QuickCAM 3D - Mobile Phone Tutorial
Overview

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This tutorial leads you through the process of converting a 3D model, such as a steriolithograpy (*.STL) file, into a CNC file that can be used to machine a solid 3D part.

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QuickCAM 3D - Mobile Phone Tutorial
Introduction

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This tutorial leads you through the process of converting a 3D model, such as a steriolithograpy (*.STL) file, describing the shape of a mobile phone, into two separate CNC files. The first CNC file will machine the top, button side of the phone, the second will machine the bottom, plain side of the phone, as shown below...

to

3D model, such as an STL file. *Machined 3D model.*

This is achieved by running the STL file through the QuickCAM 3D software twice, changing the view of the 3D model in the second sequence. The two CNC files can then be machined into a single foam block, to produce a solid 3D part that can be painted or vacuum formed to produce the phone "shells".

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Before beginning the tutorial

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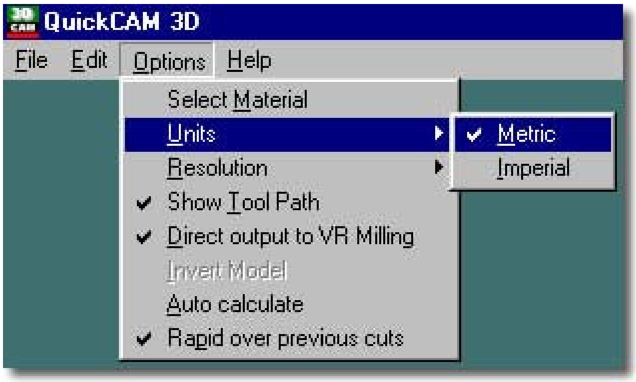
General layout of QuickCAM 3D

QuickCAM 3D opens at the "Select 3D or Image" screen - the first of nine separate stages. On each of these stages, the main QuickCAM 3D is always split into the same two areas:

1. A viewing pane, located on the left side and taking up the remaining two thirds of the main QuickCAM 3D window. This area is used for displaying graphic representations of the 3D model and billet. Currently this area will be blank, since no file is loaded.
2. An information pane, located on the right side and taking up around a third of the main QuickCAM 3D window. This area is used for entering and displaying any data relating to the stage being completed.

Setting the units of measurement

Before beginning the tutorial, set the QuickCAM 3D software to run using metric (millimetre) units. Click the "Options" menu, select "Units", then click the "Metric" text, if necessary, so a tickmark is displayed, as shown below.



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Stage One - Select 3D Model

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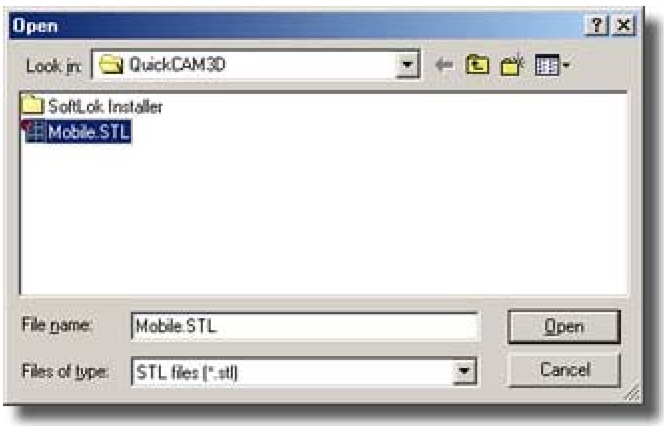
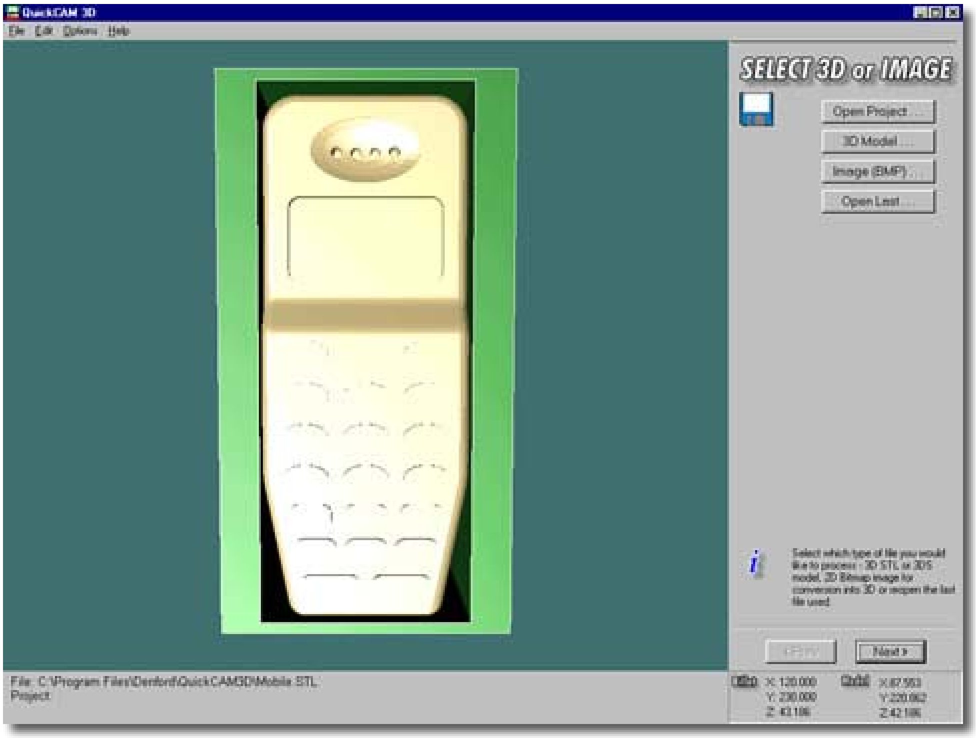
The "Select 3D or Image" stage allows you to load the 3D file you want to convert.

Locate and load the 3D model file

Click the [3D model...] button. The "Open" window is displayed, as shown below.



Locate and select the file named "Mobile.STL". If QuickCAM 3D was originally installed using the default folders, this can be found at location...
C:\Program Files\Denford\QuickCAM3D
Click the [Open] button. The 3D model is loaded into the viewing pane of the main QuickCAM 3D window.
Your QuickCAM 3D window should look something like the example shown below. (Note that the billet size, determined later, may currently be the wrong size for the model)



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Stage Two - Orientate Model

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The "Orientate Model" stage allows you to set how the 3D model will be positioned relative to the working area of the CNC machine. Imagine the left pane as the view through the front window of your CNC machine.

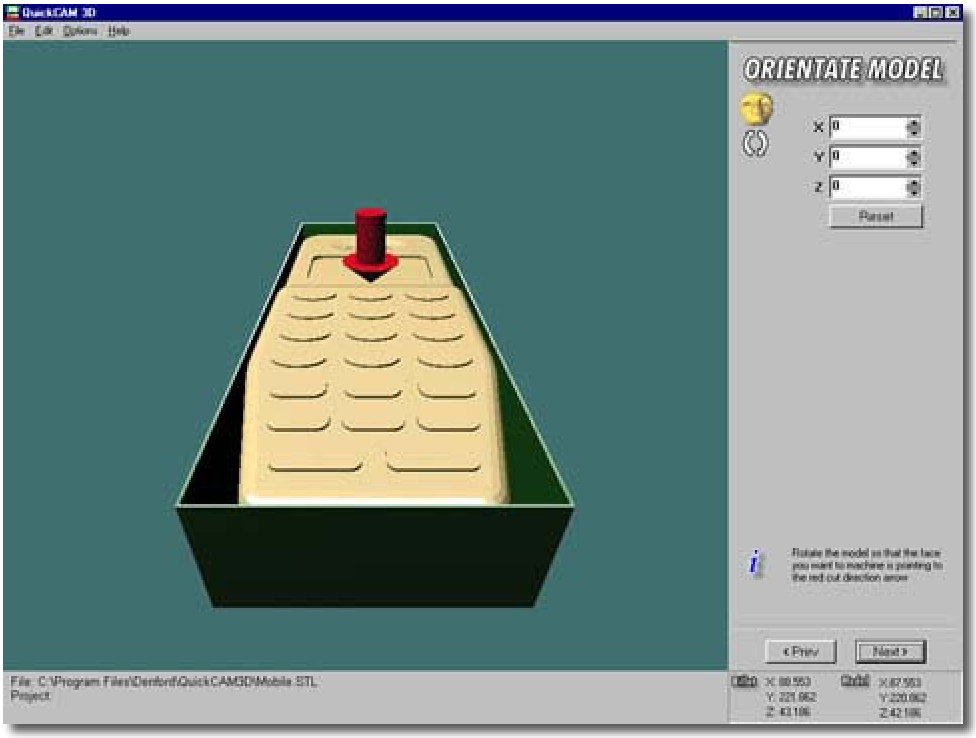
Manipulating the view

Change your view of the 3D model by zooming in and adding a bit more perspective, so you can see the red arrow pointing down. The red arrow represents the direction that the cutter will approach the billet, or in other words, the Z axis of the CNC machine. You can see the red arrow more clearly by manipulating your view of the 3D model, as described below.

To zoom in...
Using your mouse, right click on the 3D model and continuing to hold the right mouse button down, move the cursor upwards. This enlarges the view of the 3D model. Moving the cursor down will make the 3D model smaller. Size the 3D model to fit the viewing pane.

To add perspective...
You can also tilt the 3D model front to back and left to right. Using your mouse, left click on the 3D model. Continuing to hold the left mouse button down, move the cursor upwards. This tilts the back edge of the 3D model down. Moving the cursor down will tilt the front edge of the 3D model. Moving the the cursor left or right will tilt down the left or right edges of the 3D model. Manoeuvre your view so you can see the front and top surfaces of the 3D model, with the red arrow pointing directly down.

Your QuickCAM 3D window should look something like the example shown below.



Setting the orientation of the 3D model

You want to create a CNC file that can manufacture the top of the phone - this will be the surface containing the mouthpiece, earpiece and buttons. Currently, the red arrow (the cutter) is pointing directly down onto this face.

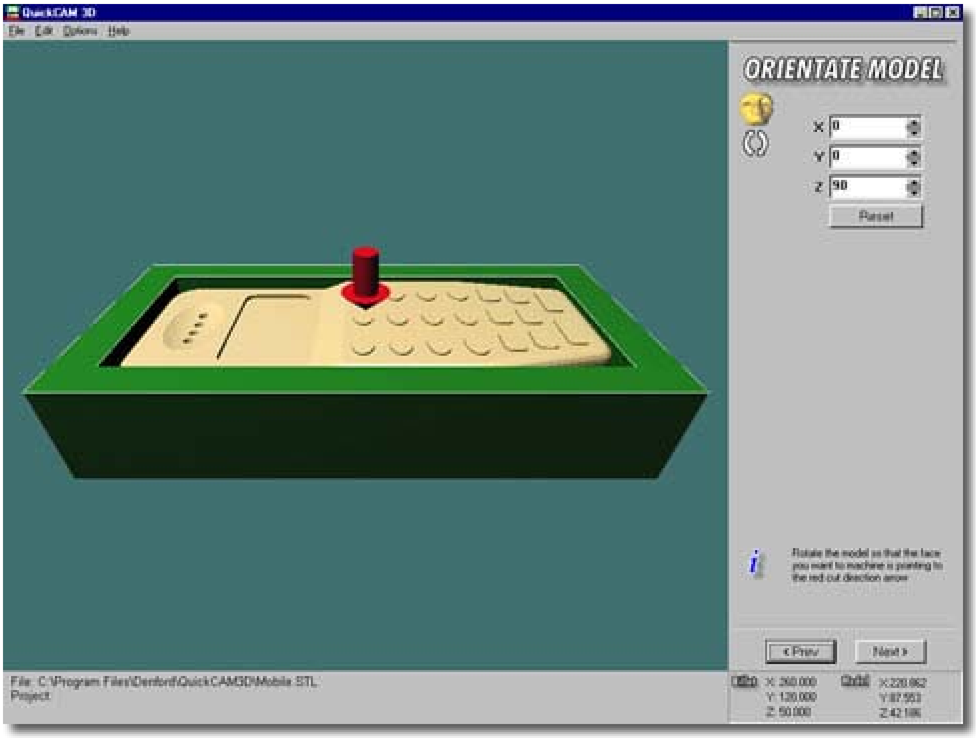
You also want to orientate the 3D model so it makes best use of the working area in the CNC machine. At the moment the 3D model is positioned with the mouthpiece end facing towards you, or in other words, the longest side of the 3D model aligns with the Y axis. On most CNC machines, you will find that the X axis will have the longest travel.

Usually, the best orientation is achieved when the following criteria are fulfilled:

- The longest side of the 3D model is parallel with the X axis (the front edge) of the CNC machine.
- The shortest side of the 3D model is parallel with the Y axis (the side edge) of the CNC machine.
- The most detailed surface of the 3D model, or the face you want to cut, points directly upwards towards the face of the cutter on the CNC machine.

The best orientation for your 3D model is when the earpiece end of the phone is on the left side of your screen, the mouthpiece end of the phone is on the right side of the screen and the red arrow is pointing directly down towards the surface containing the buttons.

To orientate your 3D model, enter values of 0º in the "X" dialogue box, 0º in the "Y" dialogue box and 90º in the "Z" dialogue box. Note that the [Up] or [Down] buttons can be used to shift the orientation of the 3D model in 90º increments. Your QuickCAM 3D window should now look something like the example shown below.



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Stage Three - Billet Definition

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The "Billet Definition" stage allows you to set the size of the billet - the material used for machining the final design.

Entering billet sizes

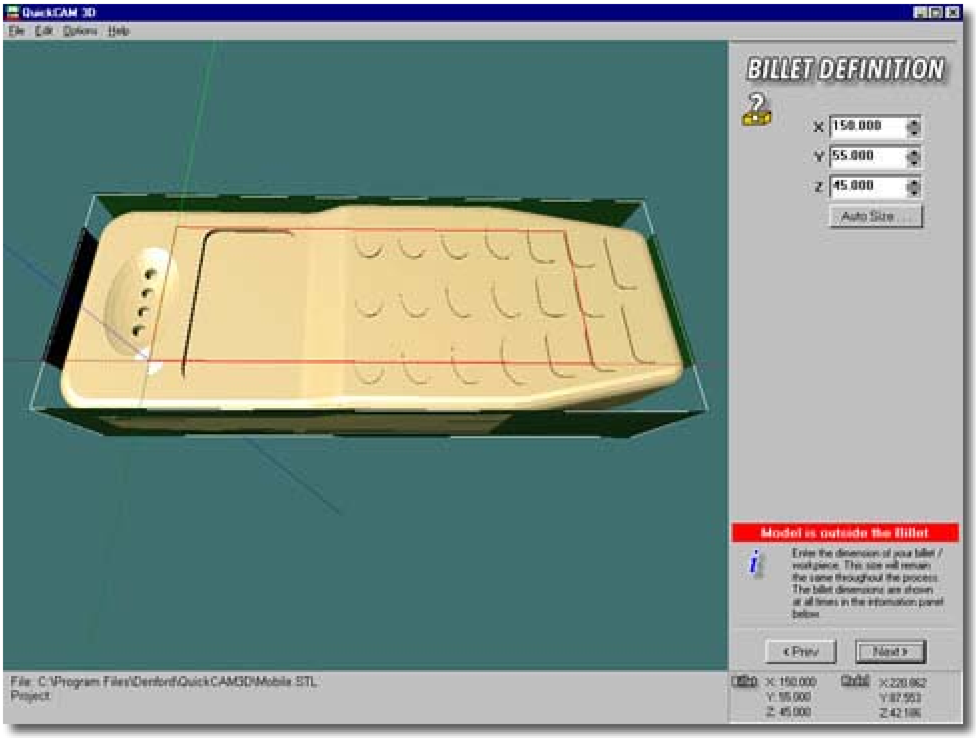
The foam billet you will use to manufacture your mobile phone will be 150mm long (X), 110mm wide (Y) and 45mm thick (Z).

Enter a value of 150.000mm into the "X" dialogue box. This is the length of the billet. You can either type directly into the dialogue box, or use the [Up] and [Down] buttons to change the value. As you enter values, notice that the billet changes size around the 3D model.

Enter a value of 55.000mm into the "Y" dialogue box. This is half the width of the billet. We will be using the remaining portion for machining the bottom, plain side of the phone, in a later stage.

Enter a value of 45mm into the "Z" dialogue box. This is the thickness of the billet. Notice that a warning is displayed informing you that the billet size you have set is smaller than the 3D model - you will reduce the scale of the 3D model, so it fits the billet in the next stage.

Your QuickCAM 3D window should look something like the example shown below.



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Stage Four - Position & Size

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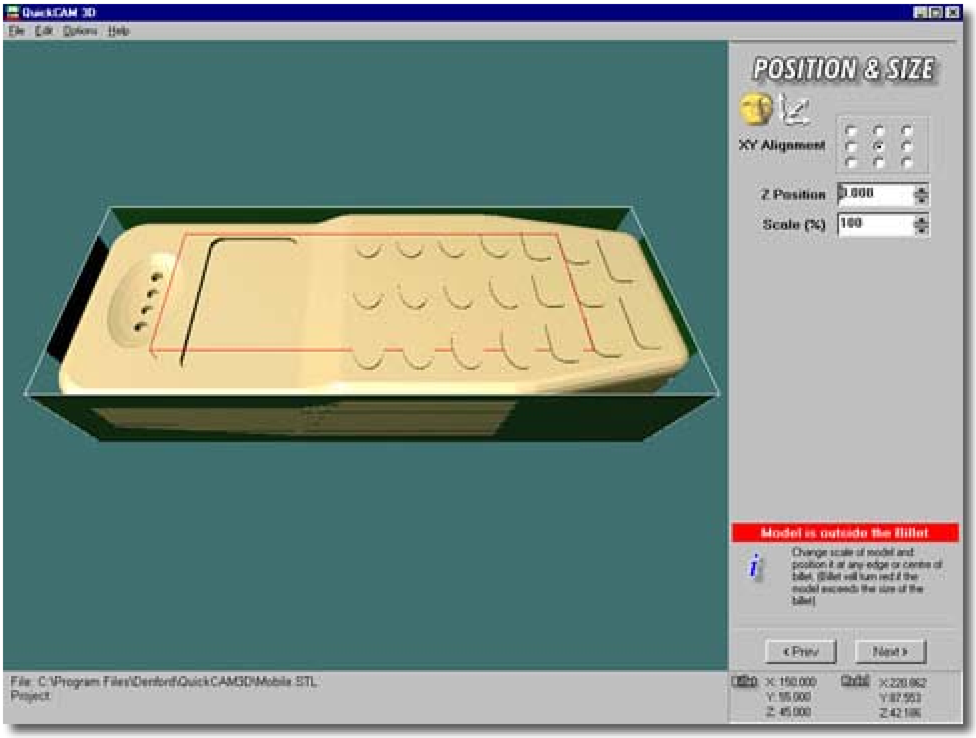
The "Position & Size" stage allows you to scale the 3D model up or down and place the 3D model in a particular area of the billet.

Using the dimensions data panel

Both the billet and 3D model dimensions are listed in a data panel, located in the bottom right-hand corner of the main QuickCAM 3D window. Viewing the data panel confirms that the 3D model will not fit inside the billet in any of the three axes, also highlighted by the red warning message.



Reading from the data panel, we can determine that the X dimension of the 3D model is 220mm. This dimension, the length of the mobile phone, is far too large. A more accurate value for this dimension would be around 120mm, yielding a much more realistically sized 3D model.

Zoom into the 3D model so the billet outline fills more of the viewing pane, as shown above. You will now scale the 3D model down, so it fits inside the billet.

Scaling the 3D model

You can use the "Scale (%)" panel to increase or decrease the size of the 3D model. The scale value is automatically configured at 100% when you load the 3D model file.

Enter a value of 55% into the "Scale (%)" dialogue box. Notice that the 3D model now fits inside the boundary lines of the billet and the red warning message has disappeared, as shown below.

Reading from the data panel, you can also confirm that the 3D model is smaller than the billet in all three axes. The overall length of the mobile phone has changed to 121mm - much more realistic.

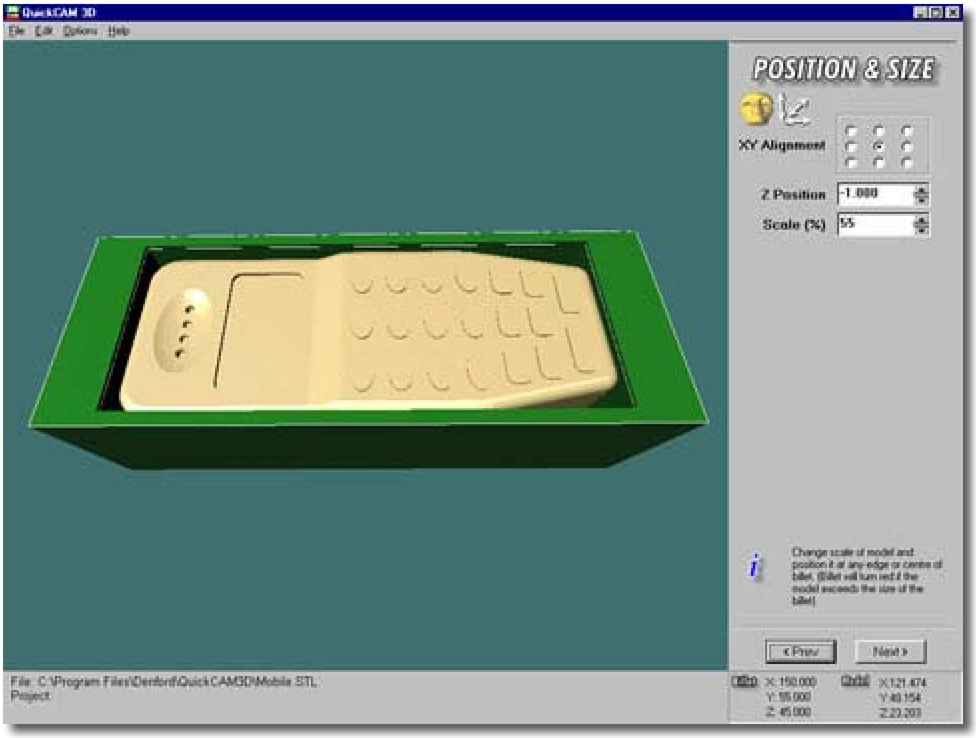
Positioning the 3D model in the billet

At this stage of the process, any part of the 3D model positioned outside the billet is rendered in a yellow colour, whilst parts of the 3D model inside the billet are shaded brown. Since the buttons are shaded yellow, they would not be machined. Although the buttons are infact exactly level with the top surface of the billet, you will lower the 3D model further - this will help to account for any inconsistencies in the level of the real billet used on the CNC machine.

Enter a value of -1.000mm in the "Z Position" dialogue box. Notice that the sign is negative, since you are lowering the 3D model into the billet - the top surface of the billet is taken as the zero plane.

The "XY Alignment" panel, at the top of the information pane, contains a series of nine white circles, set in a 3 x 3 grid. This represents the plan view of the billet. Ensure that a black marker dot is present in the middle white circle. This ensures that the 3D model will be positioned in the middle of the billet.

At this stage, your QuickCAM 3D window should look something like the example shown below.



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Stage Five - Tooling Setup

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The "Tooling Setup" stage allows you to choose the type of cutting tool and how it will be used. At this stage, you can also render the 3D model in realistic materials.

Configuring the type of cutter

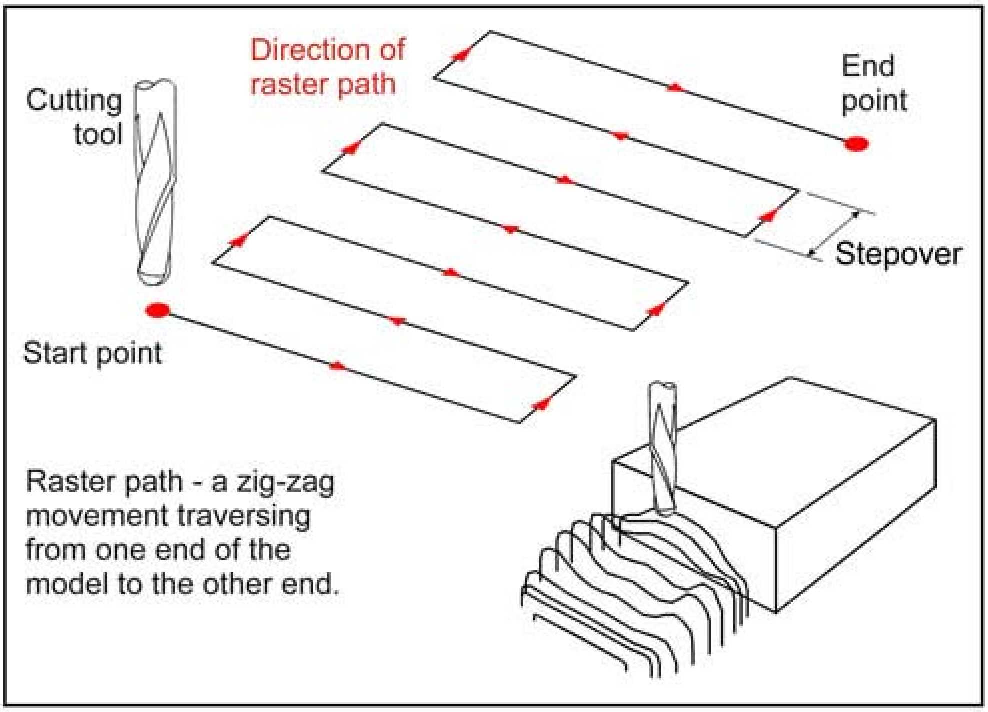
For this tutorial, you will use a ¼" (6.35mm) diameter ball nose cutter. This gives a smoother edge on the changes between surface depths on the main body of the phone, although some definition will be lost on the buttons.

Tip: For greater detail use a smaller diameter tool, although remember that your final design will take longer to machine.

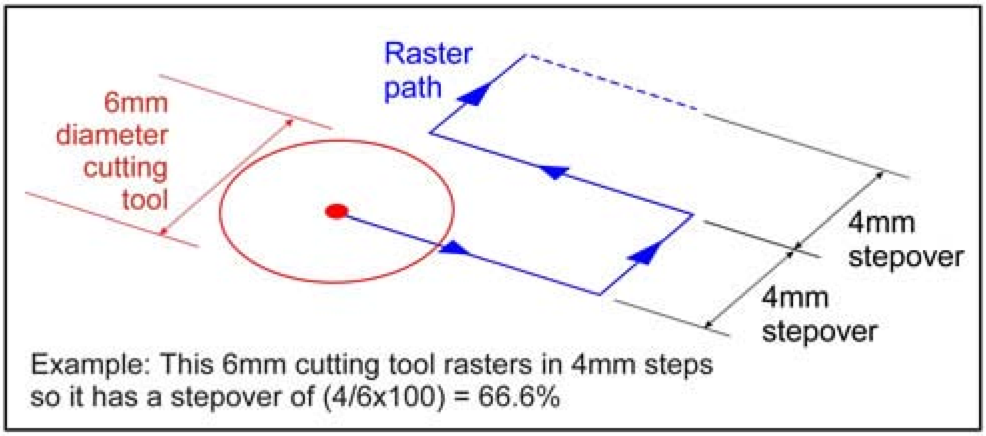
In the "Type" panel, ensure that the black marker dot is positioned in the top white circle, next to the "Ball Nose" text, then set the diameter of the tool as 6.350mm, using the "Diameter" dialogue box.

Setting a value for the stepover

Your mobile phone will be machined using a raster path - a series of parallel zig-zag lines followed by the tool, as shown in the diagram below.

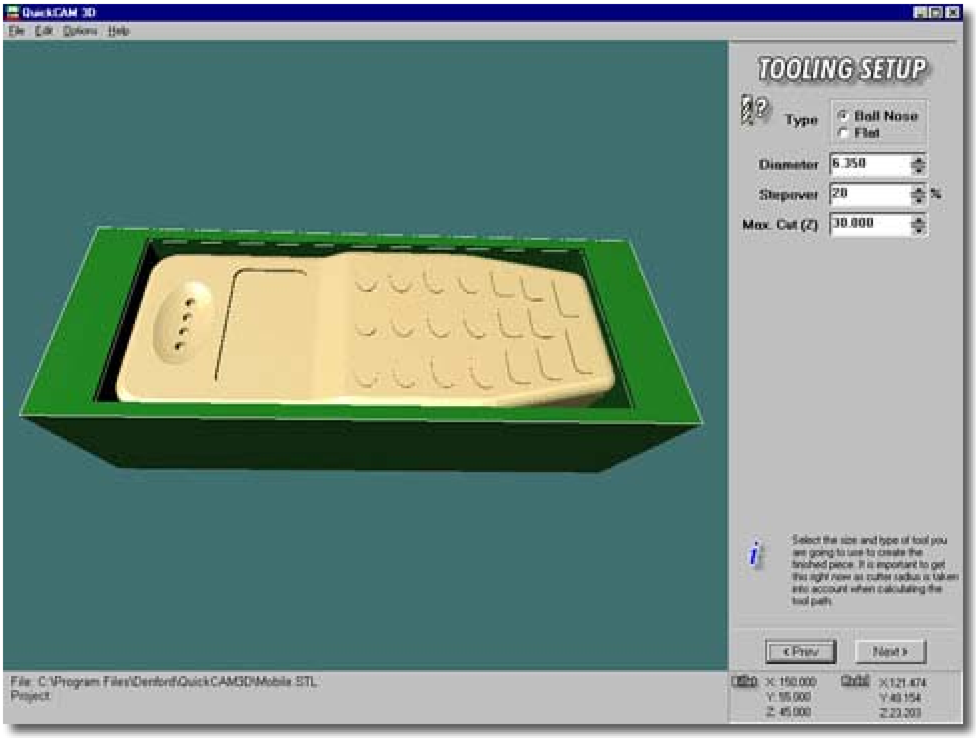


"Stepover" determines the spacing between these lines, creating a coarse cut (such as 95%) or a fine cut (such as 5%). The stepover value is a percentage of the tool diameter value, as shown in the diagram below.



A fine cut gives excellent definition to detail but at the expense of long machining times, since there are more tool path lines. Enter a value of 20% into the "Stepover" dialogue box.
Tip: In most jobs, a stepover of 20% gives a good compromise between detail definition and machining time.

The maximum amount of material that can be removed by the cutting tool in one pass is configured using the "Max. Cut (Z)" dialogue box. Amongst many other factors, this value is determined by the type of material being machined and the flute length of the cutter. Set this value as 30.000mm. Your QuickCAM 3D window should look like the example shown below.



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Stage Six - Cutting Plane

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The "Cutting Plane" stage allows you to determine the maximum depth the cutting tool will machine into the billet.

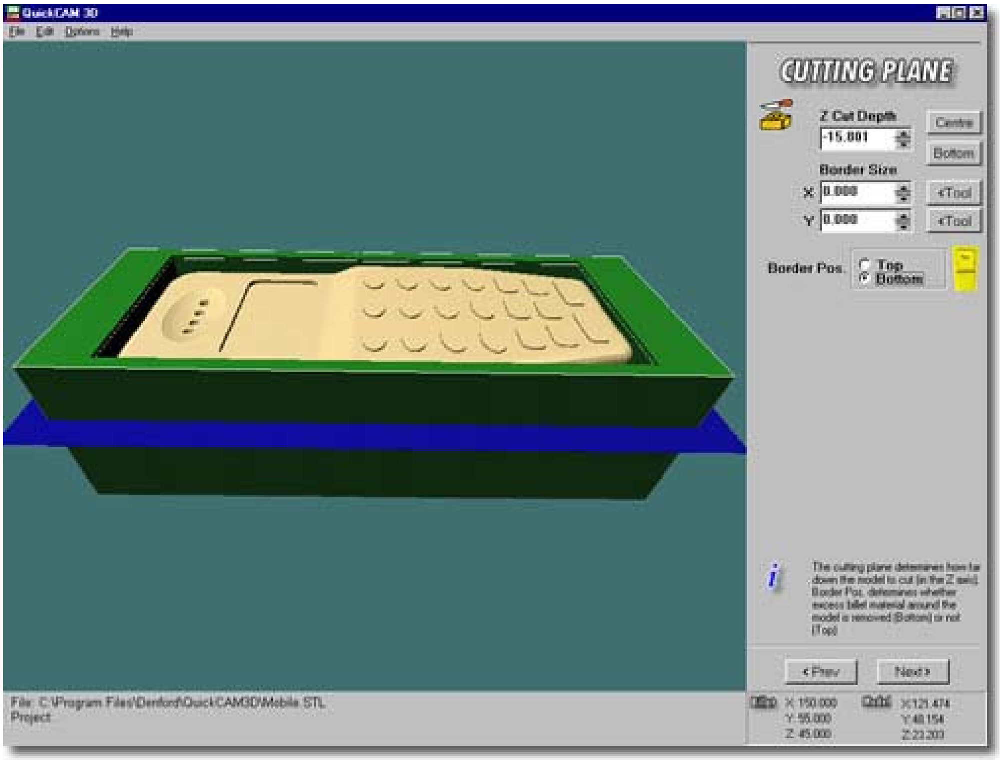
Positioning the cutting plane

The "Cutting Plane" defines the maximum depth of cut for the 3D model, or in other words, how much of the 3D model you want to manufacture. Any parts of the 3D model below the cutting plane will not be machined. In this tutorial, you want to machine the mobile phone as two separate halves.

Click the [Centre] button. This positions the cutting plane exactly through the middle of the 3D model. The cutting plane is defined on-screen using a blue rectangle.

Notice that that the value in the "Z Position" dialogue box automatically changes to read -12.601mm. This value is half the billet Z dimension, 23.203mm/2 plus the extra 1mm you lowered the 3D model in the previous stage. The value is negative to indicate that the cutting plane lies 12.601mm under the top surface of the billet (taken as the Z zero position). Remember, you can use the data panel in the bottom right-hand corner of the main QuickCAM 3D window to verify dimensions at any time during the process.

You will use a ¼" (6.35mm) ball nose cutter to machine the final design. Since the tip of the cutting tool is rounded, lower the "Z Position" by an extra 3.2mm. Although a radius chamfer will still be machined around the design, dropping it by the radius of the tool ensures the chamfer will not interfere with the part of the 3D model you want to keep. Type a value of 15.801mm into the "Z Position" dialogue box. Your QuickCAM 3D window should now look something like the example shown below.



Configuring a border

The "Border Pos." panel allows you to determine whether to leave the area of billet material surrounding the 3D model untouched, or machine all this remaining material down to the depth of the cutting plane. For this tutorial, you want to machine all of this surplus material away.
This also means that you do not need to enter any border size (clearance between model and billet) values for X or Y.

Ensure that the black marker dot is positioned in the lower white circle, next to the "Bottom" text.

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Stage Seven - Machining Strategy

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The "Machining Strategy" stage allows you to set the feedrate and spindle speed, together with the direction of the raster tool path.

Entering feedrate and spindle speed values

Both the feedrate and the spindle speed can be influenced by a number of factors, including:

- The material being machined.

- The type, size and condition of the cutting tool.
- The type, capabilities and condition of the CNC machine.

The "Feed" dialogue box is used for setting the value of the feedrate, measured in millimetres per minute (mm/min). Values entered must be suitable for machining high density urethane foam. Enter a value that matches the Denford CNC machine you intend to use or consult your CNC machine manual:

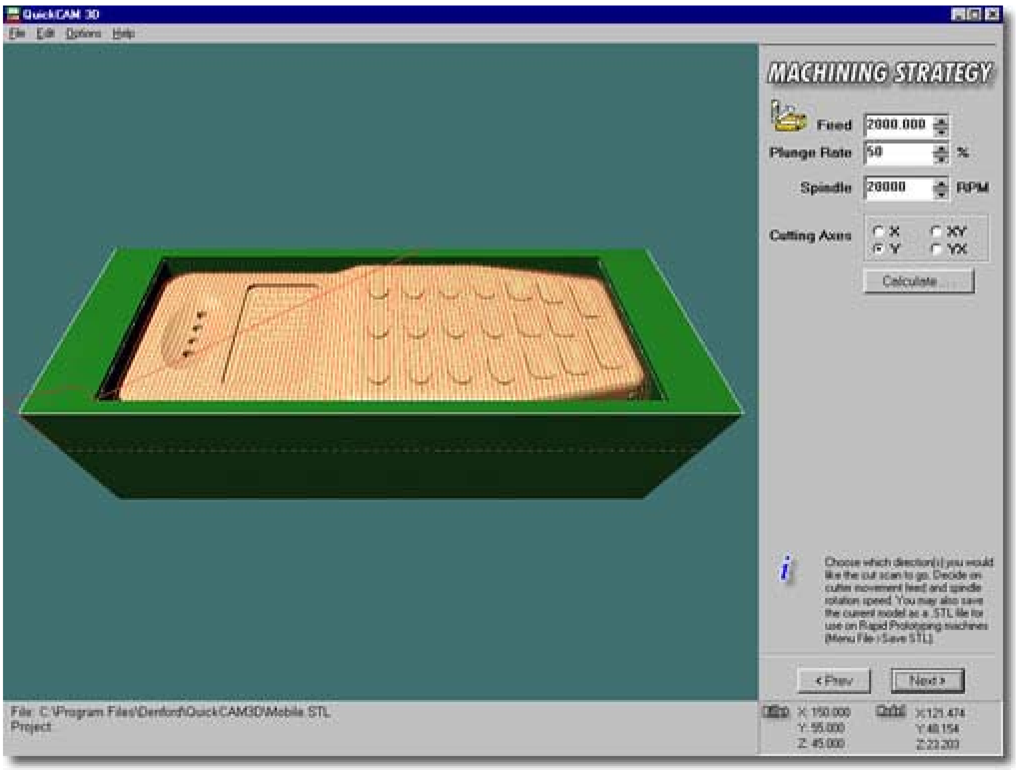
- Micromill - 300
- Novamill - 300
- Triac - 900
- Triton - 900
- Microrouter - 2,000

The "Spindle" dialogue box is used for setting the value of the spindle speed, measured in revolutions per minute (RPM). Values entered must be suitable for the capabilities of your CNC machine. Enter a value that matches the Denford CNC machine you intend to use or consult your CNC machine manual:

- Micromill - 2,500
- Novamill - 2,500
- Triac - 2,500
- Triton - 2,500
- Microrouter - 20,000

For foam, it may be wise to set the Plunge Rate percentage to something like 50% feed. Doing this means the first cut into the foam will be slower and safer because the first cut usually contacts with the whole circumference of the tool. There is also less chance of the billet being pulled away from its clamps. (See Machining Strategy for more information on plunge rate)

Your QuickCAM 3D window should look something like the example shown below - we have entered values for a Denford CNC Microrouter in our screenshot.

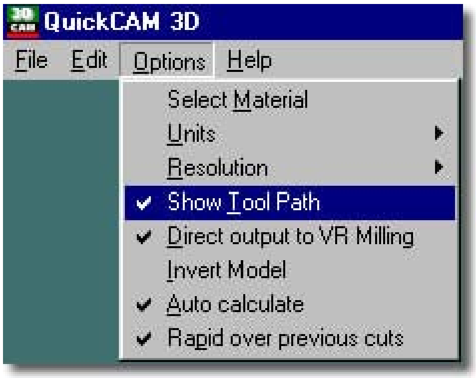


Choosing a raster tool path direction

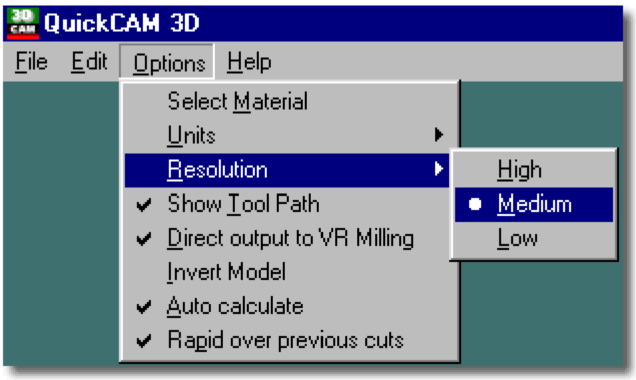
The number and direction of the raster tool paths is set using the "Cutting Axes" panel. For this tutorial, you want to machine just one raster path parallel to the ends of the billet - this will be the Y direction. Ensure that the black marker dot is positioned in the white circle next to the "Y" text.

Calculating the tool path

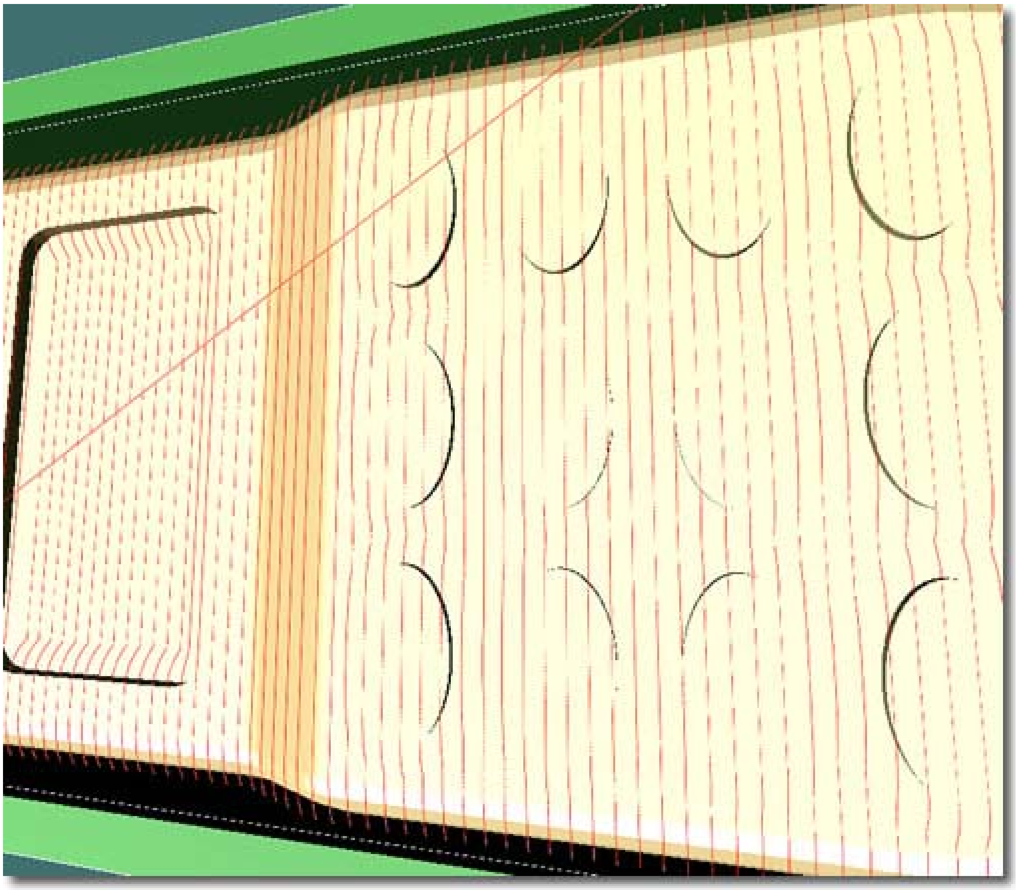
Before calculating the toolpath, switch on the show tool path feature. Click the "Options" menu, followed by the "Show Tool Path" text, if necessary, so a tickmark is displayed, as shown below.



For this type of model, it is best to select medium resolution (default) for the calculation. This option gives a good finish to the calculated toolpath, without taking too long to process:



Click the [Calculate...] button to calculate the tool path for your 3D photograph. The raster tool path lines are plotted on the 3D model in red at the end of the calculation sequence:



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Stage Eight - 3D Simulation

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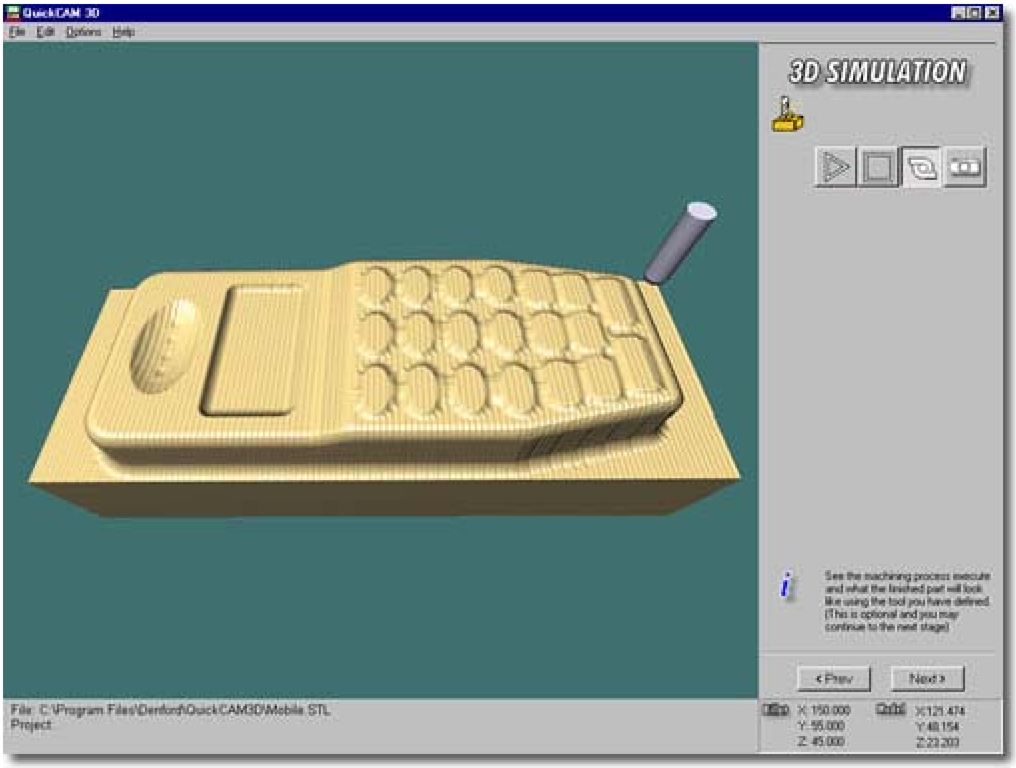
The "3D Simulation" stage allows you to simulate the machining of the 3D photograph, using the values set in all the previous stage screens. You can then examine the machined part and if not happy with the result go back to the previous stages and change values accordingly.



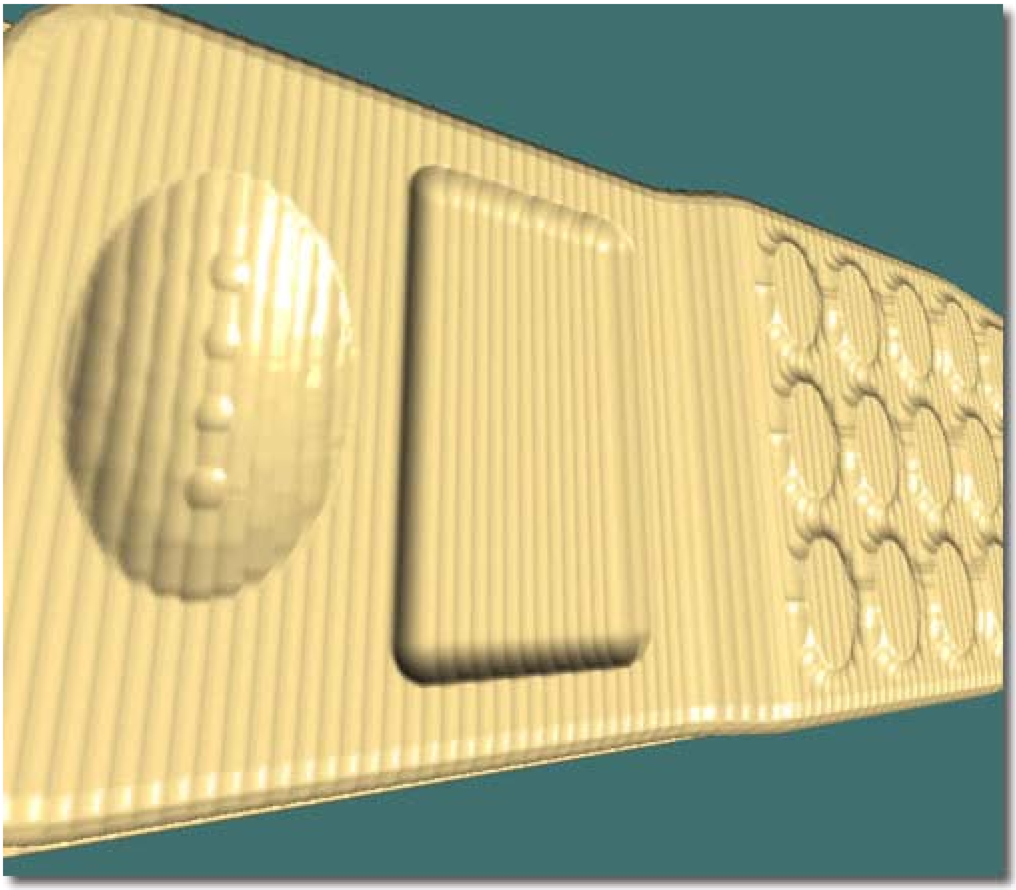
Running a simulation

The controls for running the simulation, listed from left to right are:

- [Play] button (triangle graphic) - Click this button to begin the simulation.
- [Stop] button (square graphic) - Click this button to stop the simulation.
- [Turbo] button (turbo graphic) - Click this button to increase the speed of the simulation.
- [Snapshot] button (camera graphic) - Click this button to capture the current view of the machined part as a bitmap.

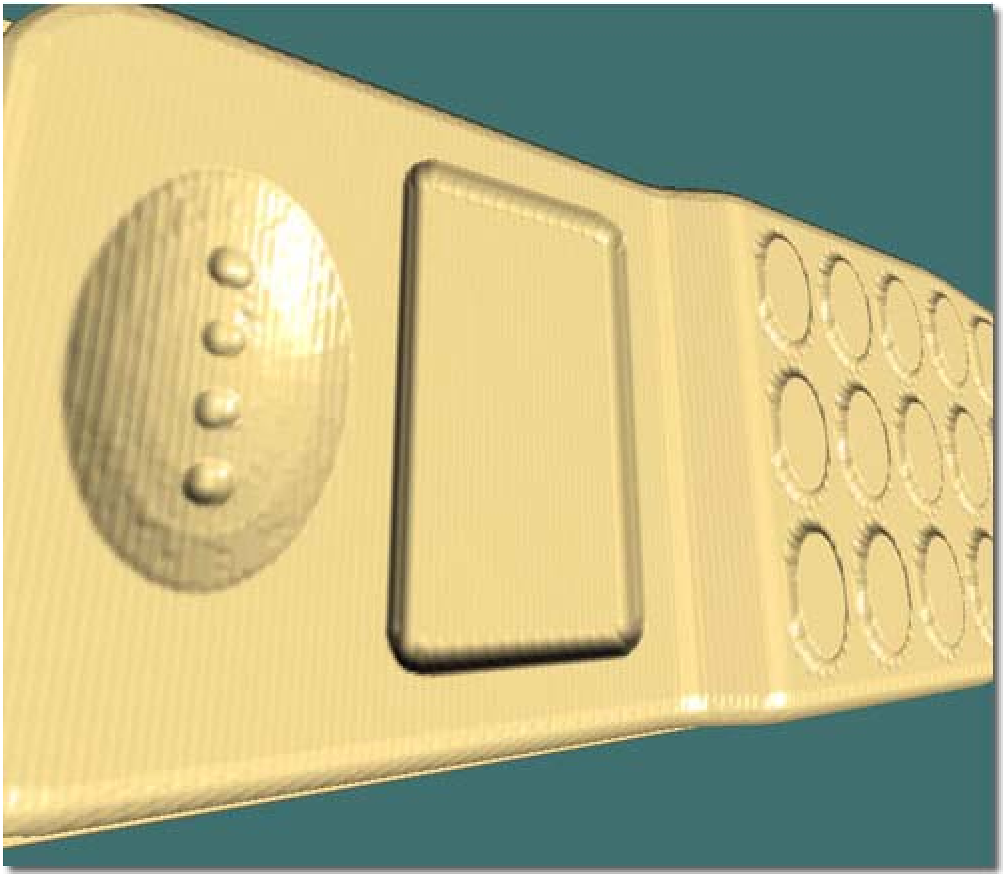
Using the simulation results

Remember, you can still zoom into the viewing window to view specific areas of the machined part in closeup. Move the mouse cursor over the graphic of the machined part, then click and holding the right mouse button down. Move the cursor upwards to zoom in or down to zoom out.



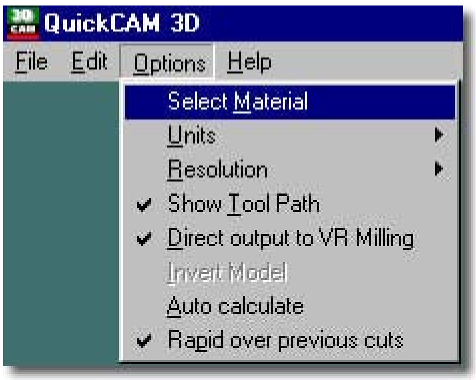
When configuring your own models, this gives a good impression of what you're likely to achieve when you try to make the model on the CNC machine. If you don't like the results, you can move back to the previous stages, change data accordingly, then re-run the simulation.

In this tutorial, using a 2mm diameter ball nose cutter would give a much finer surface finish and level of detail but the manufacturing time would be far greater. The screenshot below shows the same file run with a 3mm cutter and resolution set to **high** (see Menubar for details of setting resolution)...



Rendering the 3D Model in Realistic Materials

At this stage of the process, the billet can also be rendered using realistic materials. To select the material type, click the "Options" menu, followed by "Select_Material".



The "Material Selector" window is displayed, as shown below.

The design will be manufactured on a high density urethane foam billet.
Click the [Foam] button to set the material.
Click the [Ok] button to close the window and apply the material choices.

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Stage Nine - CNC File Output

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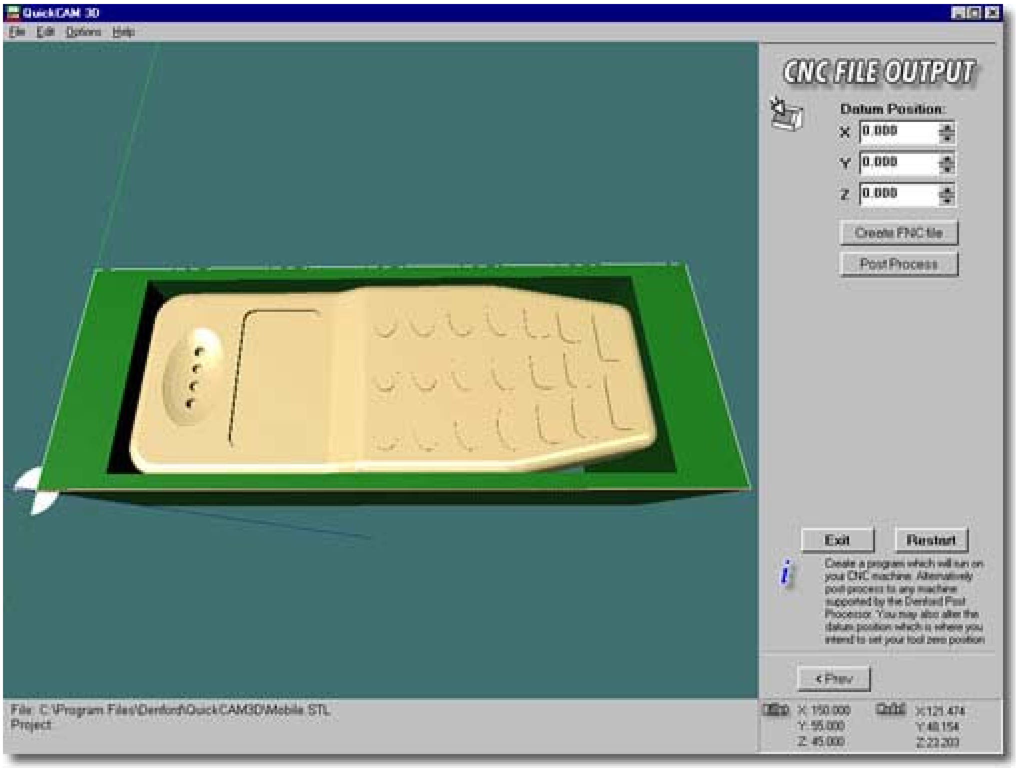
The "CNC File Output" stage allows you to set the position of the CNC program datum, then process and save the CNC file, ready to transfer to a CNC machine.

Configuring the datum position

The datum you can set in this stage refers to the zero co-ordinate position of the CNC program, indicated by the circle graphic, split into four segments. In the tutorial example, you must set the datum to the front(Y), left(X) top(Z) corner of the billet.

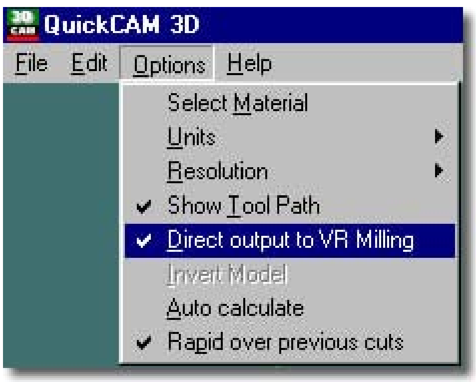
The "Datum Position:" panel contains three dialogue boxes, "X", "Y" and "Z". Enter a value of zero in each of the three dialogue boxes - this will configure the datum in the position suggested above.
Tip: Always try to set the datum in a position you will be able to find again on the real billet. When you place the real billet in your CNC machine, you must configure the machine offsets (effectively shifting the zero datum of the CNC machine) to align with the datum position you are currently setting for your CNC program.

Your QuickCAM 3D window should look something like the example shown below.



Creating the CNC file

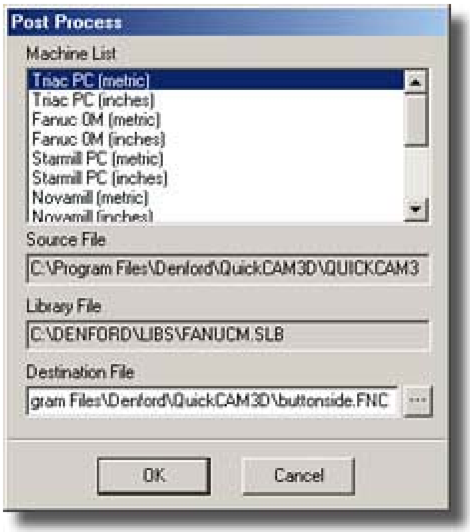
If Denford VR CNC Milling software version 2.14 or above is installed on your computer, you can configure QuickCAM 3D to automatically start VR Milling and load the newly created CNC file. Click the "Options" menu, followed by the "Direct output to VR Milling" text, if necessary, so a tickmark is displayed, as shown below.



To create the CNC file, click the [Create FNC file] button, then save the file in the appropriate hard drive folder or floppy disk with the name "buttonside".

Post processing the CNC file

To post process your design, click the [Post Process] button to display the "Post Process" window, as shown below.



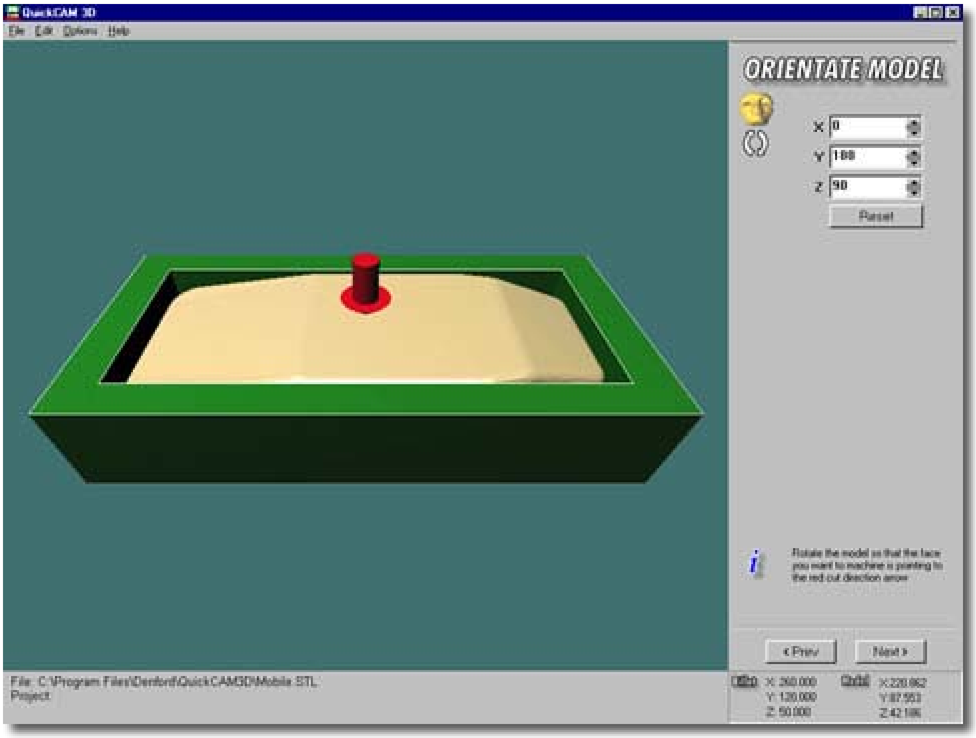
Select the required CNC machine from the "Machine List", then post process and save the file using the name "buttonside" in the appropriate hard drive folder or floppy disk.

To produce the CNC file that machines the bottom, or plain side, of the mobile phone, you can run the same 3D model through QuickCAM 3D again, changing values where necessary.

Currently, the QuickCAM 3D software is displaying the "Stage Nine - CNC File Output" screen. To start the process again using the currently loaded 3D model, click the [Restart] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage One - Select 3D or Image" screen is now displayed. You do not need to reload the 3D model, so click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage Two - Orientate Model" screen is now displayed. The red arrow is pointing down towards the button side of the mobile phone. For the second CNC file, you want this red arrow to be pointing down towards the plain side of the 3D model. Enter a value of 0º into the "X" dialogue box, a value of 180º into the "Y" dialogue box and a value of 90 º into the "Z" dialogue box, to correctly orientate the 3D model. Your QuickCAM 3D window should look like the example shown below.



Now click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

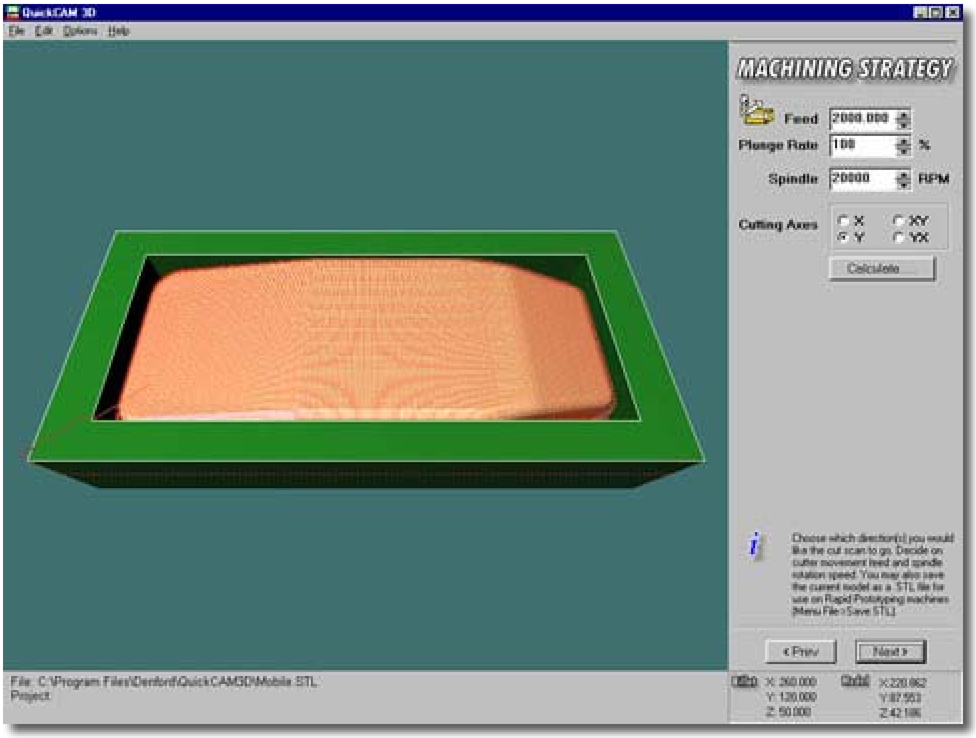
The "Stage Three - Billet Definition" screen is now displayed. The values should read "X=150mm", "Y=55mm" and "Z=45mm". You should not need to change any values on this screen. Click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage Four - Position & Size" screen is now displayed. The values should read "XY Alignment=Centre", "Z Position=-1mm" and Scale (%)=55%". Again, you should not need to change any values on this screen. Click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage Five- Tooling Setup" screen is now displayed. The values should read "Type=Ball Nose", "Diameter=6.350mm", "Stepover=20%" and "Max. Cut (Z)=20mm". You should not need to change any values on this screen. Click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage Six- Cutting Plane" screen is now displayed. The values should read "Z Position=-15.801mm" and "Border Pos.=Bottom". Note that you may need to edit the "Z Position". Click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage Seven - Machining Strategy" screen is now displayed. "Feed" and "Spindle" values should be set according to the capability of your CNC machine (see the original stage seven section of this helpfile for more information) and the "Cutting Axes" option should be set on "Y". However, you should not need to change any values on this screen. Click the [Calculate] button to compile the new tool path.



Click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage Eight - 3D Simulation" screen is now displayed. Run the simulation, then click the [Next] button, in the bottom right-hand corner of the main QuickCAM 3D window.

The "Stage Nine - CNC File Output" screen is now displayed. Set the "Datum Position" of the CNC program to "X=0mm", "Y=0mm" and "Z=0mm". Finally, create or post process your FNC file with the name "plainside".

To close the QuickCAM 3D software, click the [Exit] button, in the bottom right-hand corner of the main QuickCAM 3D window.

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QuickCAM 3D - Mobile Phone Tutorial
Machining your 3D Model

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Materials and equipment required

In order to manufacture your mobile phone on a CNC machine, using the data supplied in this tutorial, you will need:

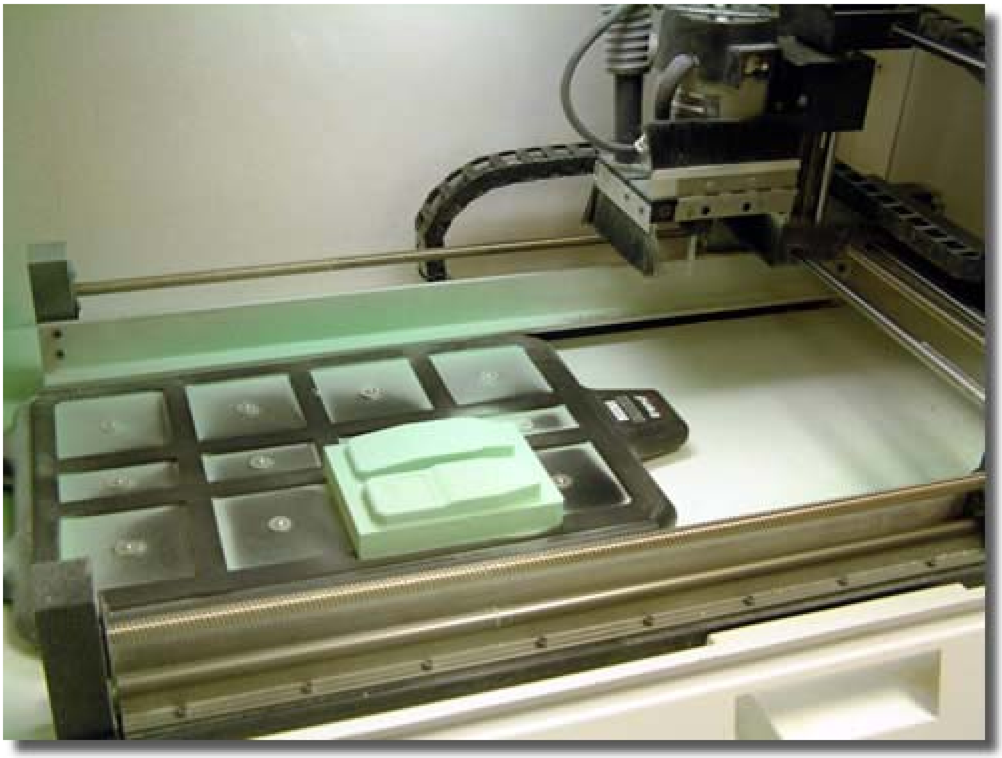
1. A ¼" (6.35mm) diameter, ball nose cutter.
   Tip: If your CNC machine is equipped with metric tooling, imperial collets are available from Denford Limited.

2. A high density urethane foam billet, 150mm x 110mm, 45mm thick.
   Tip: Use low density foam (styrofoam) as a low cost alternative.

3. Access to a CNC machine.

Holding the billet

The easiest method of fixing your foam billet into the working area of the CNC machine is by using a vacuum bed, as shown below...



Above: In this finished model, the foam billet was held in position using a vacuum table on a Denford Microrouter.

Ensure the vacuum bed is positioned"square" to the machine axes. Use an engineers square and any reference edges (such as the front edge of the actual machine table, the cabinet panels or the axis rails) as a guide. Similarly, use references on the vacuum bed to help align your foam billet "squarely".

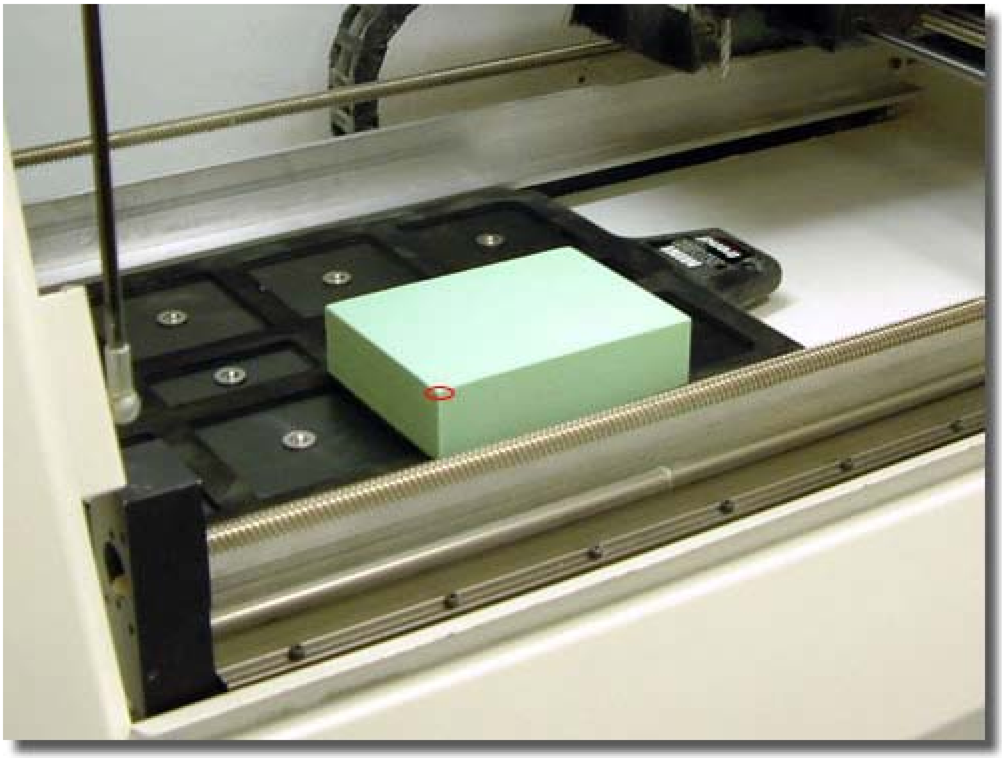
If a vacuum bed is unavailable, use double sided tape and a temporary machine table, usually a sheet of MDF or laminated board, as a low cost alternative. Ensure the material used as a temporary machine table is completely flat. Hold the temporary machine table in the CNC machine using clamp rails, miteebite clamps or nut/bolt assemblies.

Remember to check that the temporary machine table is positioned"square" to the machine axes. Hold the foam billet onto the temporary machine table using sufficient strips of strong, double sided tape. Again, ensure that you place the billet "square" onto the temporary machine table.
Tip: Since the foam is slightly "porous", remove any "dust" particles from the foam surface before applying the tape. This will give better adhesion.

Configuring the Offsets

To machine the first side of the mobile phone - the top, or button side of the mobile phone, configure your machine offset to align with the front, left, upper corner of the billet. This is the datum (zero position) used by your first CNC file, named "buttonside".

Datum offset	Align with position
X	Left edge of foam billet
Y	Front edge of foam billet
Z	Top surface of the foam billet



Above: The red ellipse indicates the offset position to produce the top (button side) of the mobile phone on the foam billet.

To machine the second side of the mobile phone - the bottom, or plain side of the mobile phone, configure your machine offset to align with the front, left, corner of the remaining portion of the billet. This is the datum (zero position) used by your second CNC file, named "plainside".

Notice that you only have to reconfigure the Y value, you can still use the X and Z values from the offset used to machine the top, button side of the model.

Datum offset	Align with position
X	Left edge of original foam billet
Y	Front edge of the remaining portion of the foam billet
Z	Top surface of the original foam billet

Above: The red ellipse indicates the offset position to produce the bottom (plain side) of the mobile phone on the foam billet.

Ordering materials from Denford Limited

All the items required to complete this tutorial can be ordered from Denford Limited, if required. For further information, regarding current pricing, availability and ordering, please contact the Denford Sales Team.
Telephone Denford Sales: 01484 717282
Fax Denford Sales: 01484 718229
E-mail: sales@denford.co.uk
Sales Department Hours: Monday to Friday 8.30am - 5.00pm GMT
For international dialing: +44 and remove first 0 from each city code.