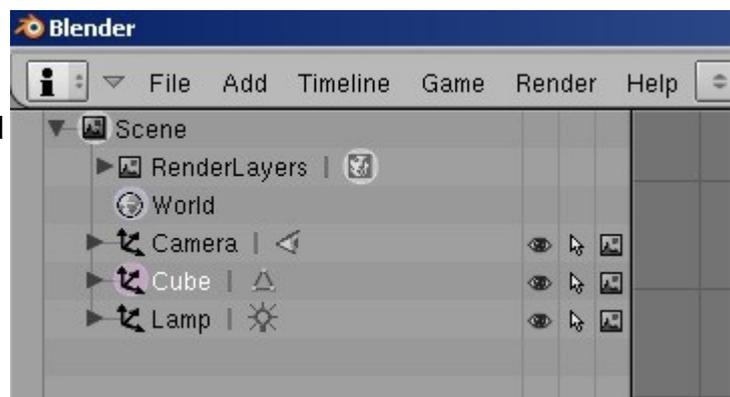
You should now see that you have two 3D windows looking at the cube.





Each window on the screen has a particular type, in this case '3D'. Things get more interesting when you realise that the type can be changed.

Click on the window type icon and choose 'Outliner' to display a tree view of the objects in the scene – this is similar to the object picker in GMax and Max. It allows you to hide/show objects and select/deselect them amongst other functions.



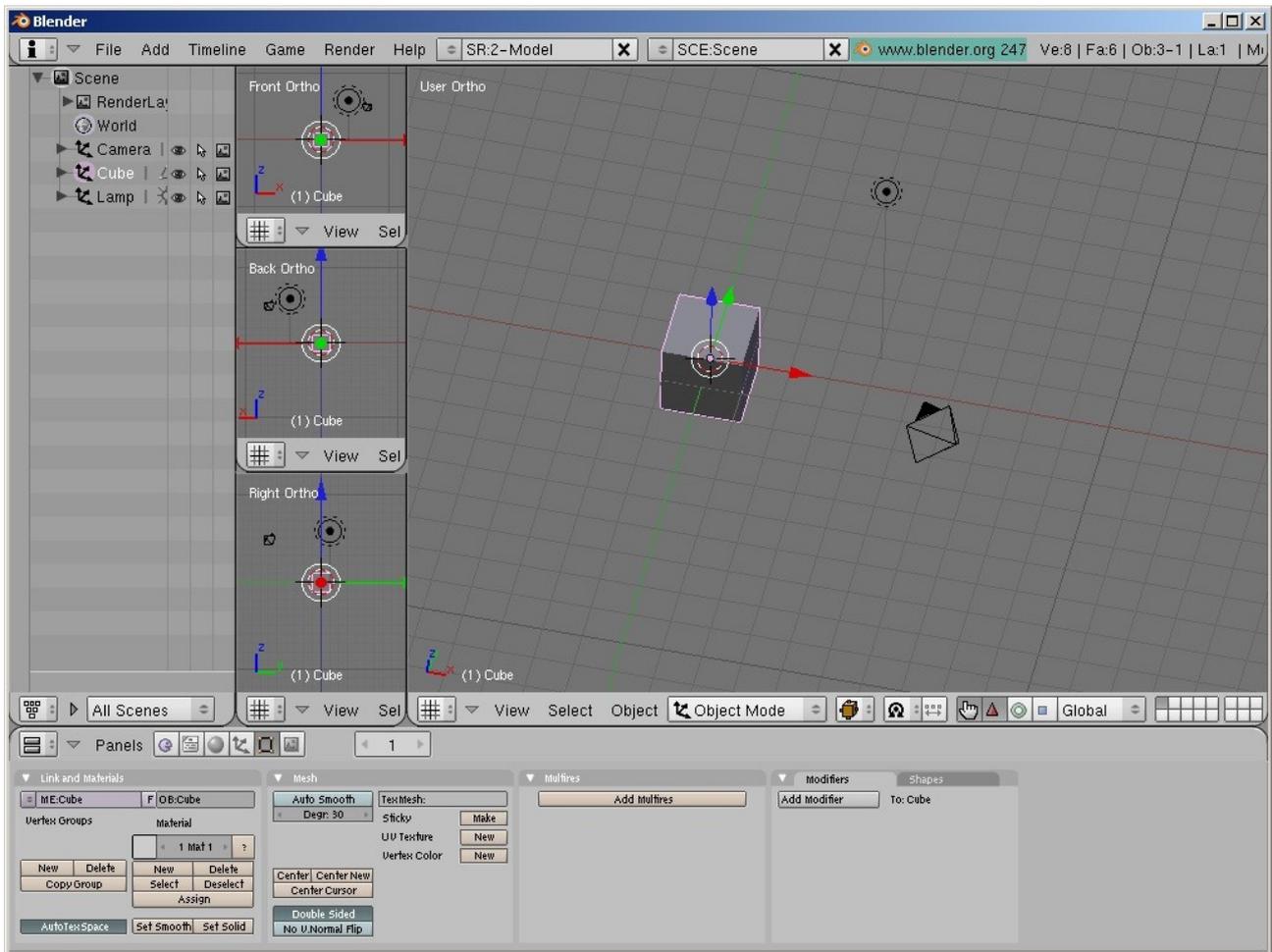
You can of course split up the main 3D window further to provide top, side and front views for working with plans. The view direction is changed using the numpad number keys **when the mouse cursor is over the window**, 1 is front, 3 is side and 7 is top. To reverse the direction of view to get a rear view for example use SHIFT or CTRL and 1. When working on a computer without a numpad an option can be set to use the normal number keys which is often needed when using a laptop (or an EEEPC!).

The option window at the top of the screen needs to be pulled down and under 'System & OpenGL' you'll find the option to emulate the numpad keys.



Armed with this information we can set up the screen in any way we want. I have the outliner on the left, to the right of which I have side, front and rear views (depending on the

views I have of the object I am modelling of course) and then the main 3D view, like this:



I should have said of course that once a window has been split you can join them back together again by right clicking on the border and choosing 'Join Areas'. You can decide then which of the windows will be kept.

Any of the windows on screen can be maximised by using CTRL up arrow and minimised again using CTRL down arrow, to to model something in the side view instead of the 3D view put the mouse cursor over the side view, hit CTRL up arrow, do the modelling and then hit CTRL down arrow to restore the display.

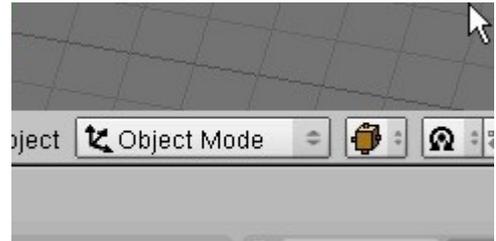
Fairly obviously the windows can also be resized by dragging the borders and views can be changed using menu selections, but it is far faster to use the keyboard short cuts.

Interestingly the options and windows that you set up are stored in the .blend file itself, not separately so each model retains the interface set up that you choose and when reopened looks exactly the same as you left it. The model that Blender opens when it starts can be changed to something that suits your preferences by simply setting up the interface and hitting CTRL-U. The next time you start Blender you will get your 'Start model' instead of the default.

At this point it would be a good idea to practice using the interface by splitting windows and rotating, panning and zooming the scene until you have the hang of it. By the way, a useful short cut introduced with v2.48 is SHIFT-B which allows you draw a region to zoom in on.

## Editing and Selecting Elements

We've already seen that complete objects can be moved around in 3D space (left click and drag the axis arrows) and that selections are usually made with the right mouse button. It is also of course possible to edit the vertices, faces and edges of an object. To do this we have to change the selection mode.



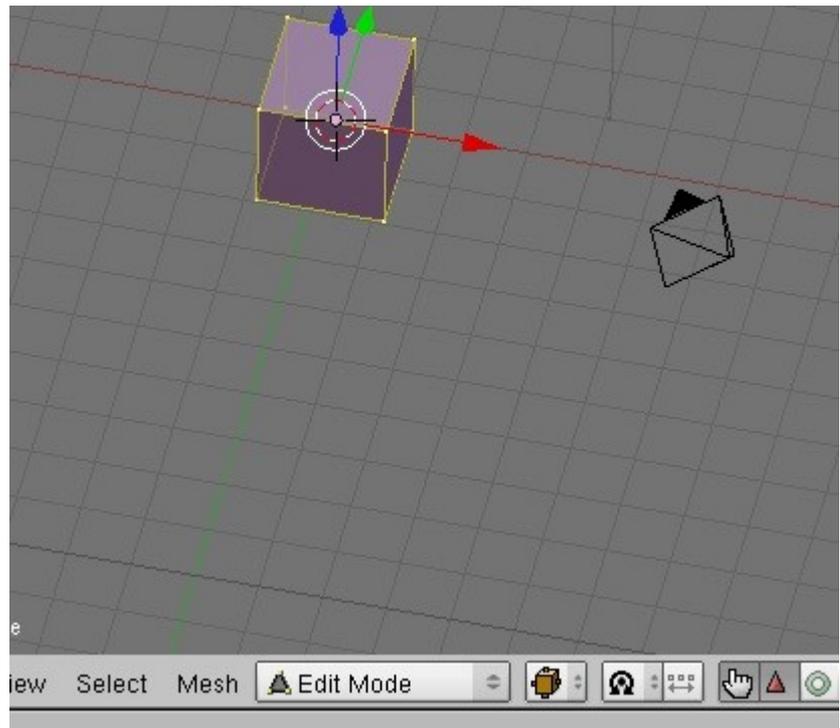
Here we are in 'Object Mode' which allows the manipulation of whole objects.

Click on this field and choose 'Edit Mode'. Assuming the cube was already selected the display changes to this:

All of the vertices are now selected. Hit A to deselect, A again to select all.

With all of the vertices deselected you can select one with the right mouse button and move it around using the red, green and blue axis arrows.

More than one vertex can be selected by holding down the SHIFT key when right clicking.

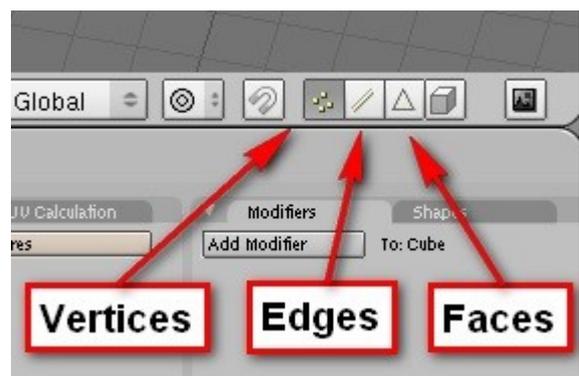


Faces and edges can be selected instead of vertices by selecting one of the icons shown here.

Once something has been selected it can be 'grabbed' with the G key and moved along one of the axes by then hitting X, Y or Z.

There are also other possibilities to select things other than by clicking on them directly, such as B for a box selection or BB for a 'brush'.

Practice now selecting and moving things around, CTRL-Z will undo any changes if they are not what you want.



That's about it for the basics of Blender, I believe the best way to learn new 3D software is to actually use it, so we'll build a loco now and pick up the other techniques as we go along. You could equally well build a house or a wagon, but it's a good idea not to start with anything too complicated – my first loco was a simple diesel shunter which had the wheels hidden by skirts, not a BR standard loco with outside valve gear.

Whatever you want to make it's a good idea to have plans available and to use them to ensure that the proportions are correct, so the next thing to know is how to do this.

## Using Background Images

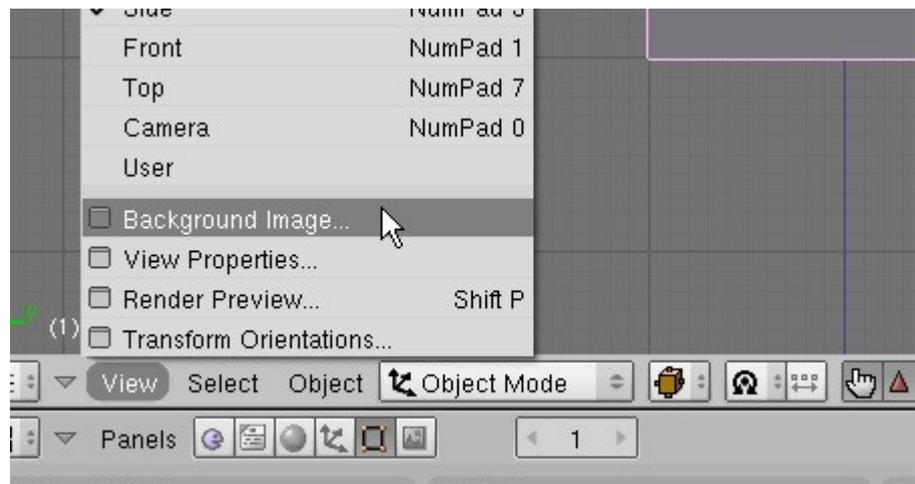
With GMax and Max it was usual to apply the plans to a box or planes as a texture, but this is not a good idea in Blender. The problem is that to display the plans you have to be in the texture display mode which means the 3D model is as well and gets in the way. Also if you switch the model to wireframe mode the textures cannot be seen.

Blender has the ability to display a background picture in each view (which works properly, unlike the similar function in GMax) which is the best solution.

Prepare the plans by scanning them in and cropping them in a bitmap editor such as PaintShop Pro or GIMP, they can be any scale and (almost) any format (GIF or JPEG are good). The bitmaps don't have to be any particular size and do not have to be square.

I'm using as an example an LNER Y7 tank loco, a nice small and simple model. Scan the plan in and make sure that the horizontal lines really are horizontal, rotating the image if necessary. Crop the image to make side, front and rear images, ensuring that the height of each is the same. Obviously if you have a top view you can prepare that as well.

To display a bitmap in a view port choose 'View -> Background image' in the appropriate window.



Click on 'Use Background Imag' (sic)

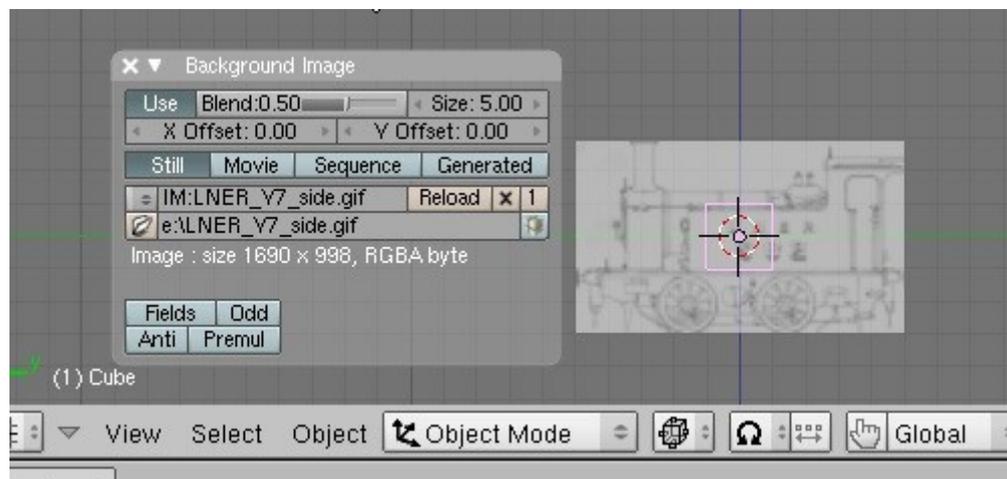


Click on 'Load' – a file selector will open to allow you to pick the image to use. (The tool tip shown here should read 'Load new Image or Movie'...)



Now navigate to where the prepared side view has been saved and load it.

As you can see the background image has been positioned so that it's centre is at 0,0.



In order to scale the image to the correct size you change the 'size' value in the 'Background Image' dialogue. At the moment it is set to 5.00 which means 5 Blender units. **Blender doesn't do units such as metres or inches, it always works in Blender units which can be anything you like.** The Trainz exporter uses the convention that 1 Blender unit is 1 metre although the latest version includes a scale option so that you can work in feet and export in metres.

To get the background image the right size you need to know how long the original was, the size that you input is then the original size/2 as Blender calculates the size of the image as an offset from 0,0.

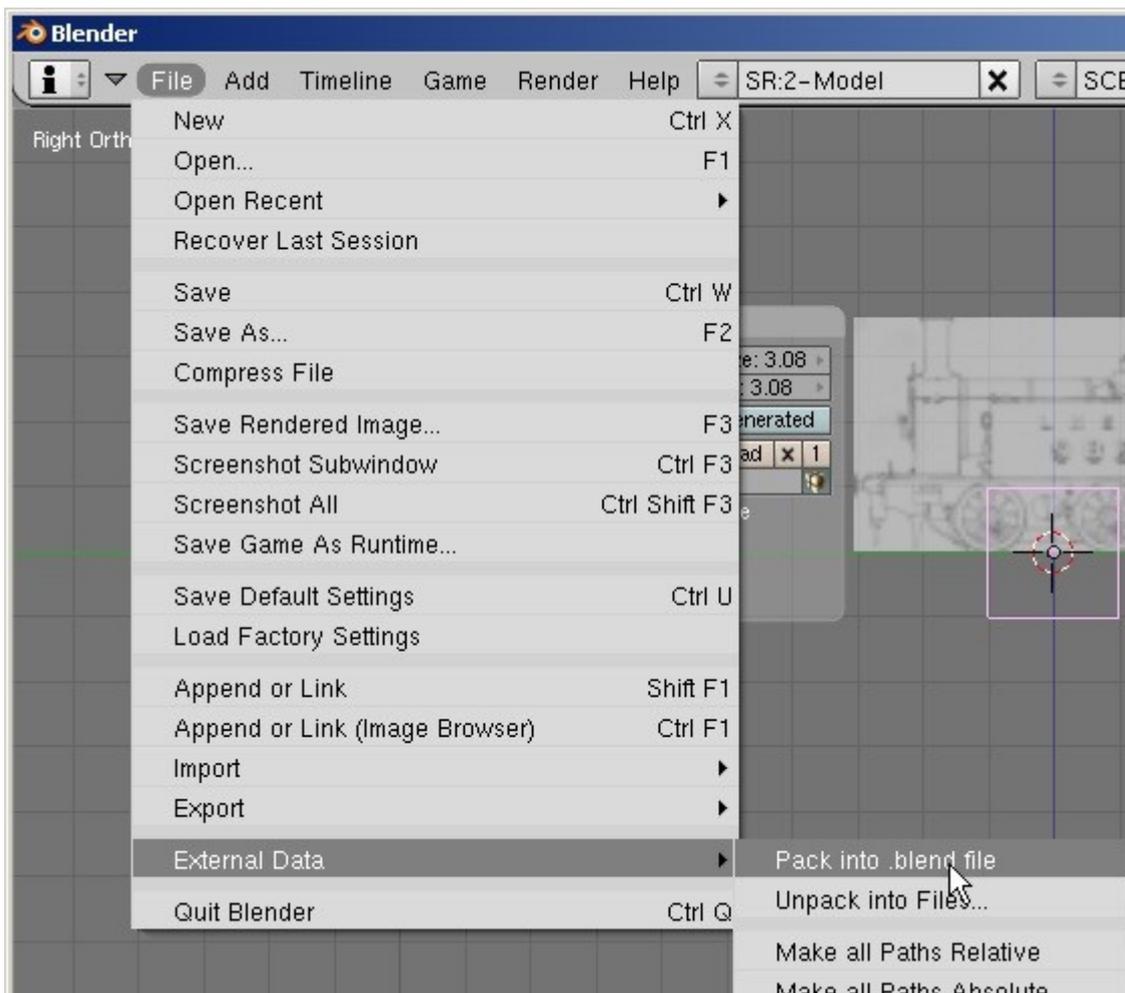
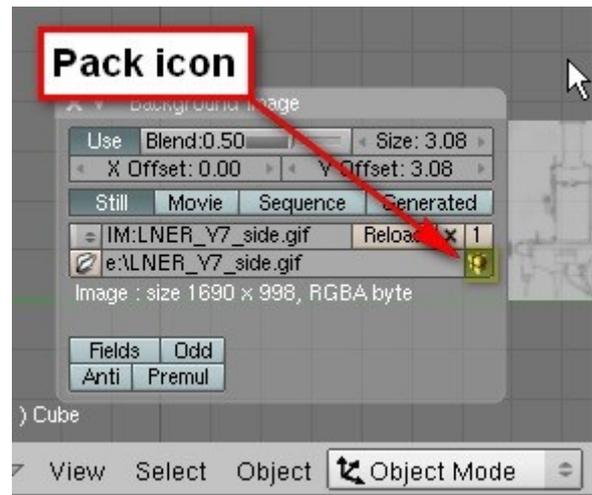
In this case the full sized loco was 6.155 metres long, so the size in the background image dialogue box needs to be 3.077. **To move the image so that the rail level is at 0,0 change the Y Offset to be the same as the Scale value** (if anybody can explain why this works I'd be grateful, there doesn't seem to be any logic behind it...). Incidentally the 'Blend' slider adjusts the transparency of the image.

To anybody used to working with the fuzzy, inaccurate display of plans that GMax is limited to, the quality of the background images will be a welcome surprise. Blender has another surprise up it's sleeve though, the bitmaps that you use for texture and background images can be stored in the \*.blend file itself. This means that the one working file contains all of the information need to display it properly.

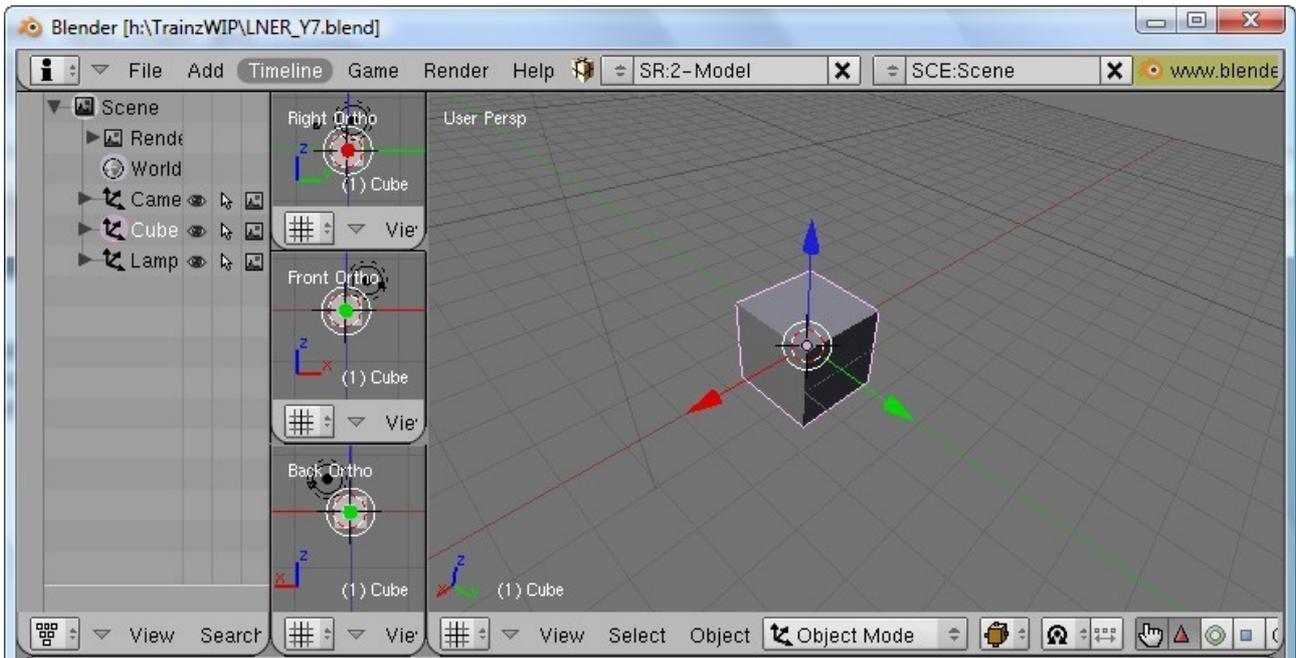
Selecting the tiny icon highlighted here tells Blender that the image should be packed into the \*.blend file.

To actually pack the images you need to choose 'File-> External Data-> Pack into .blend file' as shown here. Finally 'File->Save' (or CTRL-W) will save the \*.blend file together with the embedded bitmaps. It's a good idea to avoid huge bitmaps though, these will increase the loading and saving times.

You can also unpack the bitmaps again if you need to do so.



Repeat the steps outlined so far to create views for each of the scans that you have, i.e. side, front and rear views. If you've been paying attention you should be able to get this far without too much trouble:



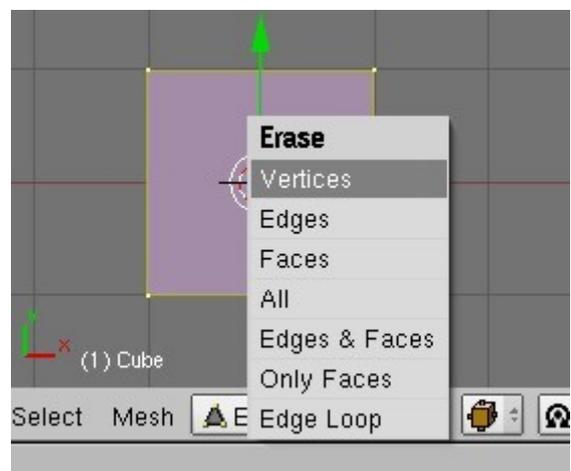
Note that the side, front and back views are named '... Ortho' This is 3D application speak for 'display without perspective', which is important for views that contain background images. You switch between Ortho and Perspective by hitting the numpad 5 key – try it on the main 3D window to see the difference.

Having set up the interface and prepared the plans we can now start to model. There are only a few basic techniques needed for this such as creating a profile and adding a thickness and rotating a profile to make a round object. Normally I would start by creating the wheels and coupling rods but I have a GMax macro to do this I would be mad to build them in Blender when I can do it in about two minutes in GMax.

Converting objects from GMax to Blender is possible, but it's pretty hard work without the appropriate tools which are not free. Using the following techniques there is absolutely no reason why you can't make the wheels and rods in Blender.

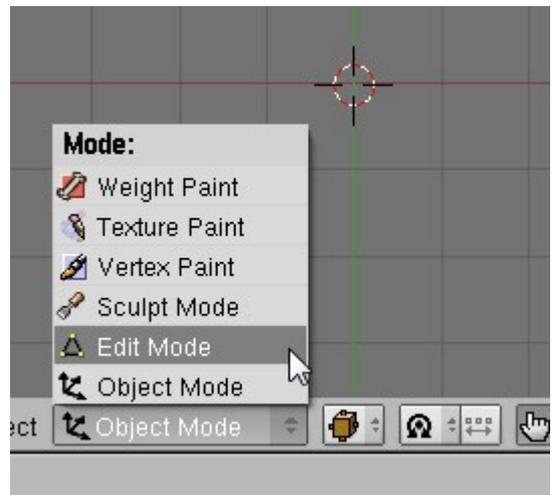
## Creating Meshes From Profiles

Let's start with the footplate to demonstrate a few things. Blender doesn't do lines by the way, it only has faces and vertices - what looks like a line is a face with no thickness. To start select the cube with a right click, switch to Edit mode and press the DEL key. From the menu choose 'Vertices' to erase the existing geometry.



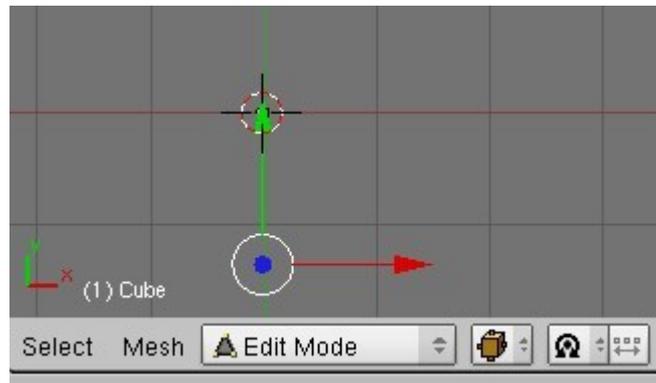
Switch the main 3D window to top view with numpad 7 and make sure you are in Ortho mode by checking the view name at the top left of the view (you have switched on view names haven't you?). Obviously if we have set up a top view with a plan beforehand we could use that window instead of the main one.

Choose 'Edit mode':

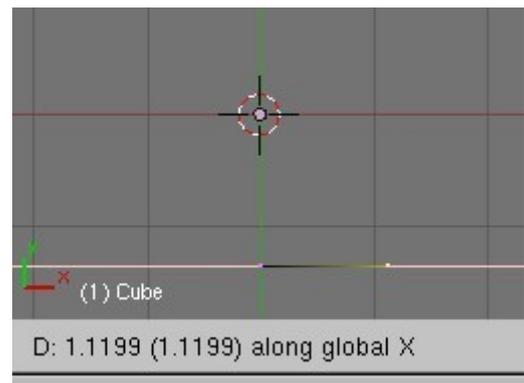


Now we are ready to sketch the shape of the footplate. Remember that Trainz convention has it that the front of the loco is on the -Y direction, so hold CTRL and left click about here:

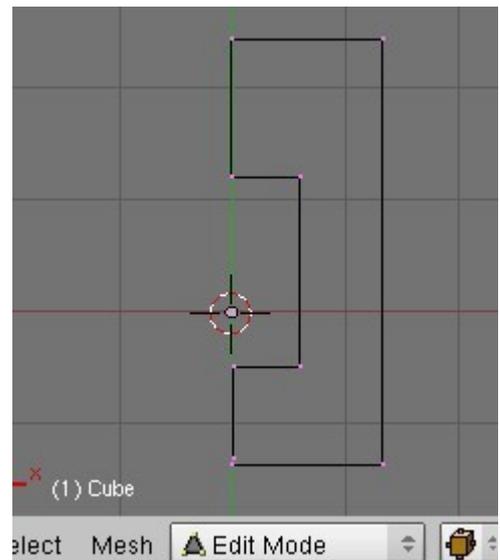
Blender has created a new vertex in the cube object and selected it.



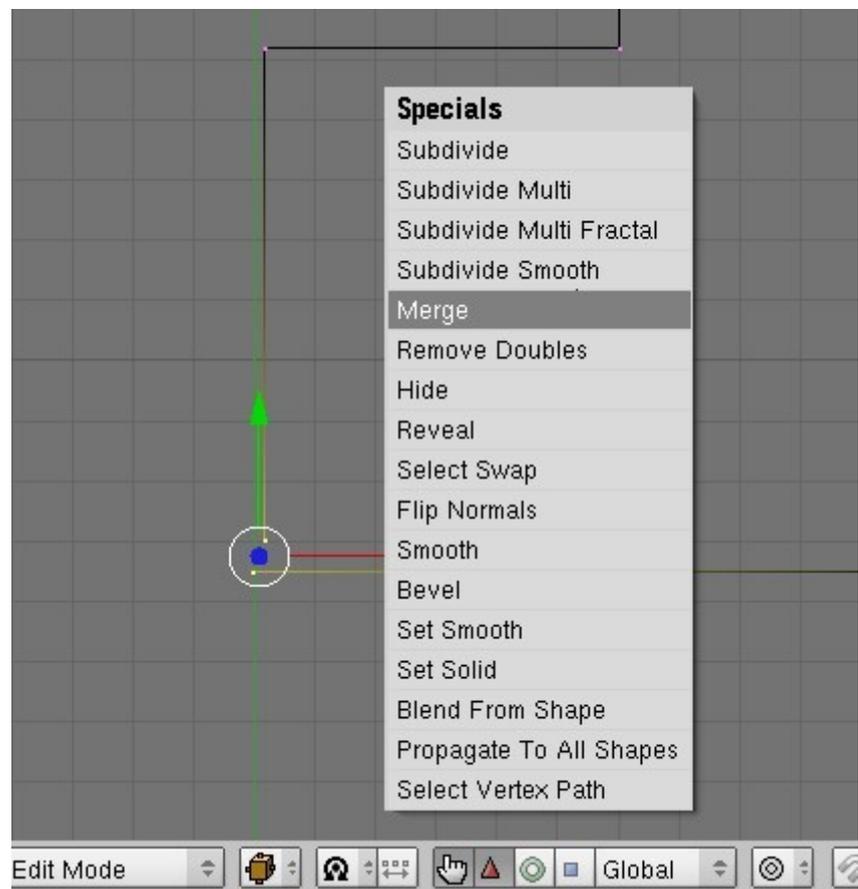
Now we'll extrude the vertex to create the rest of the shape with by hitting E and then X to extrude to the right (direction +X):



Carry on extruding until the shape looks something like this:

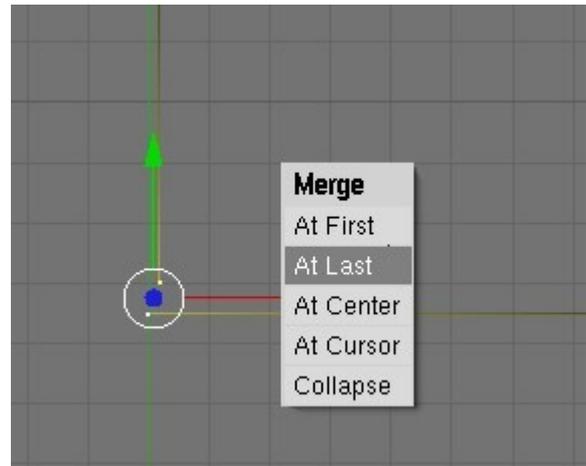


Note that the first and last points are not at the same coordinates – no problem, select them with a right click followed by a SHIFT right click and then hit the W key. From the menu first menu choose 'Merge'

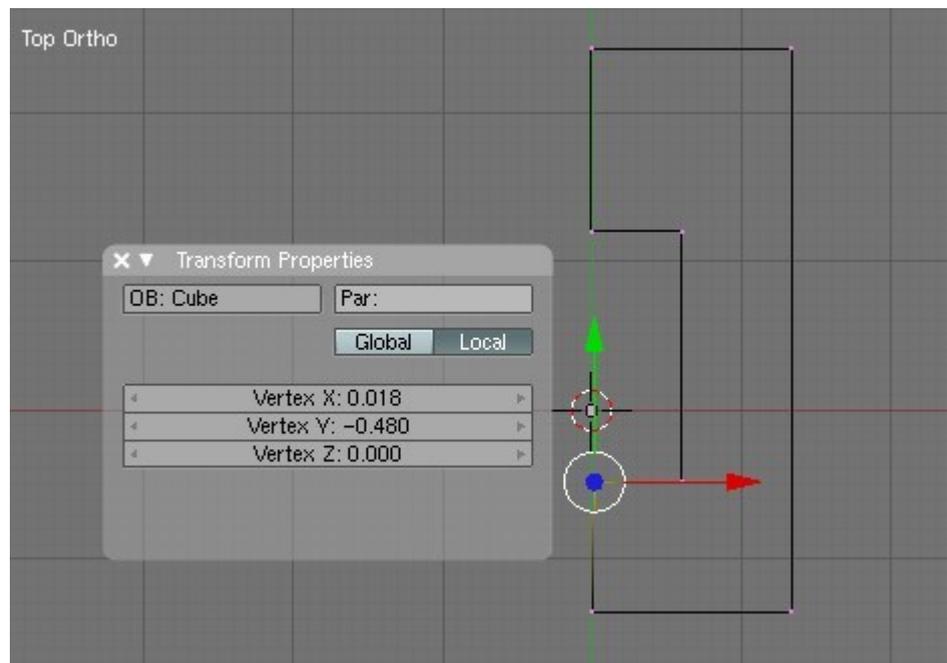


From the second menu choose 'At Last'. In this case the first vertex you selected (or a group of vertices, very useful) will jump to the position of the last one you selected. The other options should be self explanatory...

Hit W and choose 'Remove Doubles' to weld the vertices together. **Don't forget to do this otherwise the following steps won't work!**

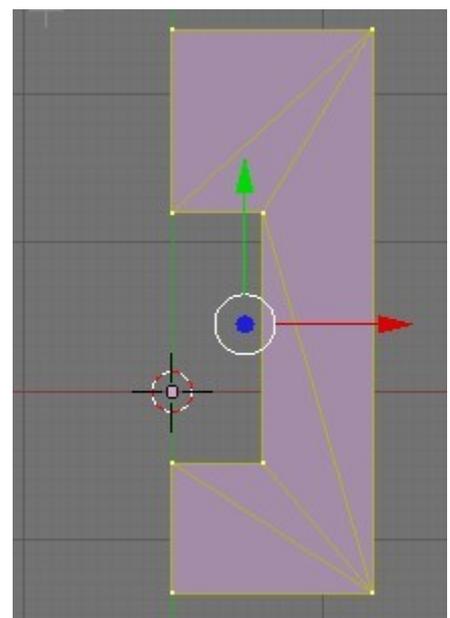


To move a vertex to a particular coordinate you can select it and then hit the N key. This opens a dialogue box where you can input the exact coordinates. In this case one of the vertices near the centreline is not at X=0, so edit the value and hit ENTER to set it.

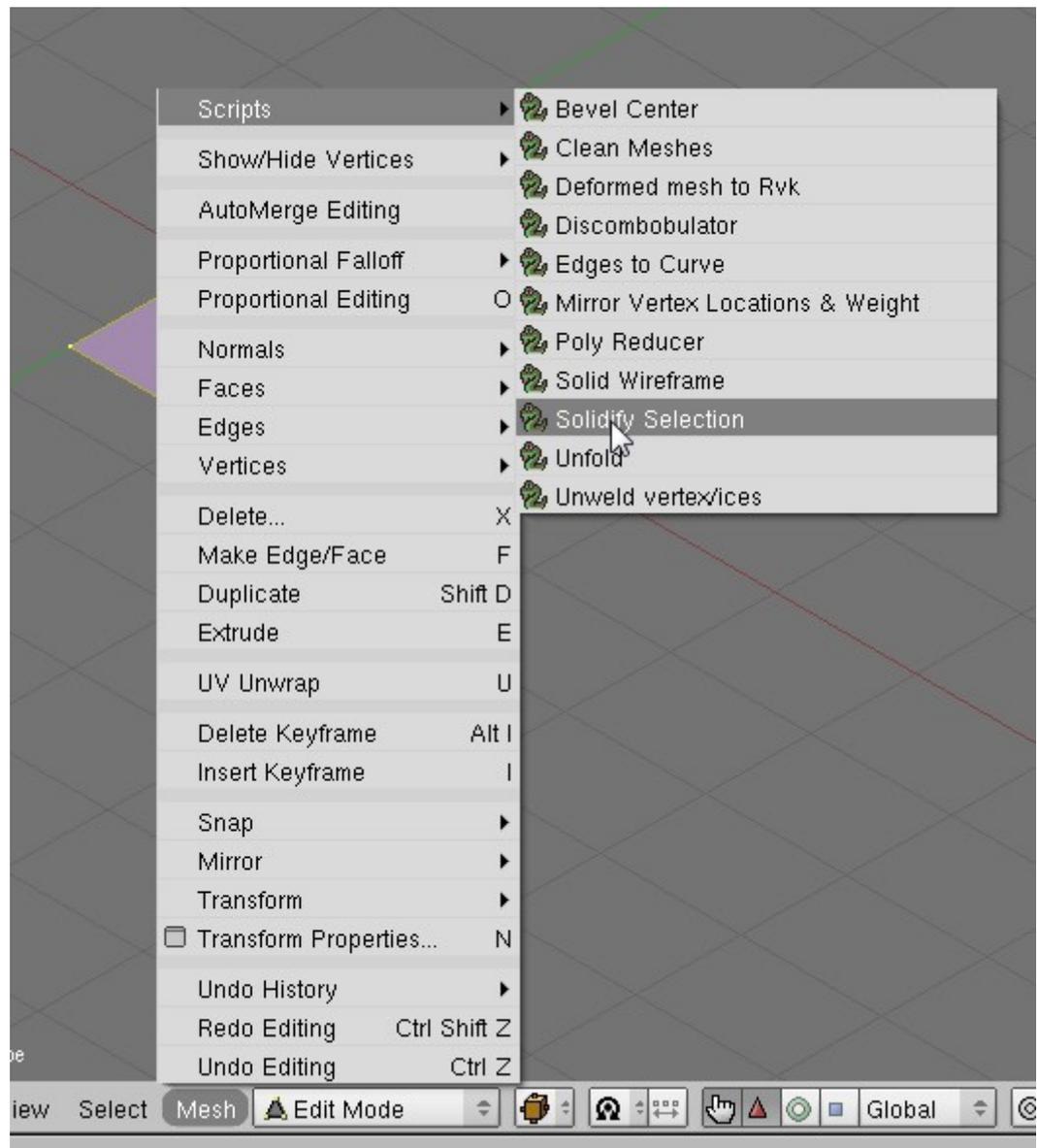


To create a mesh from this shape select all the vertices and press SHIFT-F:

That wasn't too hard was it?

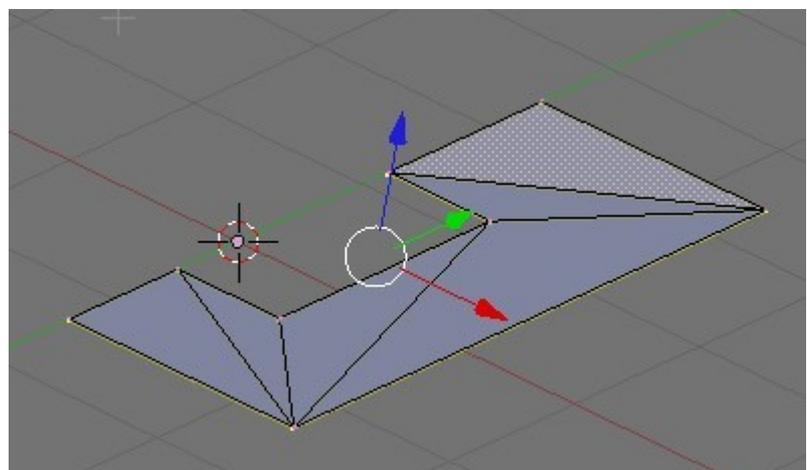


Now to make a solid body out of the faces select them all (after creating them they stay selected) and choose the following menu option:



Make the thickness about 10mm (0.01 Blender units). The result looks like this:

A thickness has been added to the mesh.



Switch to the Right Ortho view (mouse cursor over it, CTRL up arrow to maximise it) and adjust the footplate to match your background image. To do this you need to use the B key to make a box selection, A to clear selections and the GY and GZ key presses to move the vertices to the correct positions. Once you've sorted out the side view do the same for the front view to get things the correct width.

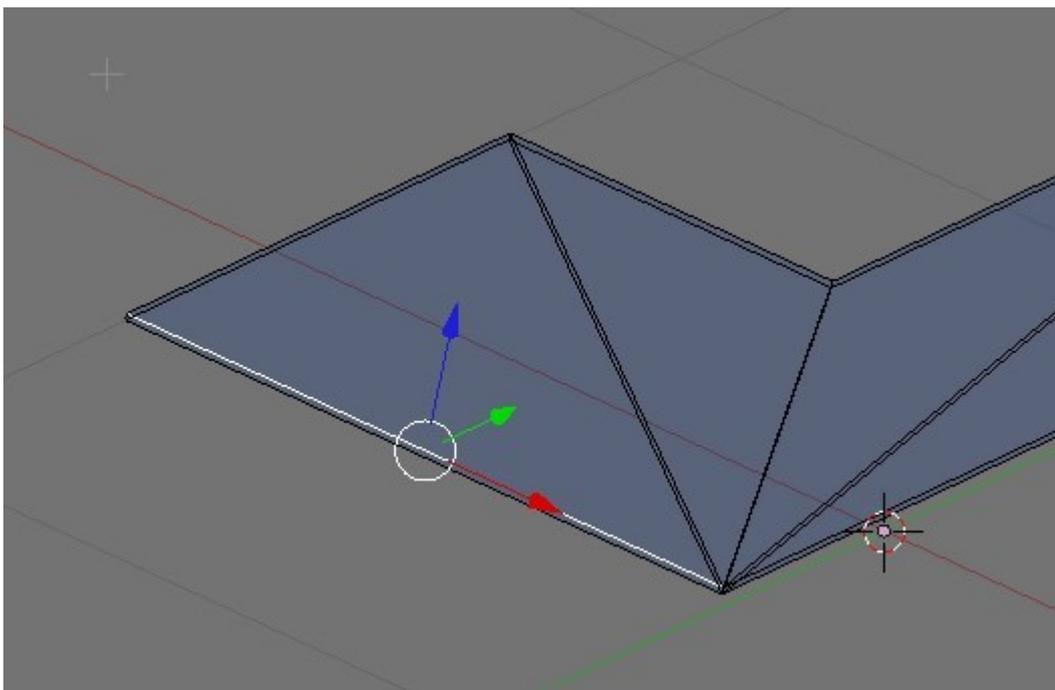
Note that we've only modelled half of the footplate, this is an old CAD trick to save time. The whole body can be mirrored about the YZ axis to make the right side. As you'll see later Blender has some more tricks up it's sleeve for making mirrored copies of meshes compared to GMax and Max.

Using this basic technique you can carry on and create the frames,buffer beams, valences, cab and tanks as well as some of the smaller details.

Let's make the buffer beam as these will use some new techniques.

## Extruding Edges and Snapping

A useful technique for building up a mesh is extruding. We've already seen that you can extrude a vertex, it's also possible to extrude an edge. Switch to wireframe mode by pressing the Z key (press again to switch back to shaded mode). Make sure you are in Edit mode (the TAB key toggles this) and that the edge select button is selected. Select the upper edge at the front of the footplate so:

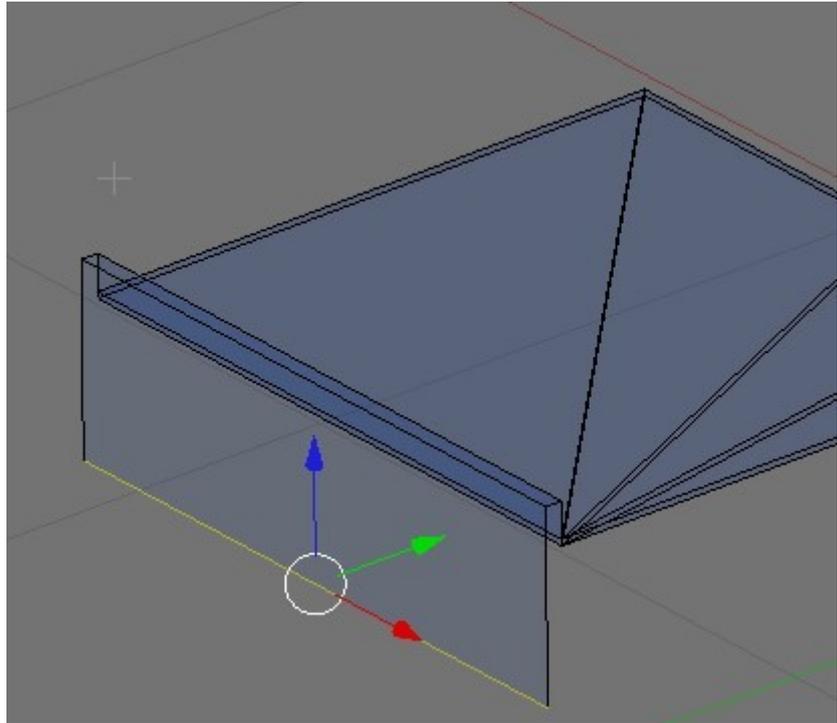


Press E (to extrude) and then Z (to constrain movement to the Z axis only). It's best to do this in the side view so that you can see how far to extrude by referencing the plan. So, mouse cursor over the Right Ortho view and press CTRL up arrow.

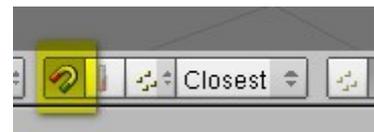
**If you know the distance you want to extrude you can simply type it in. In this case a negative value will extrude downwards, positive upwards. To extrude +100mm, input 0.1 (Blender units).**

By extruding the edge in the X and Z directions we arrive at this result:

Now we want to extrude in the Y direction, but only as far as the front of the footplate. Blender has a real time saving feature for this, you can snap to existing vertices, edges or faces.

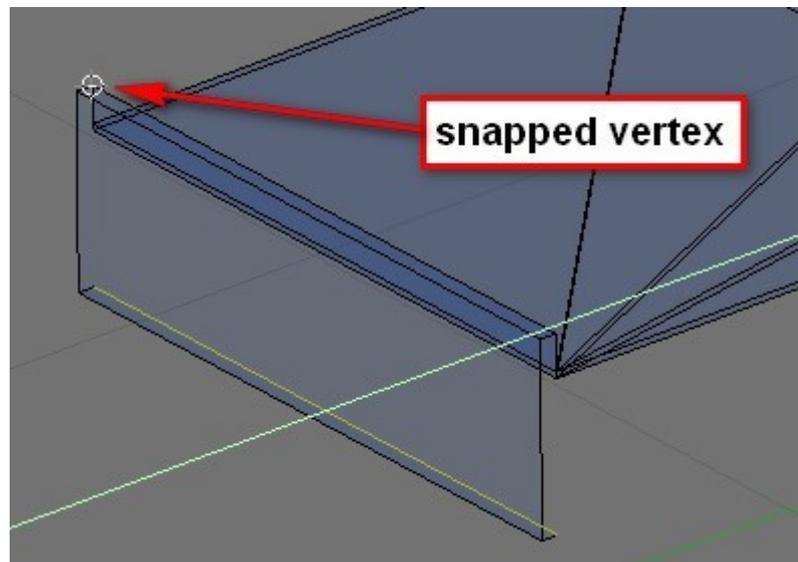


To turn this on, press SHIFT-TAB or select the highlighted icon:

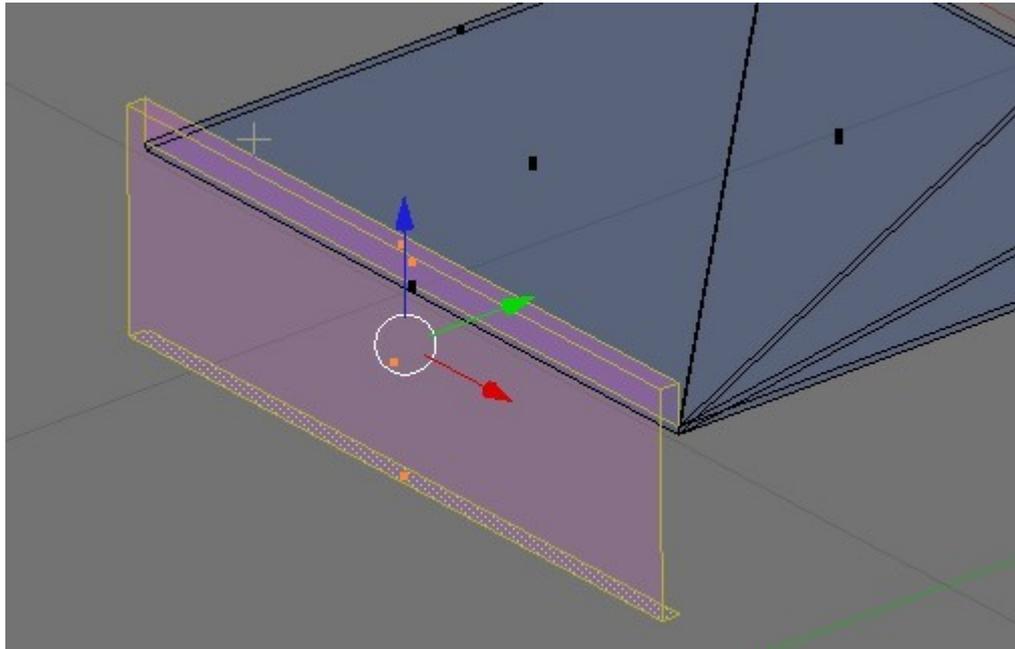


Now press E and then Y and hold down the CTRL key while dragging:

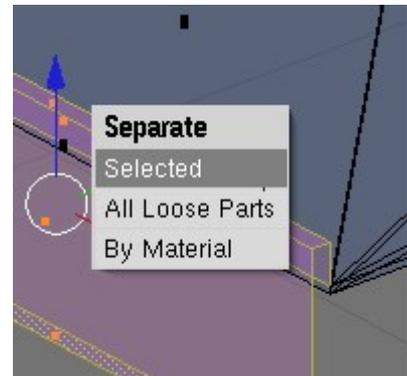
By the selected edge (yellow) moves along the white line (the Y axis) and snaps to the coordinates of the vertex under the mouse cursor (the white circle).



Switch now to face select mode and select the faces belonging to the buffer beam using right click and SHIFT right click. When in face select mode each face has a small dot at its middle point making it easier to select. The .faces turn pink when they are selected



We are now going to split the buffer beam away from the footplate to make a second object. To do this simply press P and choose 'Selected' from the menu.

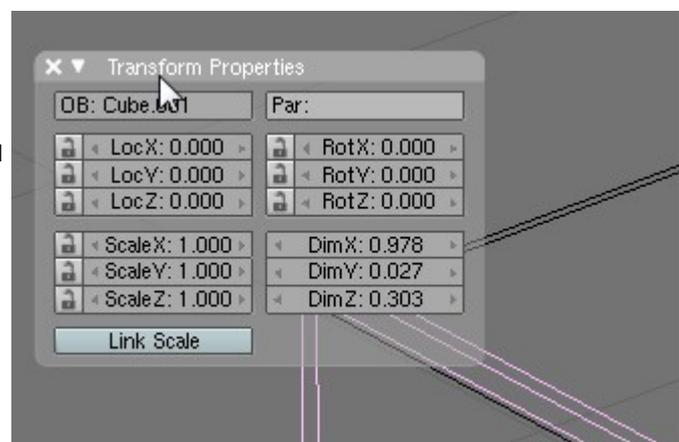


We now have a second object called 'Cube.001'. Switch to Object mode and select it.



Now switch back to Edit mode and select the bottom rear edge of the buffer beam. Extrude it in the Z direction using a vertex on the top face of the beam to snap to. You can complete the buffer beam by extruding the top horizontal edge of the beam, snapping to a vertex on the bottom edge.

To keep things tidy you can rename the objects using the 'Transform Properties' dialogue box by typing a new name in the OB: field.

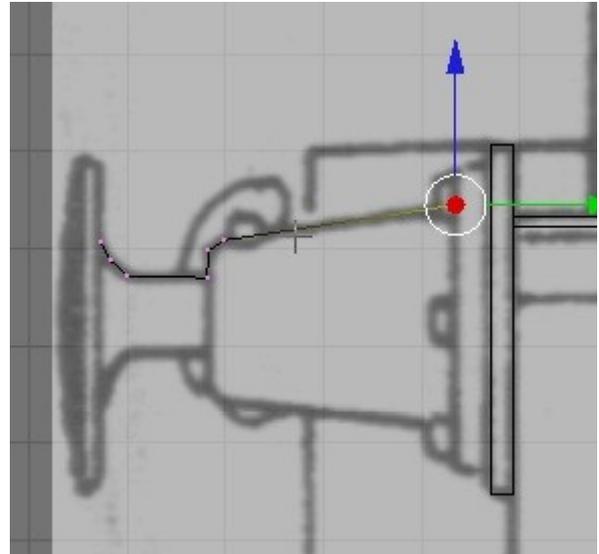


## Making Round Objects and Moving the 3D Cursor

The next major technique we will need is to rotate a profile around a centre point to create a round object ('Lathing' in GMax parlance). There are a couple of things to watch out for in Blender, for example the rotation centre is always the centre of the 3D cursor. Also the rotation axis is always normal to the view - you cannot rotate around a line or a point for example.

Switch to the Right Ortho view and create a new cube with SPACE Add ->Mesh -> Cube. Select the new cube and switch to edit mode. Delete all the vertices (press DEL and choose 'Vertices') to leave an empty body to create the new object. Make sure that you still in Vertex editing mode and sketch the outline of the buffer using a combination of CTRL left mouse clicks and extruding as we did for the footplate.

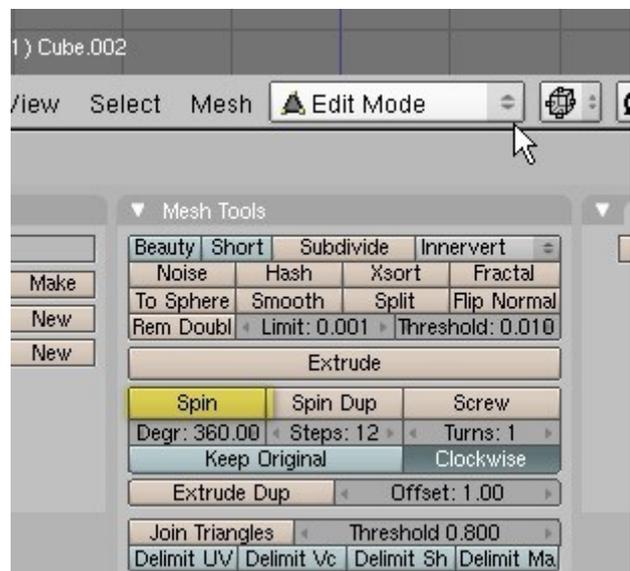
I'd recommend doing the buffer head itself separately as it really needs more segments (polygons) than the ram and the housing. The base of the buffer in this case is square so we'll need to do that with a cube. Now we need to position the 3D cursor to the centre of the buffer.



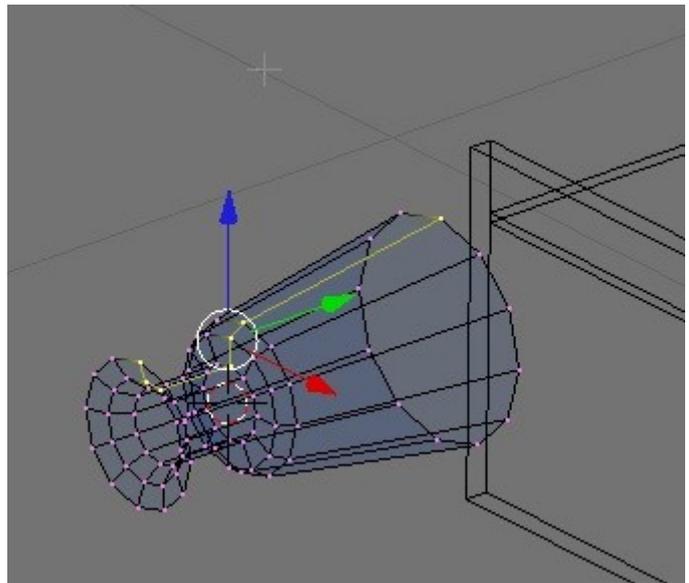
The simplest way to move the cursor is just to left click, but this is of course not very accurate. The cursor can be moved to a particular coordinate by accessing the View properties though. For now, left click to set the cursor position.

Now switch the main 3D to front by pressing 1 and press F9 to bring up the mesh editing panel at the bottom of the screen. Select all the vertices of the buffer profile with A and set up the mesh panel is shown here:

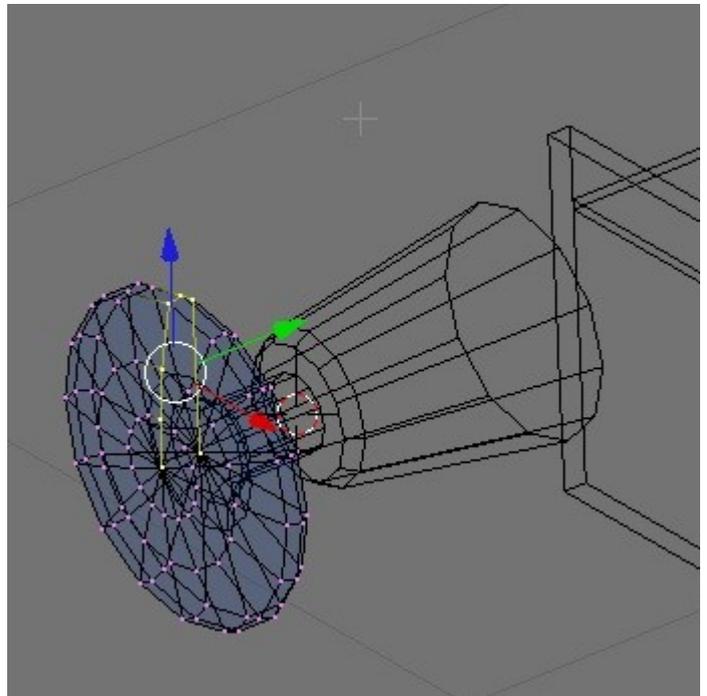
'Steps' is the number of segments to create, 'Degr' the rotation value in degrees. Click on 'Spin' - the cursor will change to a question mark if you have more than one 3D window visible. Click on the main window to create the rotation body.



The result looks like this:

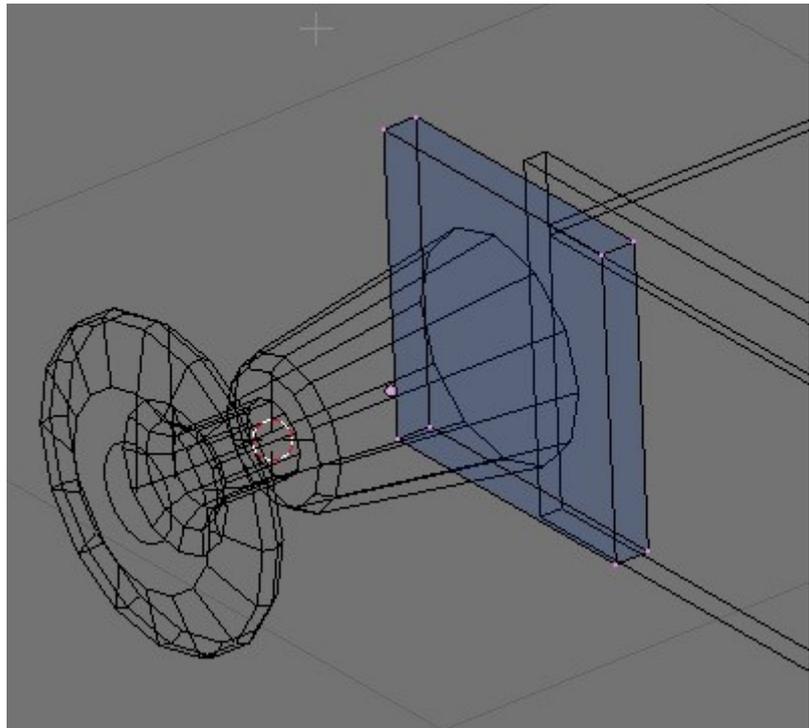


Create the buffer head in the same way, but be careful not to move the 3D cursor by accidentally left clicking as the head needs to have the same rotation centre as the housing.



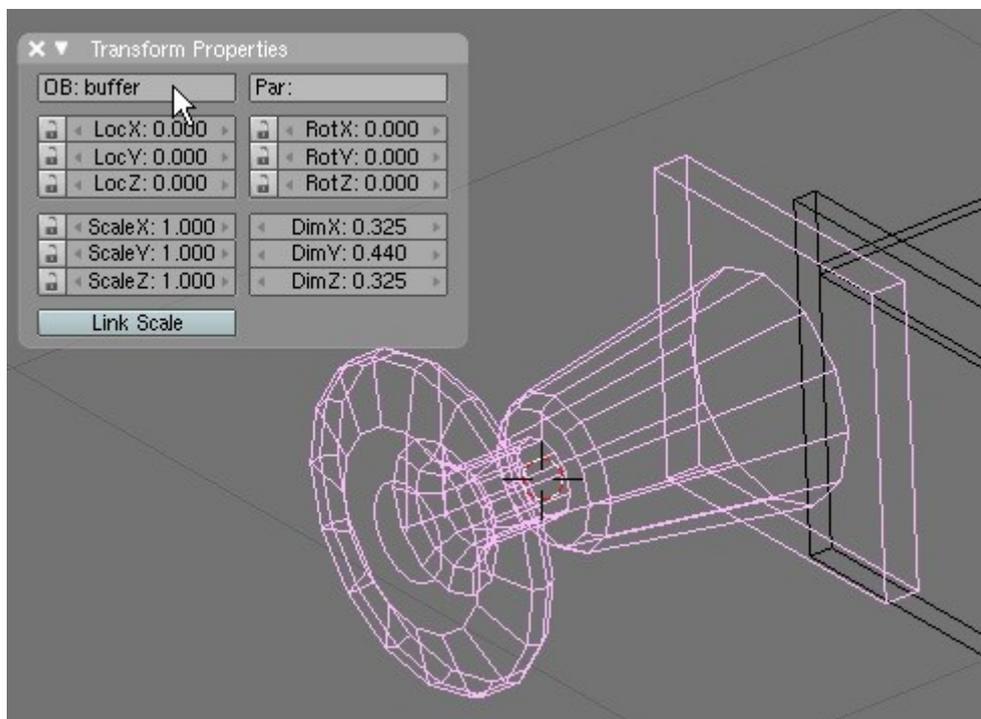
To create the square base for the buffer housing make a new cube with SPACE -> Add -> Cube (the new cube will be created centred on the 3D cursor which is exactly what we want) and select the cube in Object Mode and press S, dragging to scale it down to the right size using the plans as a reference.

Use the snapping tool to align the front and rear faces of the cube to the buffer beam and the rear of the buffer housing.



## Joining Objects Together

This is dead easy, in Object Mode select the objects with right click and SHIFT right click and press CTRL J. Note that the joined object will take the name of the last object that you clicked on. Select all the individual parts of the buffer now and press J to join them.

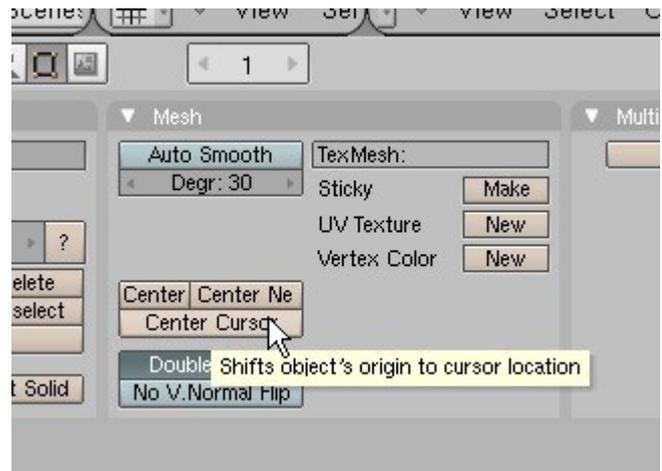


You can rename the buffer object at this stage using the 'Transform Properties' dialogue box (press N if it is not open already). Clean up the mesh by going into Edit Mode, select all the vertices, press W and choose 'Remove Doubles'. This will remove the duplicate

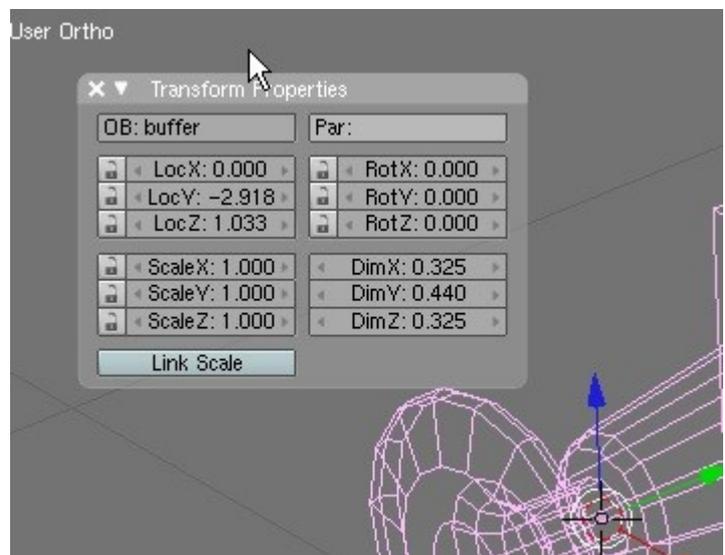
vertices created by the spin operation.

Now we have to move the pivot point of the buffer to its centre point so that we can move it to the correct position. In Object Mode click on 'Centre New' in the Buttons panel.

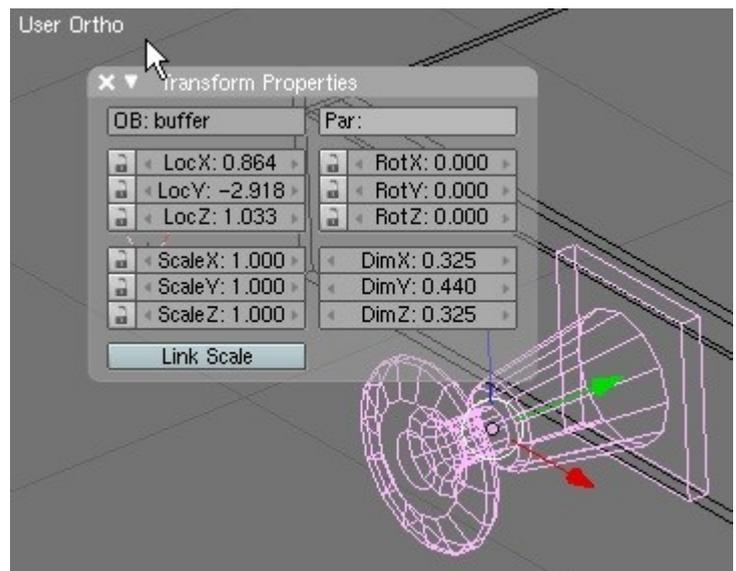
The pink dot will jump to the geometric centre of the buffer object.



The 'Transform Properties' dialogue box now shows the coordinates of the buffer:



For UK locos the buffers were almost always at 5'8" (1.727m) centres and at a height of 3'5" (1.041m) above rail level. The Z height of the buffer in this case is only 9mm too low which is near enough, and the X coordinate is 0. This needs to be changed to  $1.727/2 = 0.864$ . Type this into the 'LocX:' field and hit ENTER. The buffer will jump to the new X coordinate.



Before duplicating the buffer it would be a good idea to add any extra detail such as bolt heads at this stage, but we'll skip that for now.

## Removing Unwanted Polygons

Before we start duplicating the objects to make the other buffers and the rear buffer beam we can remove a few polygons that cannot be seen in the finished model, for example the rear face of the square part of the buffer housing. With the buffer object selected go into Edit Mode (press TAB) and make sure that the selection mode is face. Simply select the polygons that you want to delete and press DEL, choosing 'Faces' from the Erase Menu.

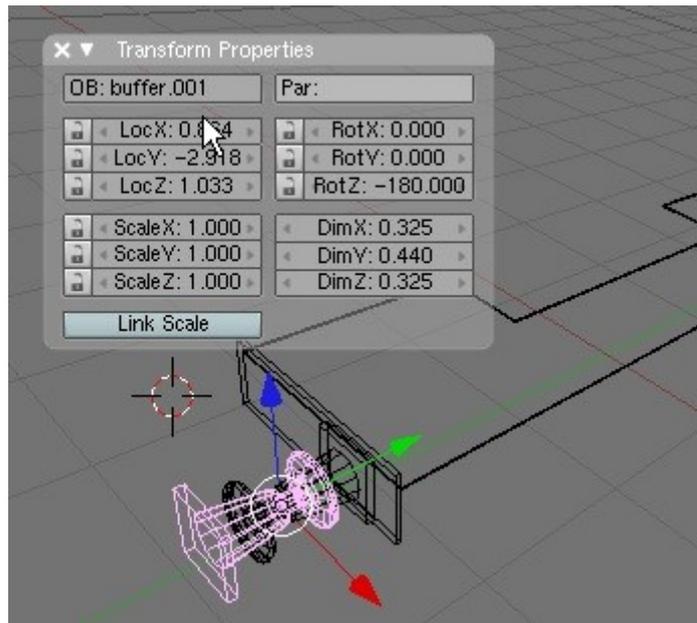
Other polygons that can be removed at this stage are at the centreline of the footplate.

## Copying and Rotating Objects

To copy and object select in in Object Mode and press SHIFT D. Do this on the buffer and the buffer beam objects to duplicate them, rotating the buffer to face in the opposite direction. This can be done by selecting the object and using the 'Transform Properties' dialogue box (it needs to be rotated 180° in Z of course).

Using the snap tool position the new buffer beam and buffer relative to the other components.

As a reminder: select the object, move it with G and then Y, holding CTRL to snap the object to an existing vertex. This makes building a mesh so much easier.

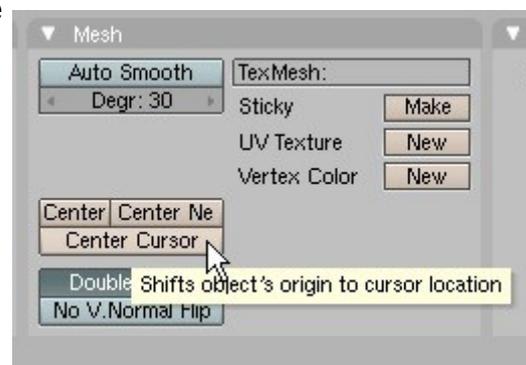


## Mirroring Objects

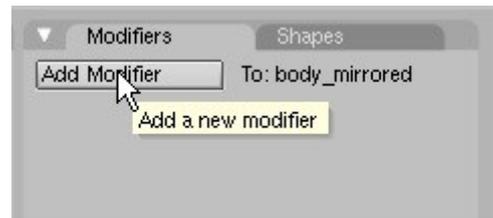
To save time we'll mirror the footplate over to make the right hand side. First, join all the objects together by selecting them and pressing J. Rename the object to body\_mirrored or some other sensible name using the 'Transform Properties' dialogue.

The mirror plane is positioned at the pivot point of the object and this needs to be at X=0 in this case. Unfortunately it is not possible at the moment to move the pivot point directly, but it can be moved to the position of the 3D cursor.

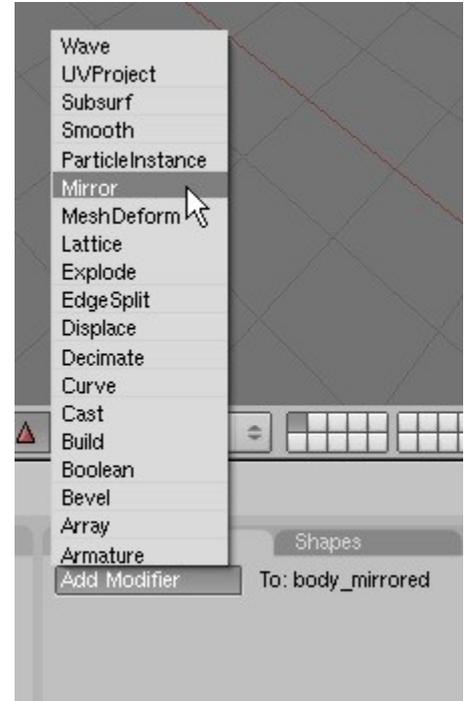
Set the 3D cursor to 0,0,0 by pressing SHIFT C, and in the Mesh panel click on 'Centre Cursor'.



Now click on 'Add Modifier' in the 'Modifiers' panel.



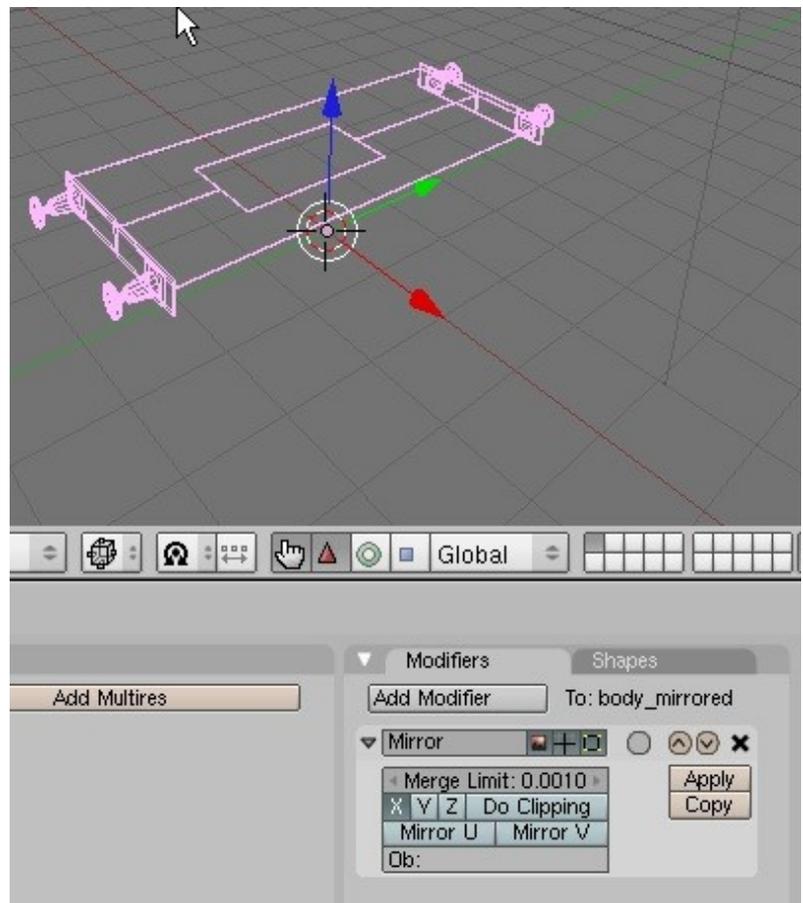
Choose 'Mirror'.



Done. Now that the mirror modifier has been applied any modification to the left hand side of the mesh will be automatically applied to the right hand side.

Also anything joined to the mirrored mesh will be mirrored to the other side, another great time saver.

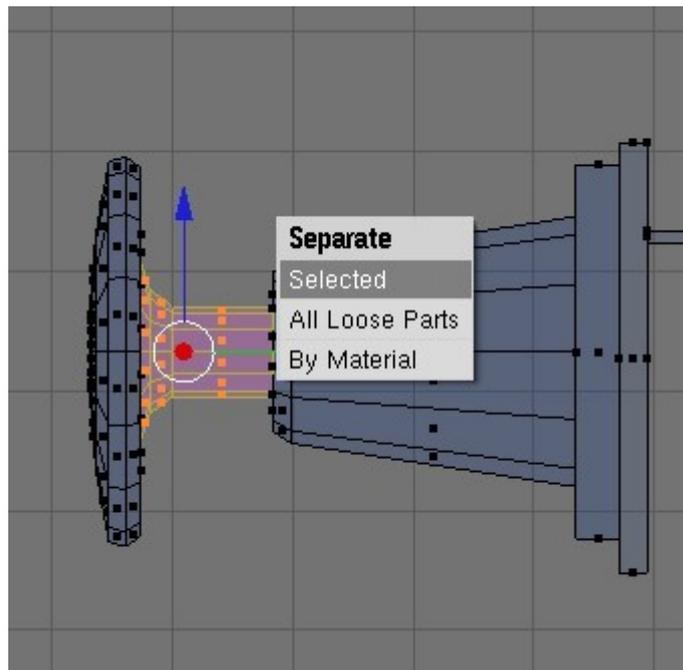
Surprisingly perhaps we have already covered most of the steps and techniques needed to create a mesh in Blender.



## Splitting a Mesh Object Apart

Looking at the buffers again it looks as though the buffer ram I made is a bit too small, so I'll split it out of the mesh, scale it up and reattach it. Select the body object and switch to 'Edit Mode' and sure you are in face select mode and the object is displayed as wireframe (press Z). Select the faces making up the buffer ram and press P to split the mesh up.

Do the same for the rear buffer ram but delete the faces with DEL instead of splitting them out.



When you split an object that has a mirror modifier applied the modifier is also applied to the mesh that you split out.

**Joining two meshes with a mirror modifier seems to confuse Blender, so it is best to delete the modifier on the mesh that you have separated.**



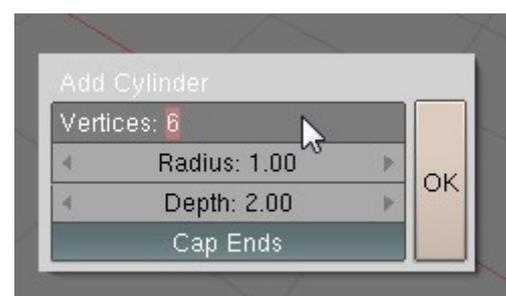
Now that the buffer ram is a separate object we can set the pivot point to the centre of it and rescale by pressing S. Having fixed that the ram can be aligned to the buffer head and housing again using the snap tools. Joining the buffer ram back to the footplate object will mirror it again about the X axis.

I could have done this without splitting the buffer ram from the main mesh, but it was useful to demonstrate how to do this.

## Creating a Bolt Head Using a Cylinder

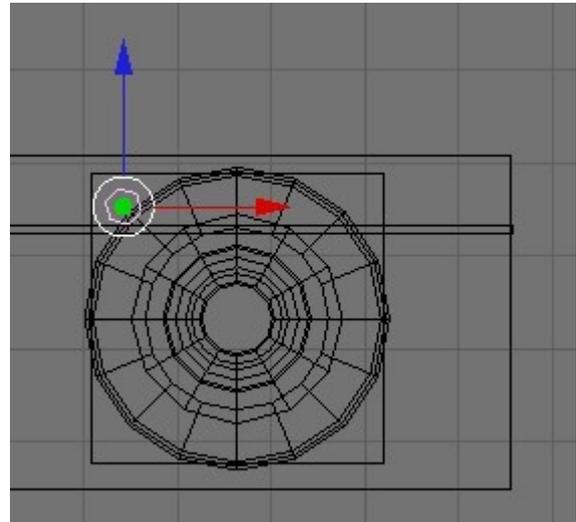
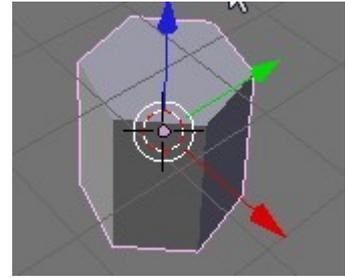
Another primitive that is available is a cylinder, which can be used for such things as boilers. We'll use one to create a bolt head for the buffer housing though (items that needed maintenance at regular intervals were never riveted, rivets have to be cut away to detach the item).

To create a cylinder it's SPACE and then Add -> Mesh -> Cylinder. As a bolt head has six sides I've changed



the value of 'Vertices', the default is 32 which is higher than you'll need even for a boiler. Watch out how many segments the final cylinder will have, they can cause the polygon count to increase rapidly.

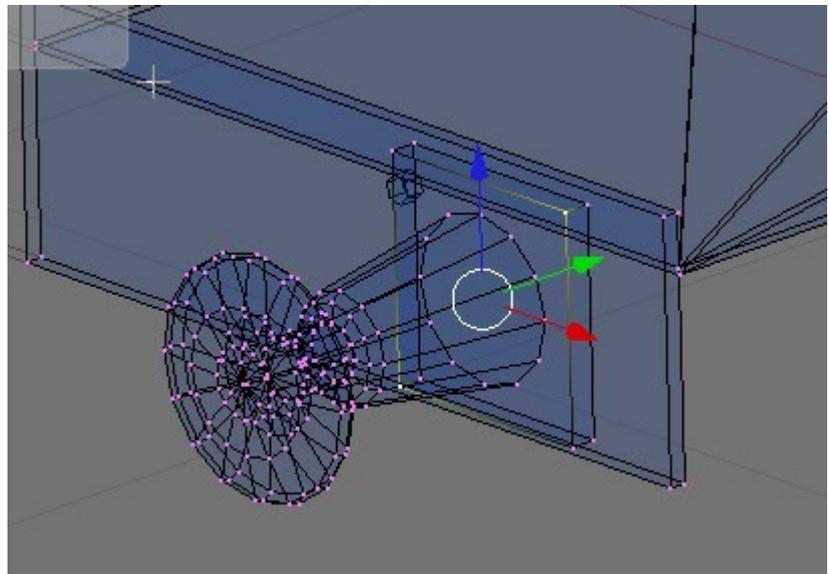
The cylinder is pretty huge, but we can scale it down easily. First though it needs rotating by using the 'Transform Properties' dialogue (press N if it is not open). Rotate it 90° about the X axis and scale it down by pressing S. Switch to the Front Ortho view and eyeball the cylinder into position, scaling it to suit. The snap tools can be used to position it on the front face of the square flange of the buffer housing. You'll find it easier to work in wireframe mode as otherwise the buffer head obscures the cylinder. Also press G to grab the selected cylinder as you can then move it in X and Z just by dragging.



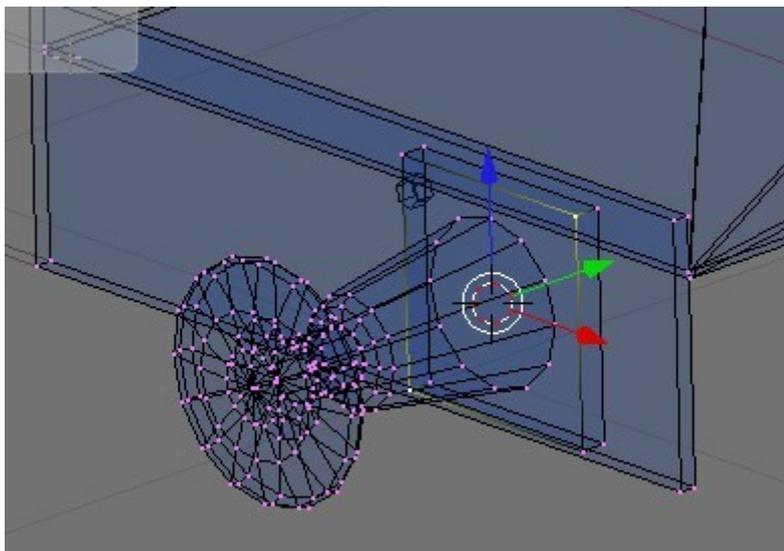
## Moving the Centre (Pivot) Point of an Object

The pivot point has remained at the centre of the cylinder during this manipulation, but in order to create the other bolt heads we'll need to move the pivot to the centre of the buffer. To do this we can select two diagonal vertices belonging to the square base of the buffer and then position the 3D cursor midway between them.

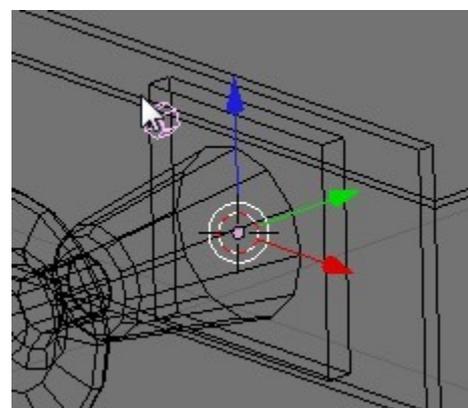
Here the two vertices have been selected:



By pressing SHIFT S and the choosing Cursor -> Selection the cursor can be positioned.

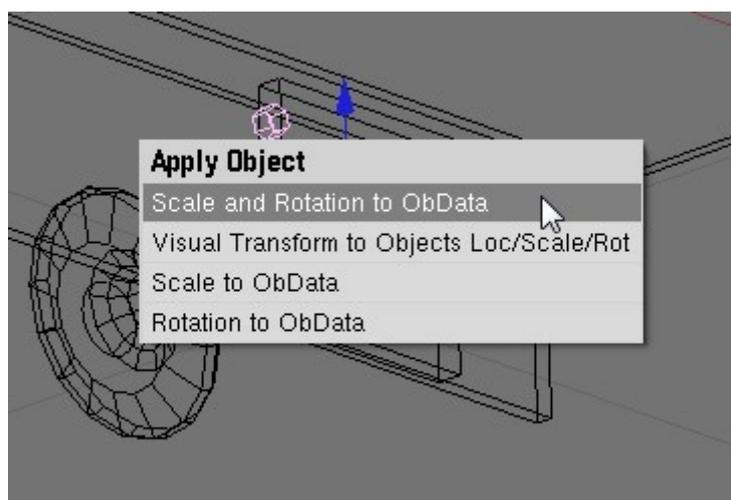


Select the cylinder again and choose 'Centre Cursor' in the Mesh panel. The pink dot snaps to the 3D cursor.



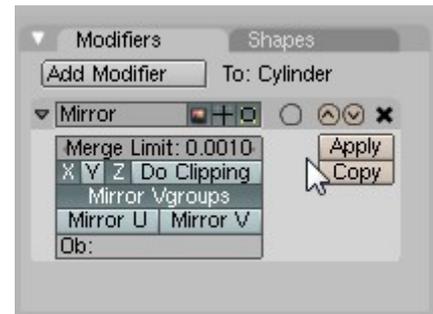
## Resetting the Transformation of an Object ('Reset XForm')

Now that the pivot point of the cylinder is correct there is one more thing to do before applying a mirror modifier to create the other 3 heads and that is the equivalent of 'Reset XForm' which resets the rotation of an object back to World Coordinates. Simply press CTRL-A and choose 'Scale and Rotation to ObData'.

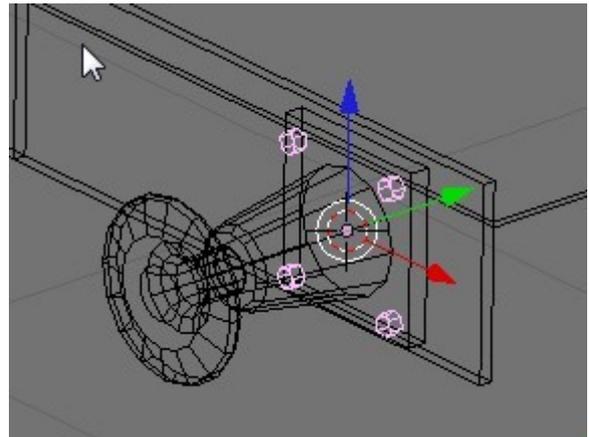


## More Mirroring

Now apply a mirror modifier to the cylinder choosing X and Z and then choose 'Apply' to remove the modifier and leave 4 bolt heads.



This is the final result. The bolt heads can be duplicated, rotated 180° and then positioned on the rear buffer housing using the snap tools. The polygons of the bolt heads that are in contact with the buffer housing can of course be removed as they can't be seen, and it would have been smarter to do the bolt heads before duplicating and mirroring the buffers themselves, but it is in any case very quick and easy to do it afterwards.



Joining the bolt heads to the main mesh will mirror them over to the other side automatically.

## Using Library Parts

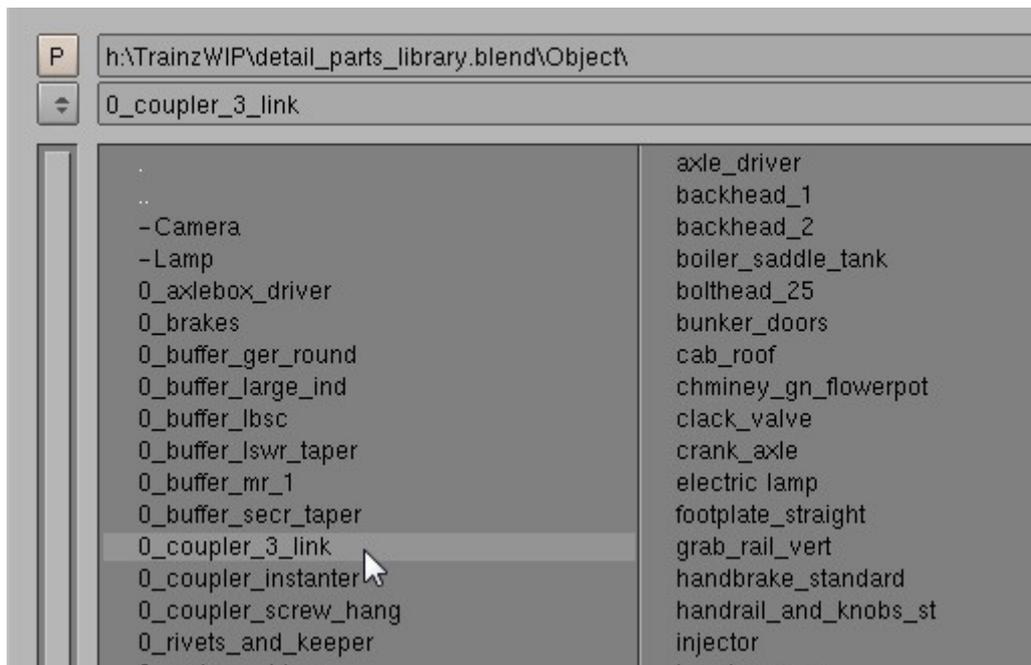
Any object in a \*.blend file can be merged into another one and we can use this to speed up mesh creation by creating standard parts that can be picked out of the library files as required - a Library file is simply another \*.blend file.

The current library that I have created can be downloaded [here](#).

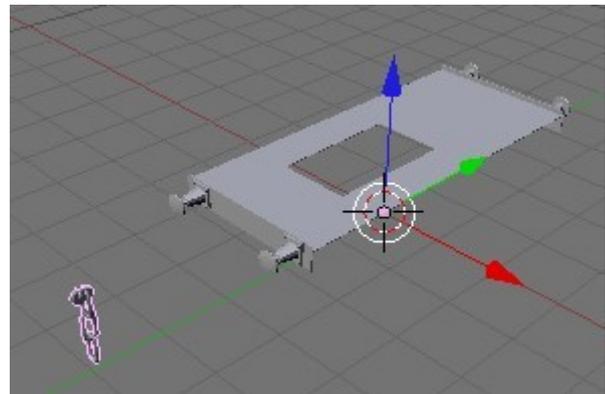
To demonstrate the use of it we'll add the 3 link couplers to the model. Press SHIFT-F1 and find the library file that you have downloaded. **Click on 'Object' in the list to see the list of available objects in the library file.**

Choose the sub mesh '0\_coupler\_3\_link' and click on the 'Load Library' button. The '0\_...' naming convention is to remind me that the sub mesh is already positioned relative to the 0,0,0 coordinates. It is also possible to load sub meshes at the current 3D cursor position which is useful for smokebox doors for example which can be inserted at the centre of the smokebox if the 3D cursor is correctly positioned. This option is controlled by the 'At Cursor' button in the mesh selection window. Actually it's a good idea to always insert at the cursor position as then you are not relying on the objects being positioned in a certain place in the library file(s).

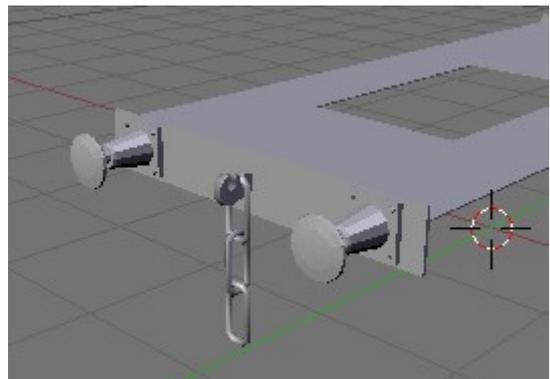
**It is also possible to insert multiple objects in one go by selecting them with the right mouse button.**



Here the coupler mesh has been inserted.



All that remains to do is to move the coupler (the snap tools are handy here) to the front of the buffer beam and to duplicate and rotate it for the rear beam.

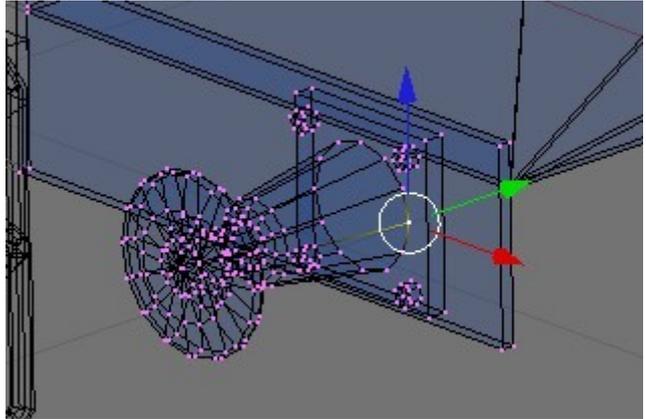


## Selecting and Smoothing Elements of an Object

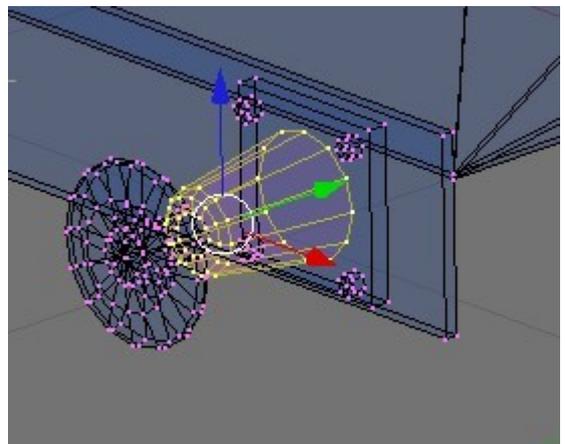
If you look closely at the buffer housing you can see the individual facets that make up the shape. This is because we haven't smoothed the mesh yet. To select the buffer housing for smoothing select one vertex on the housing (you have to choose the left side ones as the right side is mirrored and cannot be edited directly) and press CTRL-L. This will select all of the welded vertices of the object in the same manner as Element select mode in GMax

and Max.

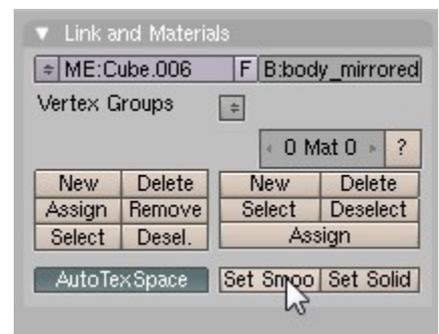
We are in Edit. Wireframe and vertex select modes here, and one vertex of the housing is selected.



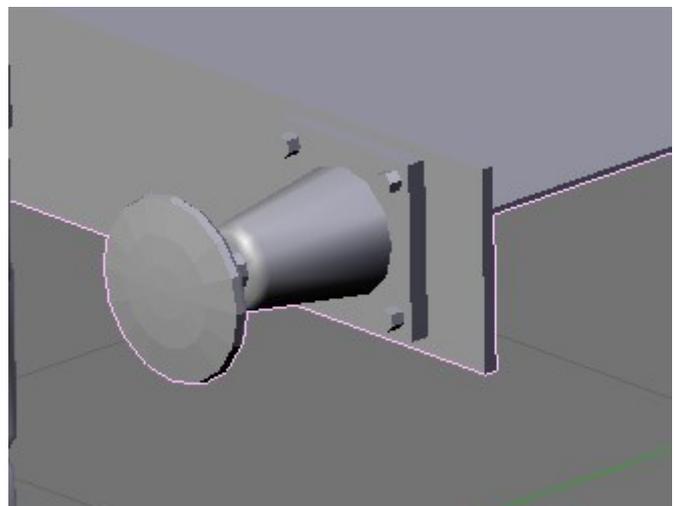
CTRL-L selects the linked vertices:



Click on 'Set Smooth' to smooth the faces



The buffer housing has been smoothed (the mirrored copy on the right side as well!). Repeat for the rear buffer and the buffer heads and rams.



## Creating Library Sub Meshes

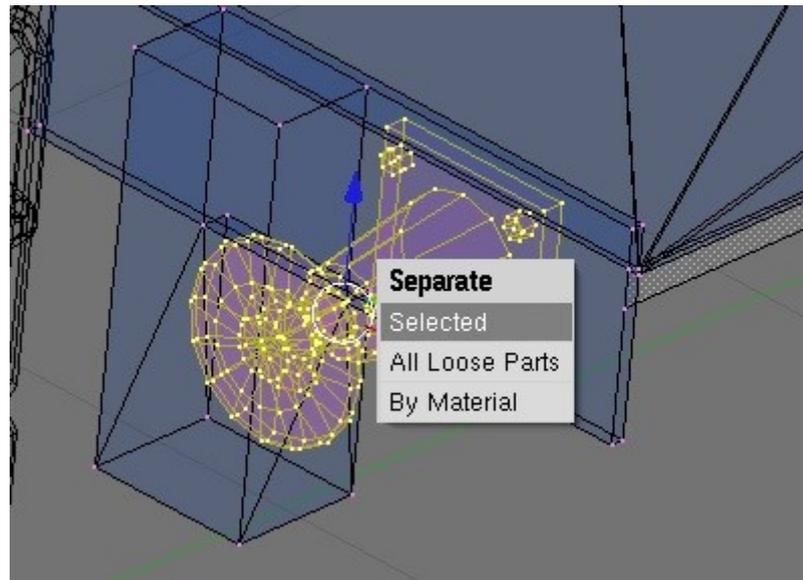
You may notice that all of the stuff that we have created so far could be used as library objects for other models. To do this all we need to do is to merge the mesh into a Library file and then split it up into suitable objects.

In this case we can save the mesh as it is now as 'MyLibrary' for example, open it and then break the mesh apart using CTRL-L to select the sub elements and P to split them out. Any mirror modifiers should be deleted and the pivot points of the objects should be moved to a sensible location (such as 0,0,0 for buffers) to make insertion in other models easier.

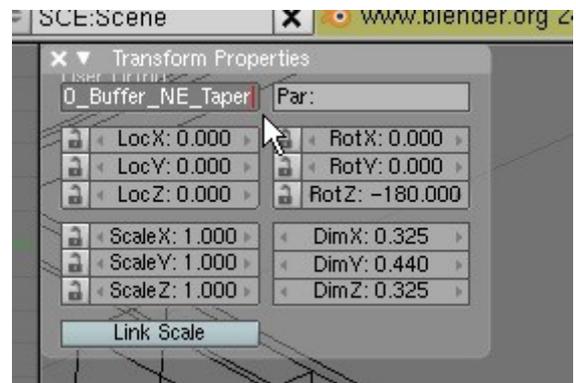
We should also do any smoothing and welding needed before extracting the sub meshes as this will be retained when we merge them into other models.

So, save the current model as 'MyLibrary' using File -> Save As (or press F2). Open this model and in 'Edit Mode' and 'Vertex Select Mode' pick one vertex on each of the elements that make up the buffer.

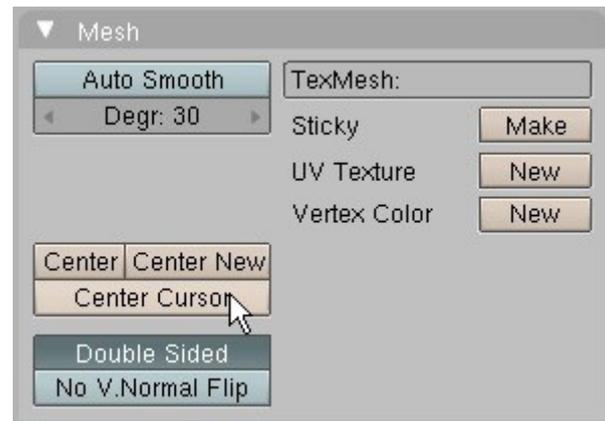
In this picture you can see the dumb buffers that I have added to the buffer beam and the footplate valance which I shouldn't need to explain how to do!



Break the buffer out of the mesh, rename it in the 'Transform Properties' dialogue box and delete the mirror modifier on the object.



Set the pivot point to 0,0,0 by moving the 3D cursor there if it is not already and choose 'Centre Cursor' in the Mesh panel.



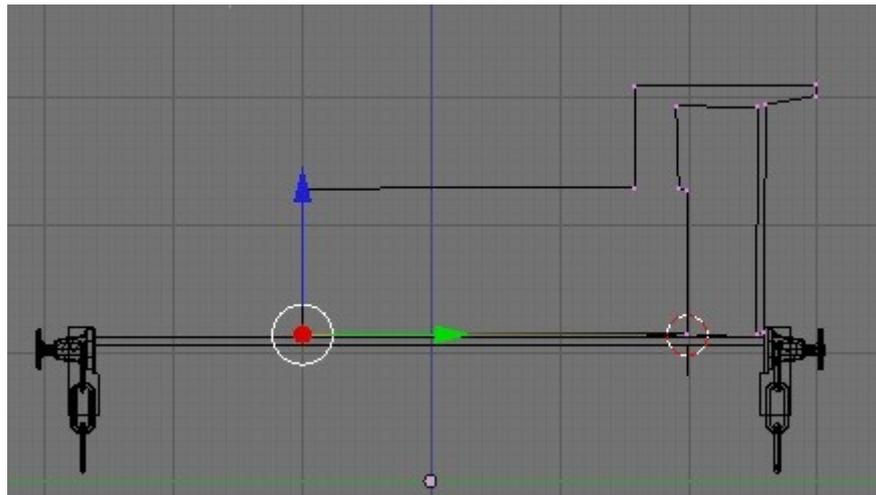
Repeat for the footplate and buffer beam to create the other Library objects. Once you have built up a library of common parts it is possible to model very quickly indeed.

## Building the Tanks and Rounding Corners

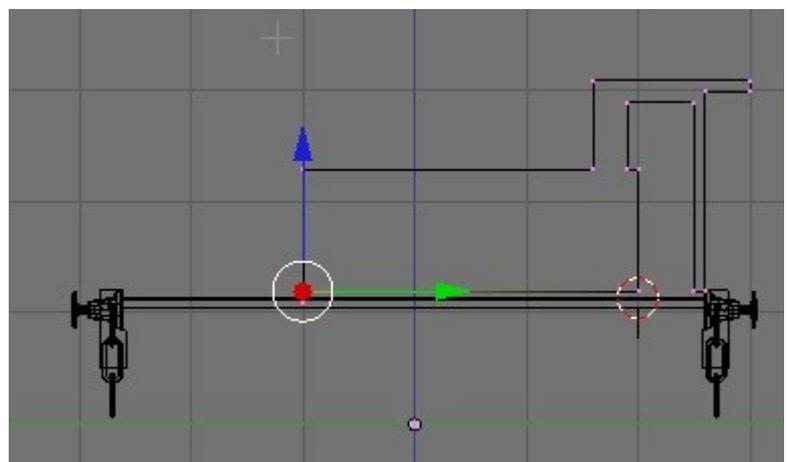
The tanks and cab side sheets are quite straightforward, the only new technique to master is filleting the corners of the cab side. Blender unfortunately doesn't do fillets – it is possible to create circles and use parts of these as fillets though. I tend to make the corners square and use the bevel tools to create the fillets though.

We'll start by sketching the basic shape in a new object, so create a cube and then delete all the vertices. In the empty object we'll create a shape by CTRL left clicking in Vertex Mode.

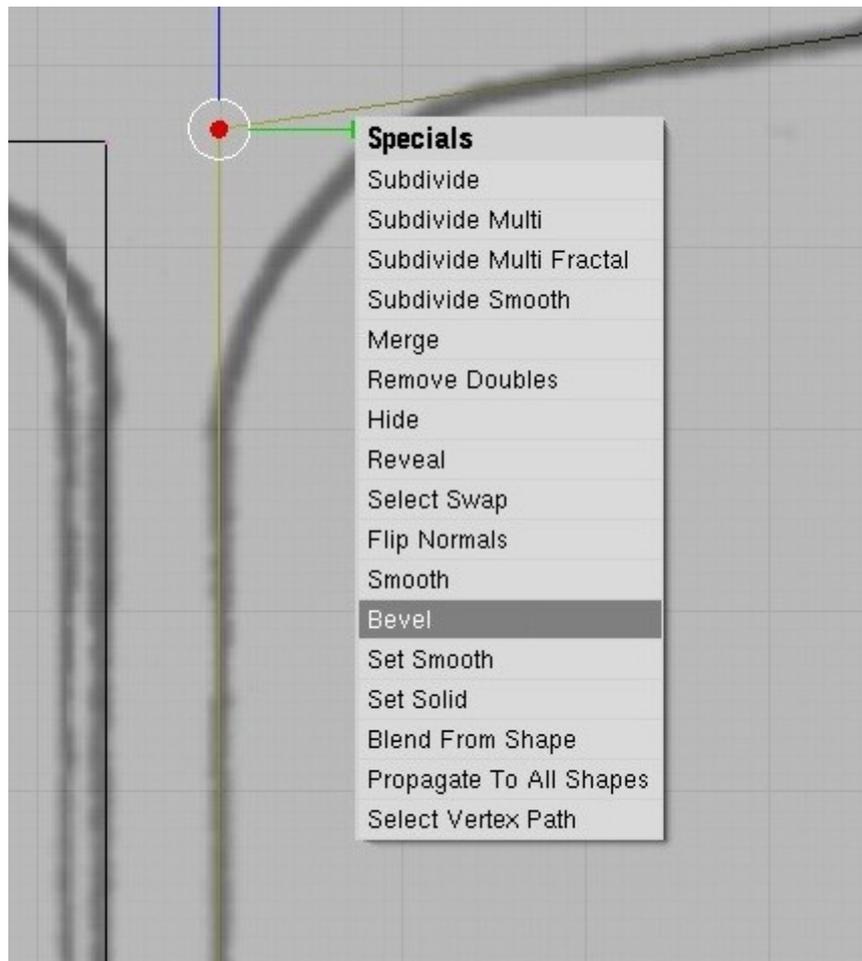
As you can see it's a bit inaccurate, but if we select all the vertices and press SHIFT-S we can snap all the vertices to the grid, squaring up the shape.



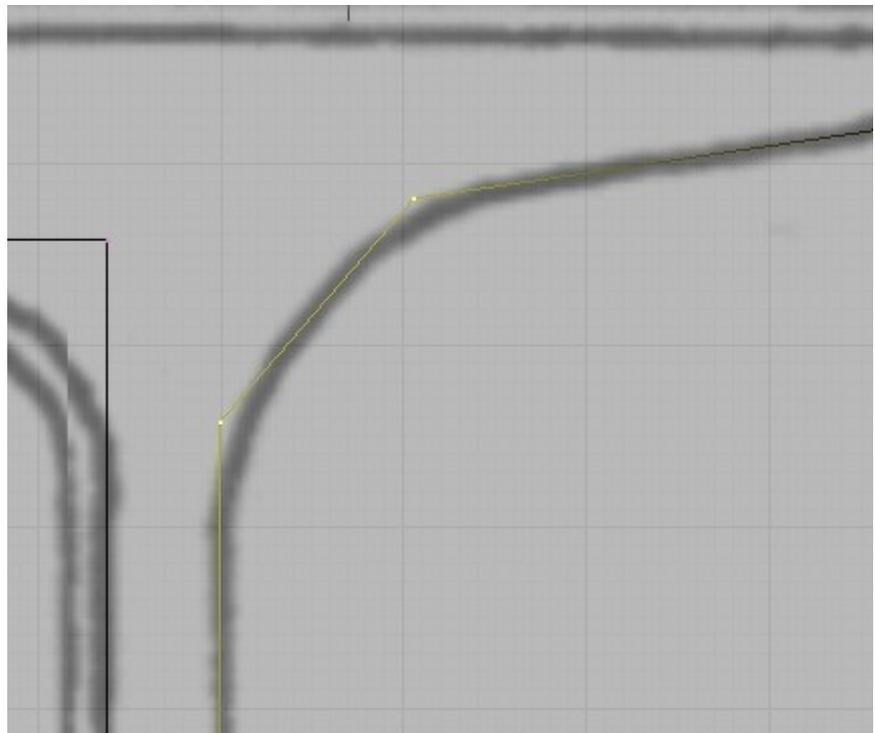
Now we adjust the horizontal and vertical lines to match the scale drawings.



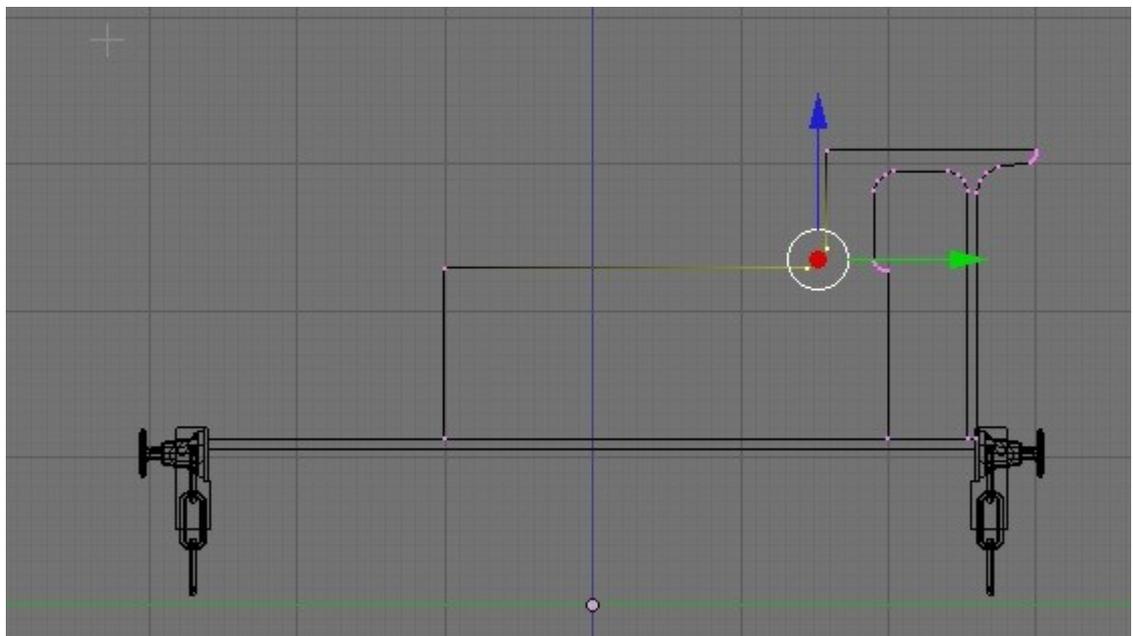
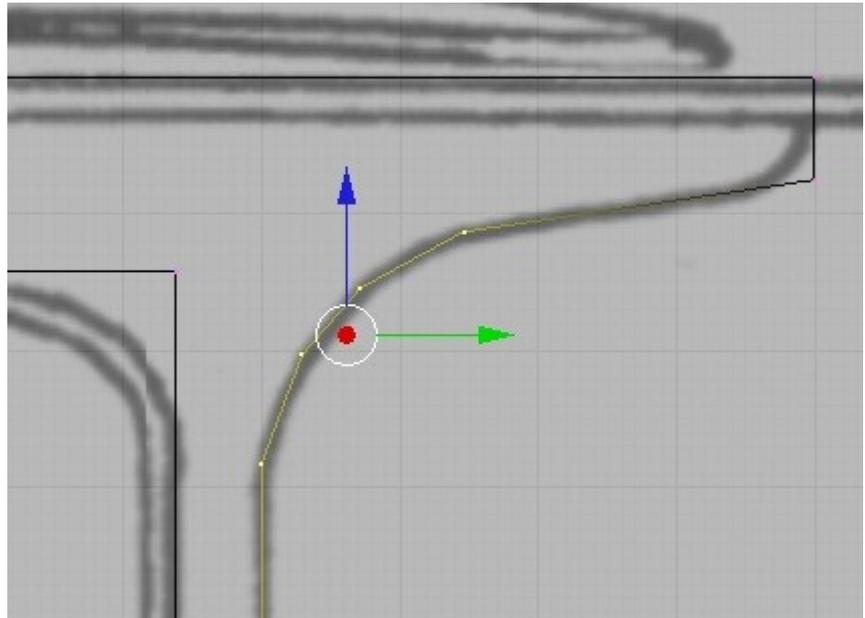
To fillet the corners select a vertex and press W, choosing 'Bevel' from the menu.



Drag the vertex with the left mouse button to create the bevel. Bevel the two new vertices again to finish the fillet.



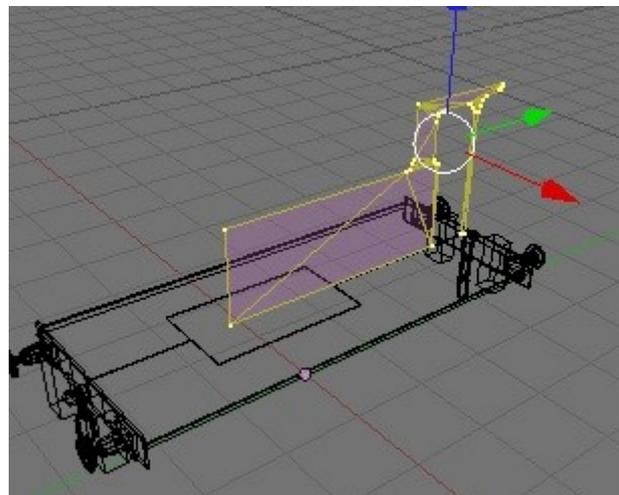
Repeat for the other fillets.



Try to get four nicely spaced vertices for each fillet. They can be grabbed with the G key and adjusted afterwards of course.

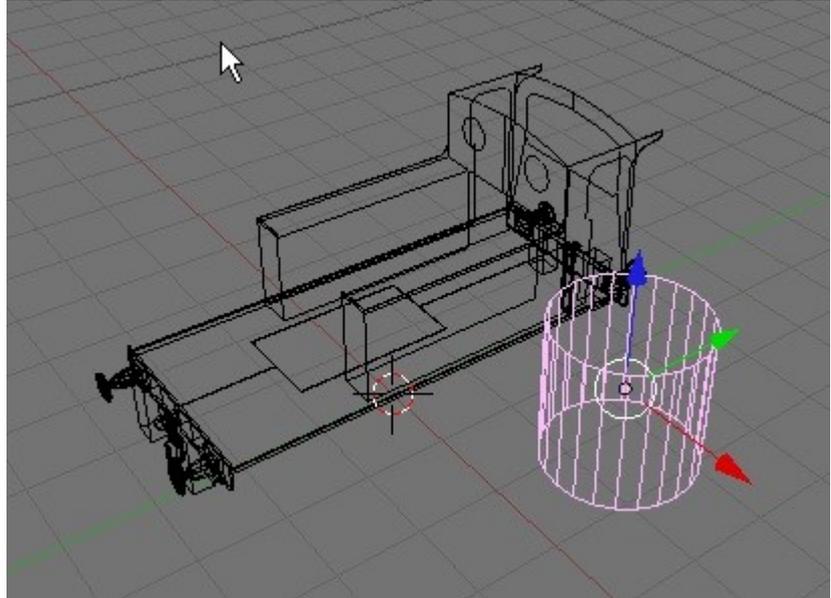
Create the faces by selecting all the vertices and pressing SHIFT-F. The tank and cab side can now be moved to the correct X coordinate and the object finished off by extruding edges or creating new shapes for the front and rear cab sheets which can be built as shown here.

The technique can be used to make all the flat sheet parts of the loco, such as the frames and brakes.

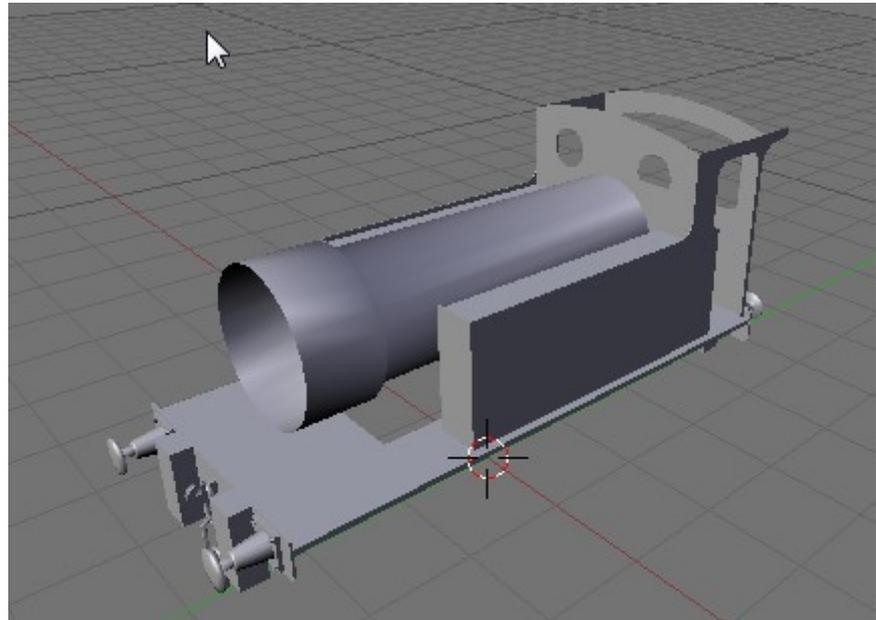


## Making the Boiler

To make the boiler we'll insert a new cylinder with 24 vertices and no end caps...



And now rotated and scaled to match the scale drawings... The smokebox has been created by extruding and scaling the front end of the boiler, this is easier if the boiler is a full 360°.

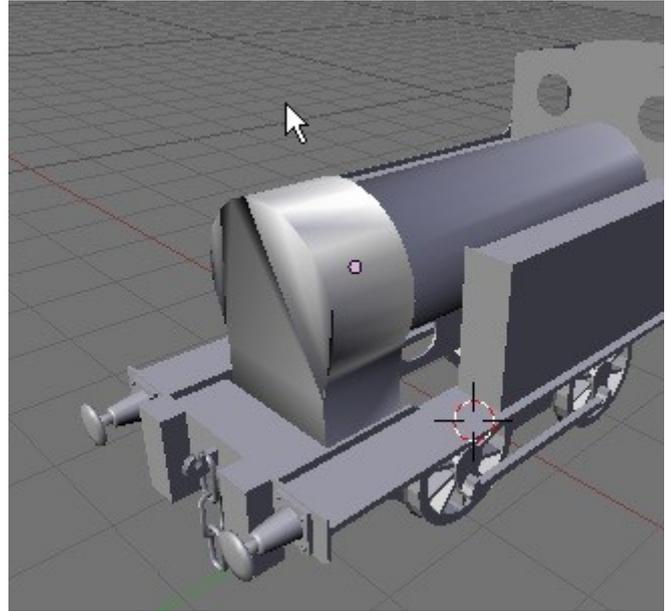


The vertical sides of the smokebox were made by deleting the 8 faces at the bottom of the circular smokebox and extruding the free horizontal edges downwards. The new faces were then detached with P and moved and resized to match the scale drawing. The area between the vertical faces and the circular part of the smokebox was filled by extruding a few faces. The front face of the smokebox was made by selecting the vertical free edges and pressing SHIFT-F.

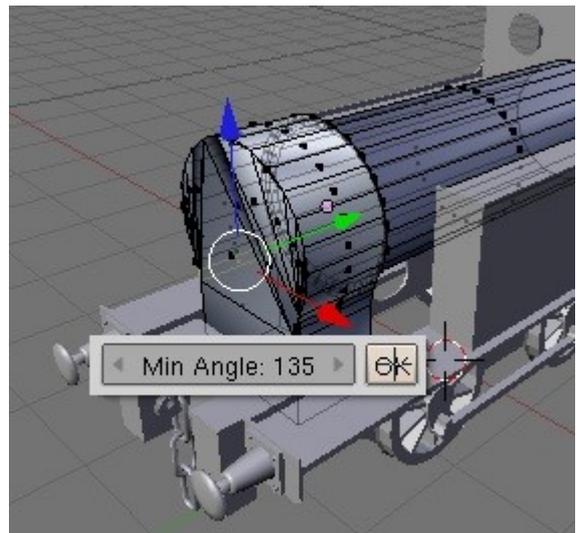
## More on Selecting and Smoothing

When we apply smoothing to the boiler object we get a result that we don't want in this case. The sides of the smokebox should be smooth but the front should be flat. The ugly shading on the smokebox front is caused by Blender trying to smooth around a 90° corner.

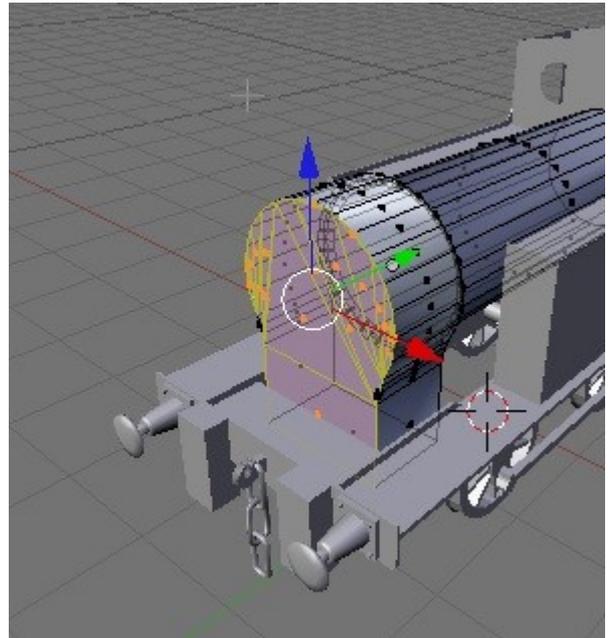
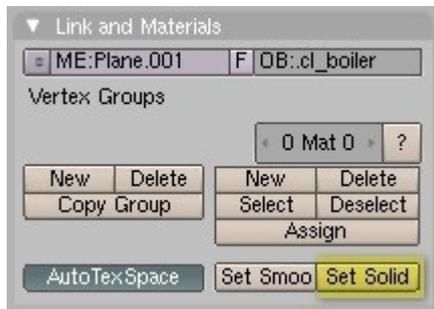
A very useful possibility for selecting faces is to limit the selection to adjacent faces that are within a certain angle tolerance of the first one selected.



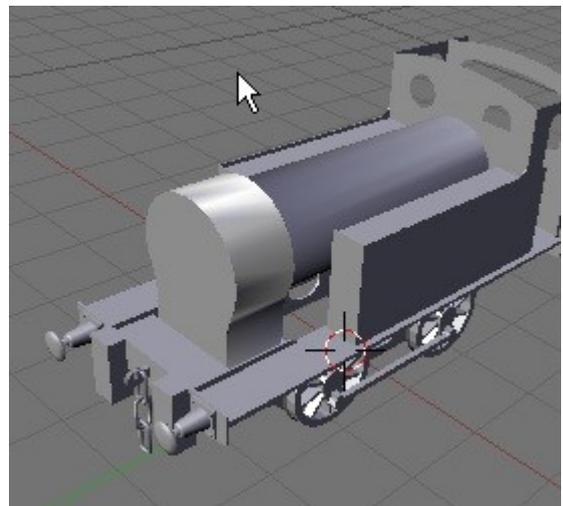
Go into 'Edit Mode' on the boiler object and select one of the faces on the smokebox front, then press ALT-CTRL-SHIFT-F. All the adjacent faces on the smokebox front will be selected, but not the curved sides.



Once the faces have been selected we can do 'Set Solid' on them to remove the smoothing.



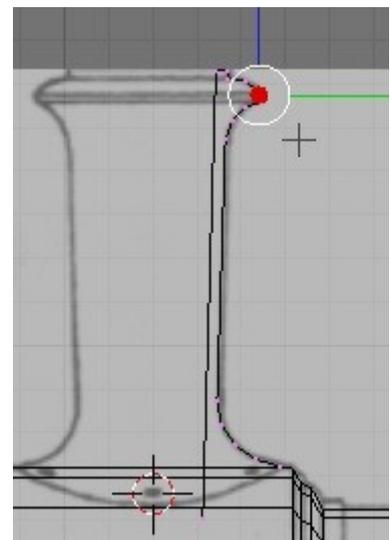
That's better...



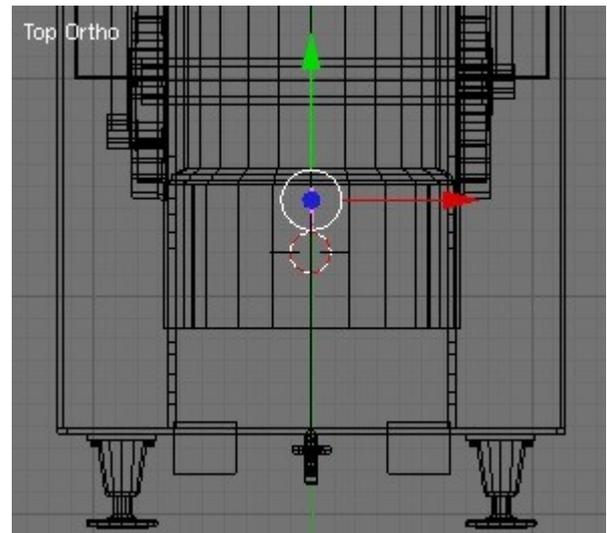
## Chimneys and Domes

These can be made in the same way as the buffers, a 2D profile rotated around the 3D cursor in the top view. It's worth only making a quarter of the object and then mirroring it though as the vertices at the base will need to be adjusted to fit neatly on the boiler or smokebox.

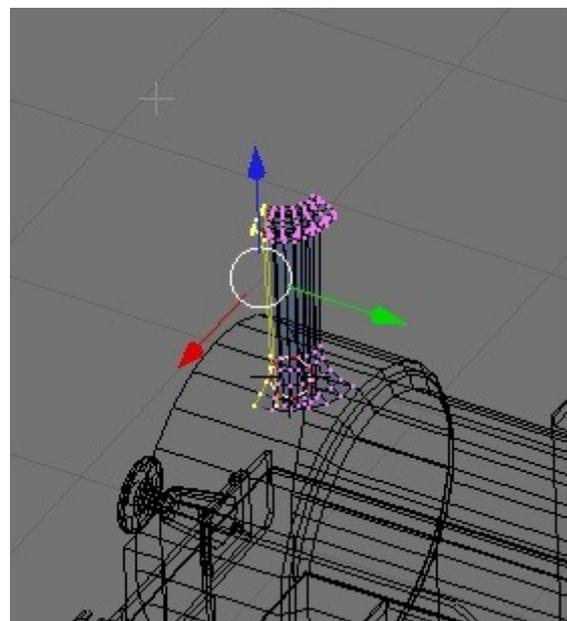
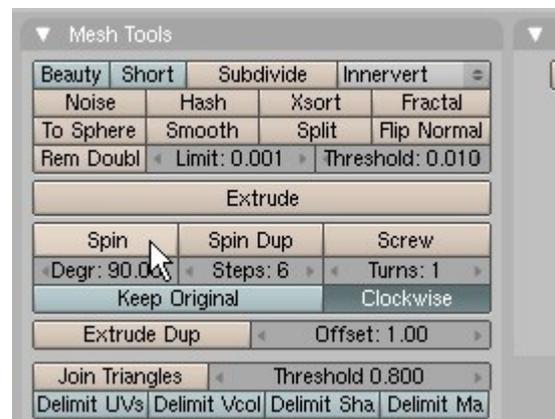
Here I've sketched the shape of the chimney and have set the 3D cursor to the centre of it (hopefully). If the centre is a bit out I can always scale the object afterwards.



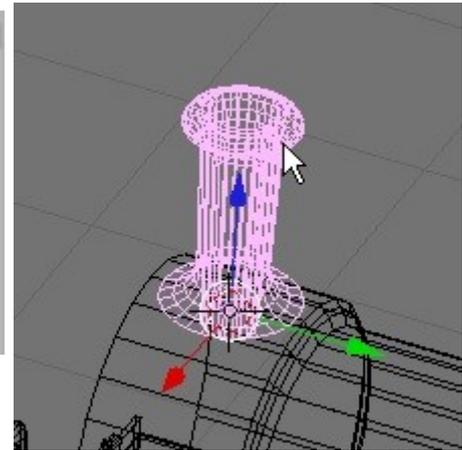
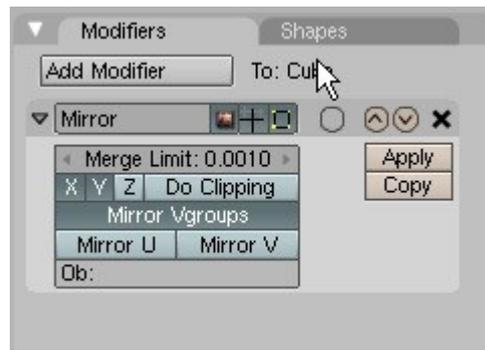
Switch the main 3D view to Top Ortho by pressing 7 and then 5 if the view was not already in Ortho mode.



Now spin the chimney 90° with the steps set to 6.

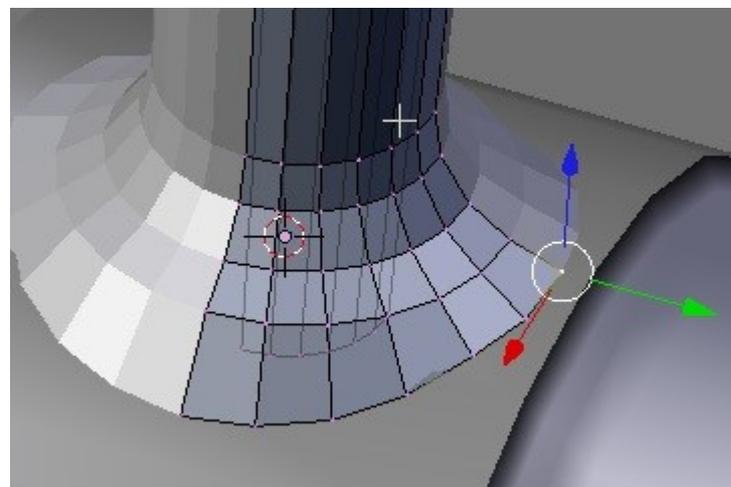
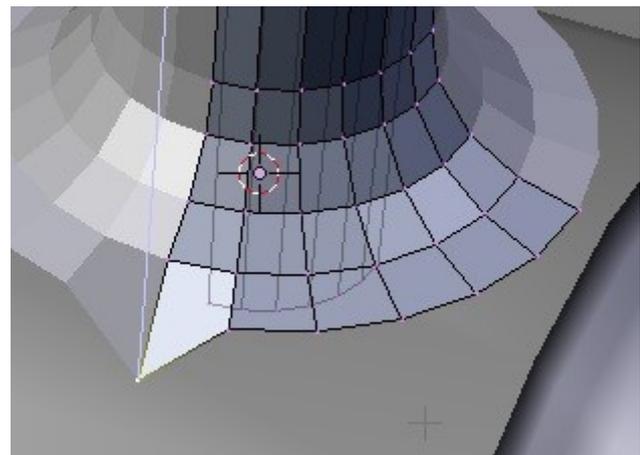


Switch to 'Object Mode' and apply a mirror modifier in X and Y to complete the chimney, but don't forget to move the pivot point to the 3D cursor first as the mirror needs to be about the centre of the chimney.

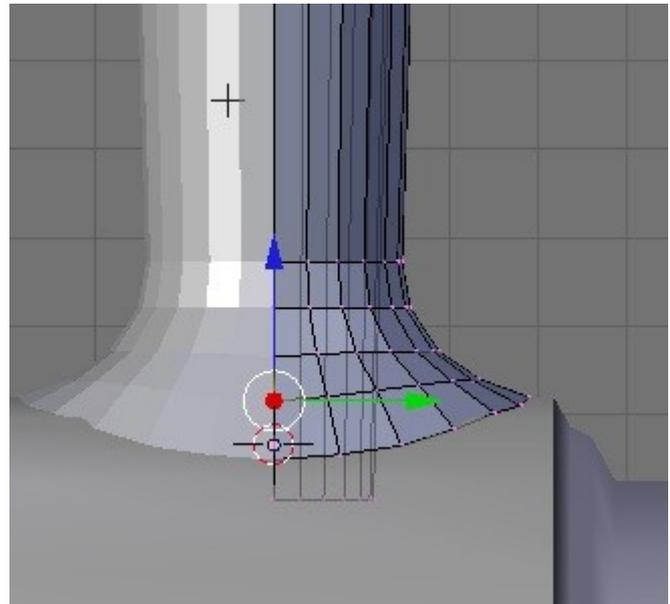


Finally in the 3D view and in shaded mode the edges of the base of the chimney must be moved in Z so that they just touch the smokebox. In the side view adjust the other vertices to make a smooth base for the chimney.

This is made a little easier by the fact that we only have to adjust a quarter of the vertices in the chimney base.

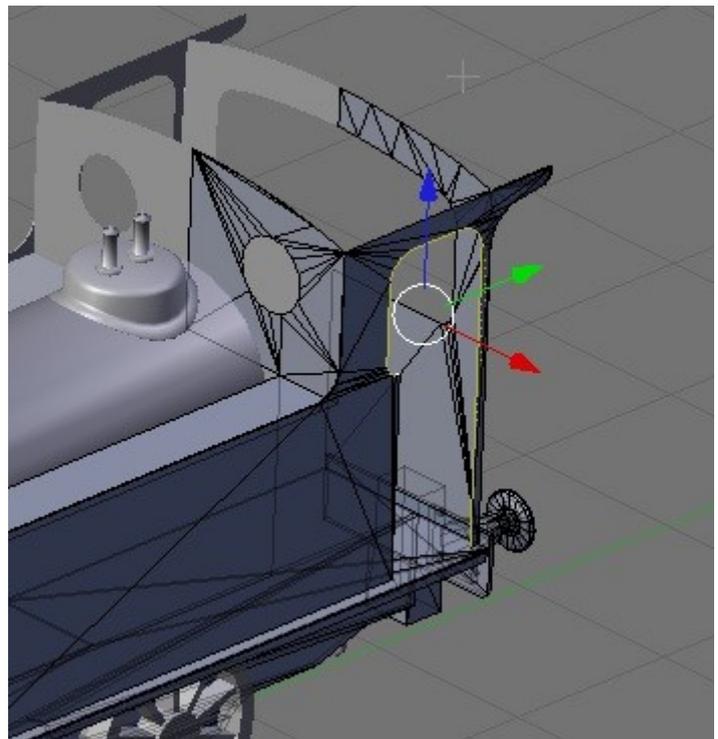


That's it for the chimney, it just needs smoothing and we are done. Domes, safety valve covers and whistles can be made using the same technique.

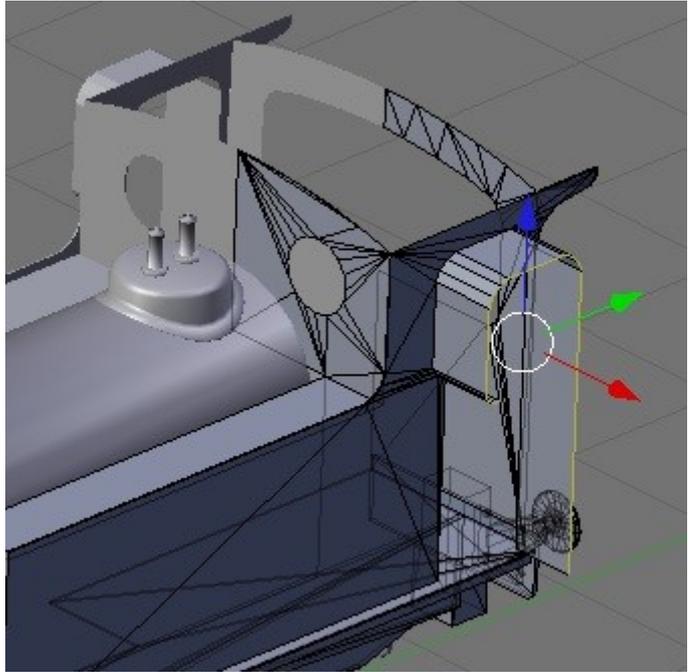


## Beading and Window Frames

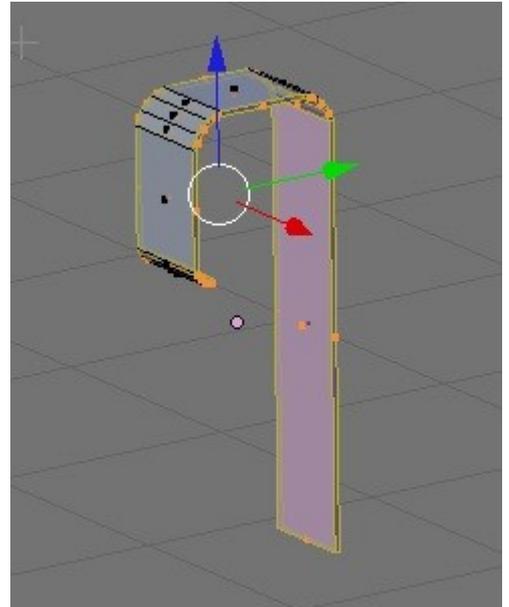
Start by selecting the edges that make up the beaded edge or the window frame:



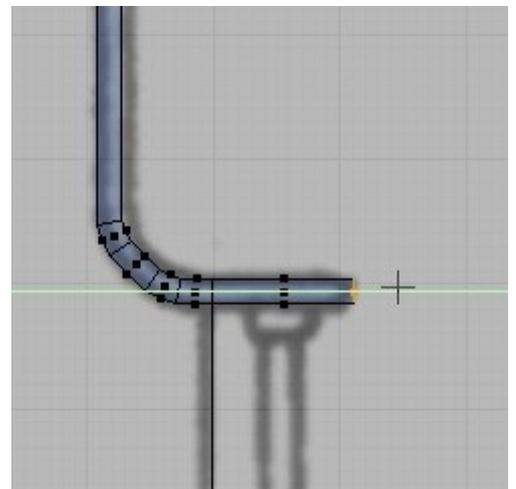
Extrude the selected edges, separate them from the body mesh and delete the mirror modifier.



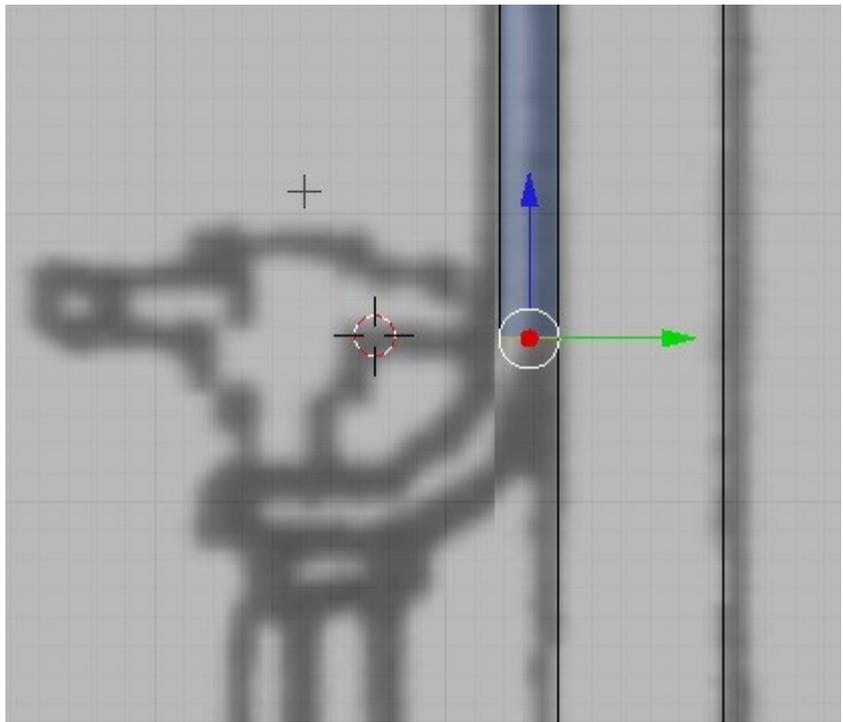
Select all the faces of the bead/frame and apply the 'Solidify Selection' script with a suitable value to add thickness.



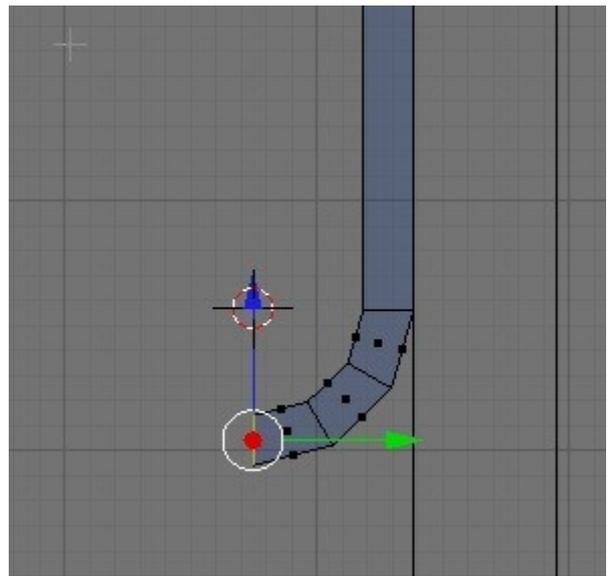
Here I've extruded the end face to add the extension for the handrail.



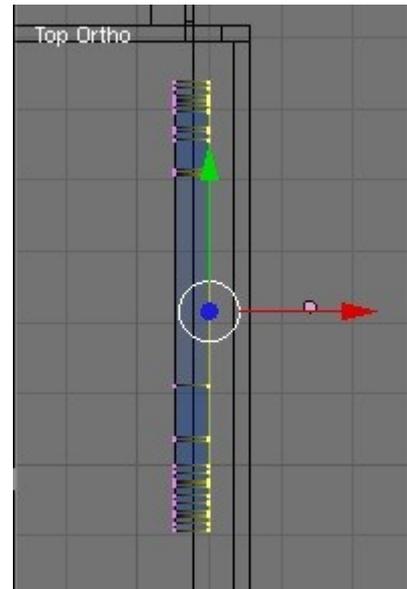
On the other side I've shortened the beading up to the start of the radius for the handrail extension and have positioned the 3D cursor to the approximate centre of the radius.



The curved end of the beading is then created with a 90° spin. A similar method can be used to create pipework incidentally.



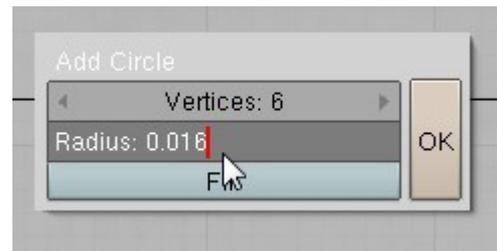
Finally the thickness can be reduced to about 50-60mm. In reality the beading was quite wide as the handrail down to the footplate would be around 32mm diameter.



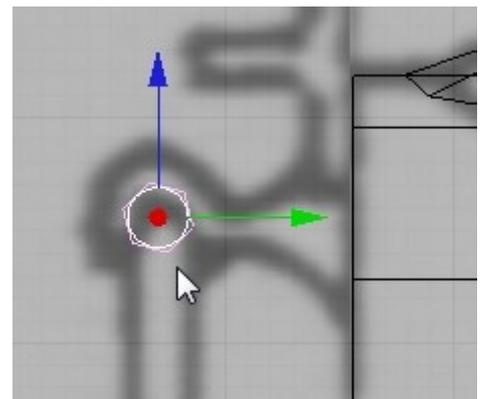
## Handrails and Pipework

This is about the only thing I've found so far that is harder in Blender than in GMax. Blender lacks a method of sketching the centreline of a pipe and then adding a thickness to it (having said that there probably is a script somewhere to do this, but I haven't found one yet).

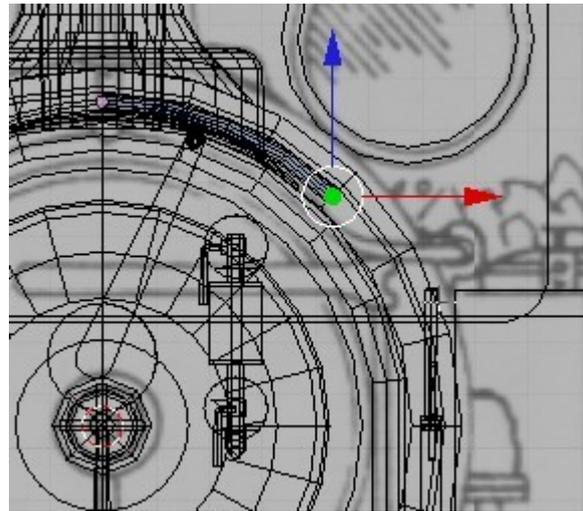
In the absence of this it is necessary to create a circle and then extrude it to make a hand or handrail.



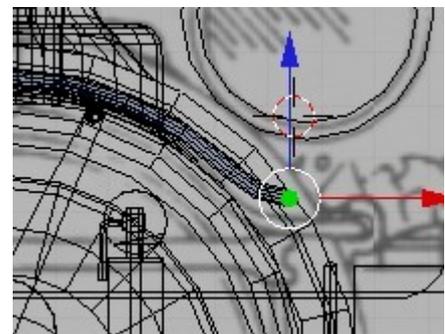
Position the circle at the highest point of the handrail in the side view....



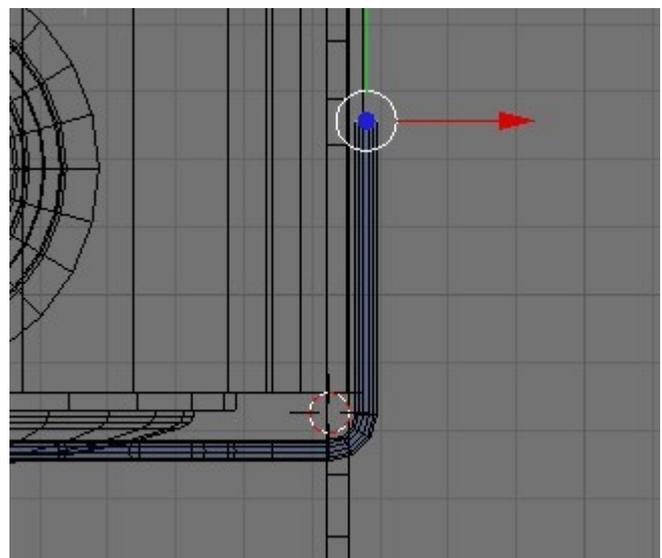
In this case the handrail is centred on the boiler, so set the 3D cursor to the boiler centreline and using 'Spin' create the first part of the handrail in the front view. You'll have to guess what angle is needed, in this case it was 45°, but if you get it wrong just hit CTRL-Z and try again.



The next step is to find the centre of the next radius, I just eyeballed this and created the next segment of 45°. Note that the handrail is being created a bit higher than the drawing shows, the height has been taken from the side view as the drawing appears to be incorrect here, the handrail in the front view is drawn too high (the boiler centre line is correct though). Unfortunately this is not uncommon in published drawings. The best thing is to take as much information as possible from the side view and only widths from the front view.



Switching to the top view the handrail was completed with an extrusion in X, a 90° spin with 3 segments around a new position for the 3D cursor and an extrusion in the Y direction.



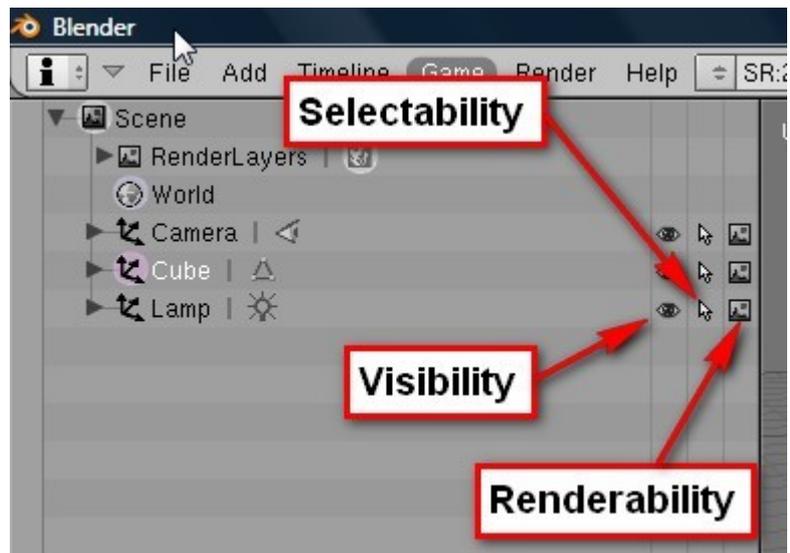
## Organising the Model, Layers and Hiding/Showing Objects

As the model gets more complicated it becomes harder to see what is going on – luckily Blender comes with several helpful tools built in. At the simplest level whole objects can be made visible and invisible in a similar manner to GMax. To do this you can use the 'Outliner' window which displays the scene as a tree view.

The three icons for each scene object can be toggled by left clicking on them with the mouse.

Toggling 'Visibility' off hides the object, on shows it again. In the same way 'Selectability' can be toggled which is useful when you have problems selecting the correct object. GMax and Max call this function 'Freeze'.

Toggling 'Renderability' excludes or includes objects in the scene renders. This is useful if you have a mirror plane in the scene (which normally extends the render time) , for a quick render the plane can be excluded.



All well and good, but a bit limited. Blender also has the possibility to work with layers, which GMax doesn't have. A layer can be thought of as a transparent sheet containing objects which can be shown or hidden, or as a way of grouping objects together. Blender doesn't waste a lot of screen space on layers, it's just a group of 20 boxes as shown here.



By default objects are created on layer 1 and only the active layer is displayed. The grey background to the box means that the layer is visible, the small circle that geometry is present on the layer. Multiple layers can be displayed by SHIFT left clicking the boxes, the active layer is the last one selected.

To move whole objects to a particular layer select it (or them) and press M followed by the layer number, i.e. M and then 2 to move the objects to layer 2.

To make working on a particular object easier it is possible to switch to what Blender calls a 'Local' view. This shows only the currently selected object(s), zooms the view to show the object as large as possible and centres the 3D cursor on the geometry.

Any new objects created in this mode are also displayed making it easy to work on objects in isolation.

To get back to the 'Global' view select it as shown in the View menu.

On a German keyboard with numpad emulation active the hotkey is '^', for other keyboards some experimentation may be needed!

For quickly hiding something there is also the H key, which hides anything selected. To unhide hidden objects press ALT-H. Interestingly this

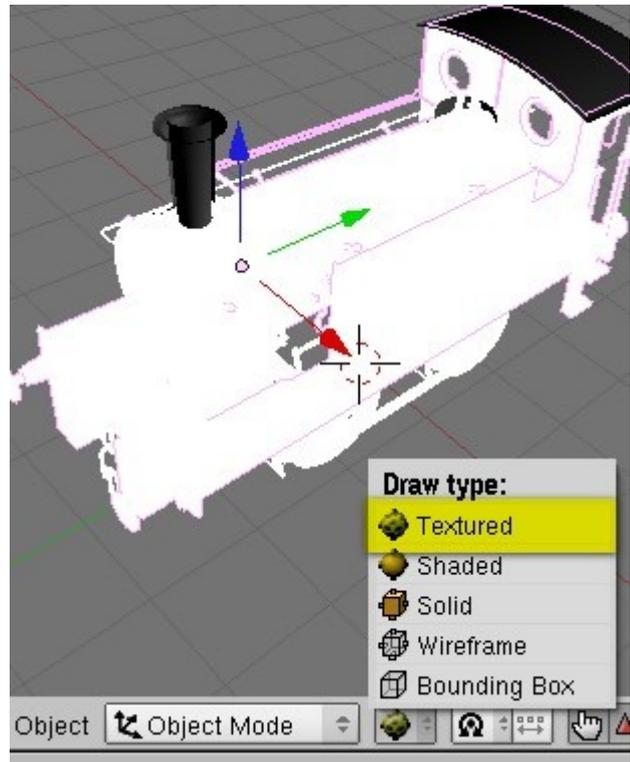


allows faces and vertices as well as whole objects to be hidden.

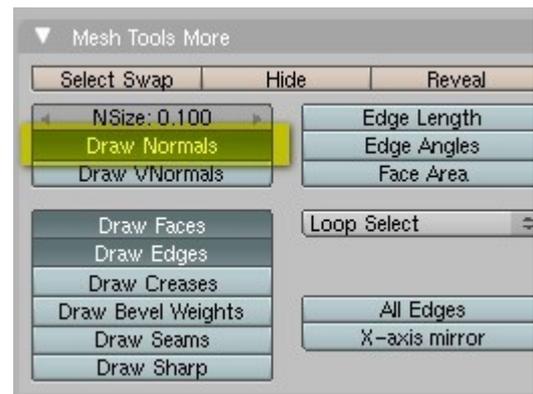
## Surface Normals and Flipping Them

The 'normal' is the direction of a face or a vertex. Each face has a visible side and an invisible side – the visible side is the viewable side. During the construction of the model it is almost certain that some of the faces will have reversed normals which need correcting before the mesh is textured and exported, otherwise the faces will have the wrong shading in-game or will be displayed inside out.

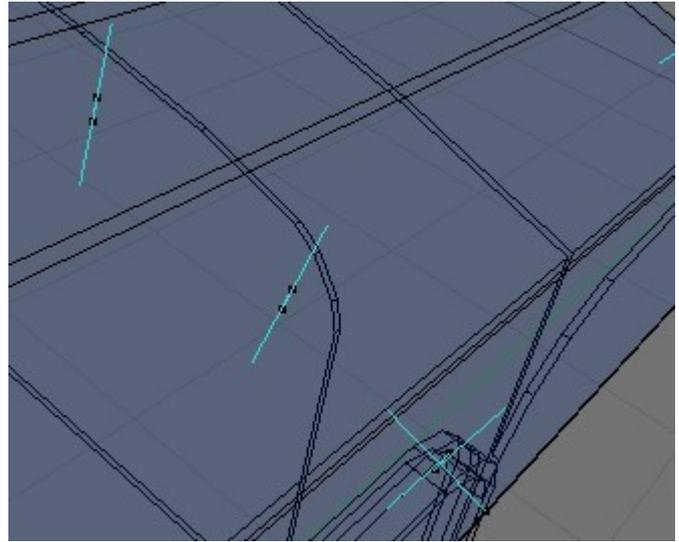
A quick way to check the mesh is to switch to the 'Textured' display mode instead of 'Solid' or 'Wireframe'. As the mesh hasn't been textured yet faces that are correctly orientated will be displayed in white, those with reversed normals in black. Here we can see that the chimney and cab roof have the normals inverted.



Another possibility is to actually display the surface normals. Select the cab roof object and switch to 'Edit' and 'Face Select' modes. Press F9 and then click on the 'Draw Normals' icon in the 'Mesh Tools' panel. You don't need to actually select the faces, just be in the right mode.

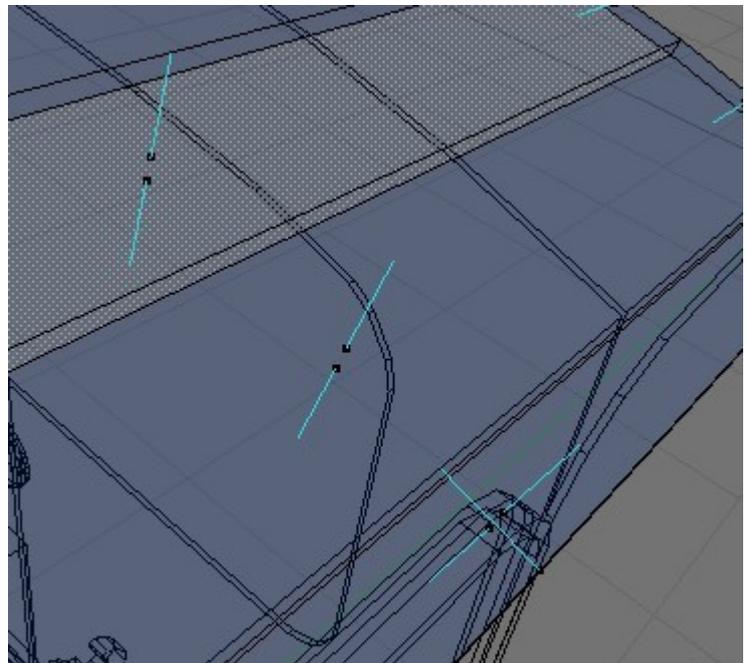


The normals for this object will now be displayed (the blue lines).



To invert a normal select the faces (SHIFT-CTRL-ALT-F to select linked faces is useful here) and press W and then 0 (or W and choose 'Flip Normals' from the menu). The normals should look like this in this case:

Obviously if you are cleverer than me – or less impatient to see the finished mesh – you can save time by checking the normals as you create stuff, or at least before you start mirroring and copying objects around.



## Adding Attachment Points

These are needed for an item of rolling stock, the minimum would be three points called a.bog0, a.limfront and a.limback. Blender doesn't have points as such, instead an object called an 'Empty' is used instead which has the same appearance as a point in GMax or Max. Create the Empty object by pressing SPACE and choosing Add → Empty from the menu.

These can be positioned exactly like other objects, but the naming and positioning of the Empties is important and is described in more detail in the Content Creation Guides. Luckily they do not have to be created in the 'Top' view to get the orientation correct as in the case in GMax and Max.

## And Finally

Obviously not all of the possibilities for creating a mesh have been covered here, but hopefully the basics have been. There are many, many other tutorials available on the Internet that will suggest more techniques that can be used.

If anybody has any suggestions for improved techniques or problems following this tutorial let me know by mailing me at [paul.hobbs@web.de](mailto:paul.hobbs@web.de) .

The (almost) finished model used in this tutorial can be downloaded [here](#)  
(LNER\_Y7.blend)