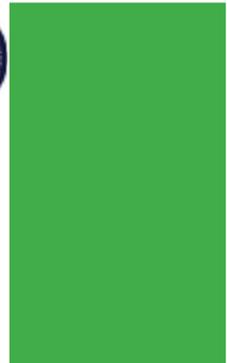
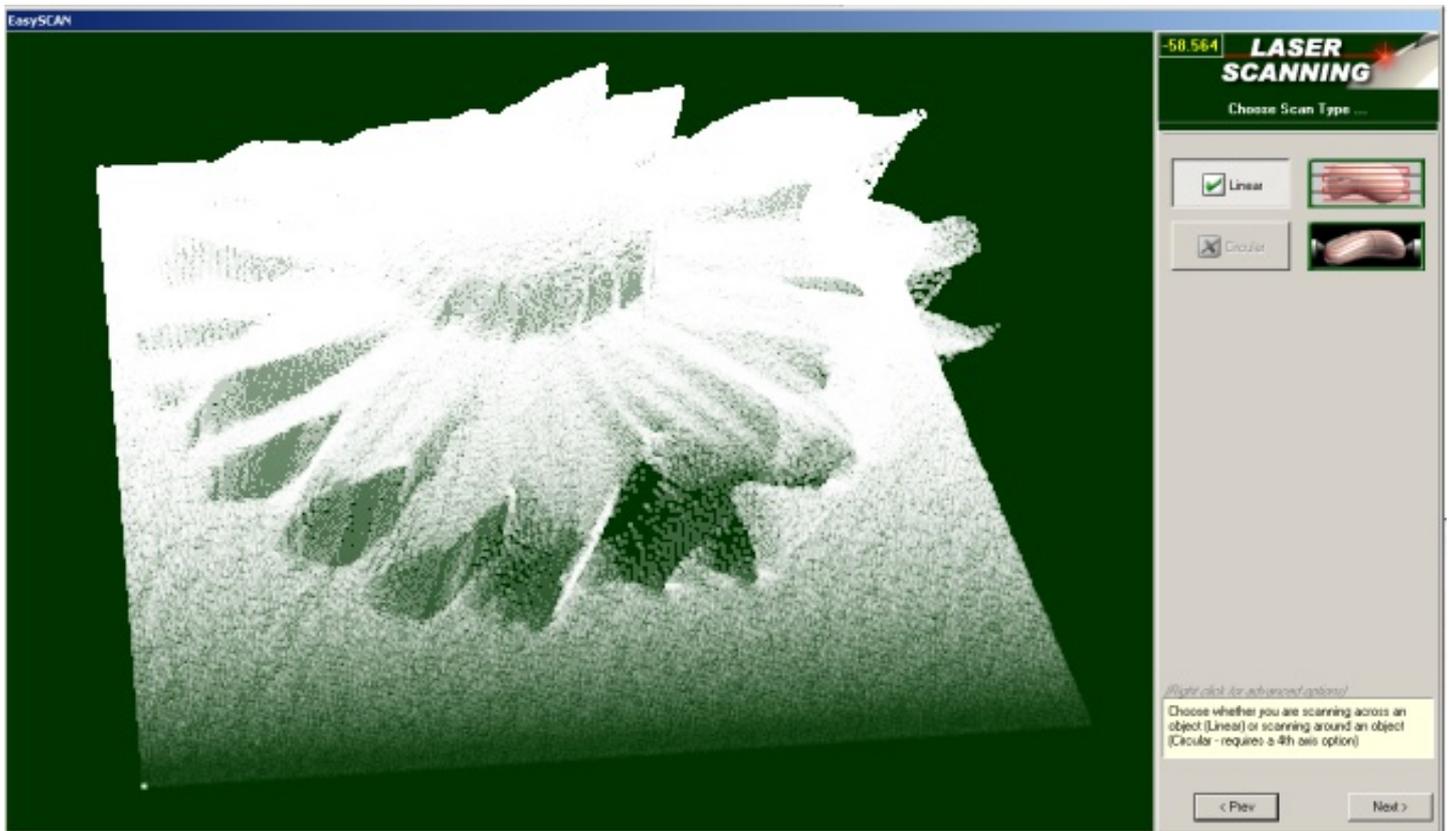


DENFORD
CAD/CAM Solutions & Projects for Education

EasySCAN 3D Scanner

3D Scanning Attachment & Software

Training Guide VR Milling V5 (V5.61)



DENFORD

3D Scanning & Manufacturing

COMPLETE 3D LASER SCANNING AND
MANUFACTURING PACKAGE

A complete 3D Scanning and Manufacturing Package which includes hardware and user friendly wizard based software for scanning, editing and saving of 3D models, prior to manufacture on a Denford CNC Router.

Ideal for Reverse Engineering Applications.

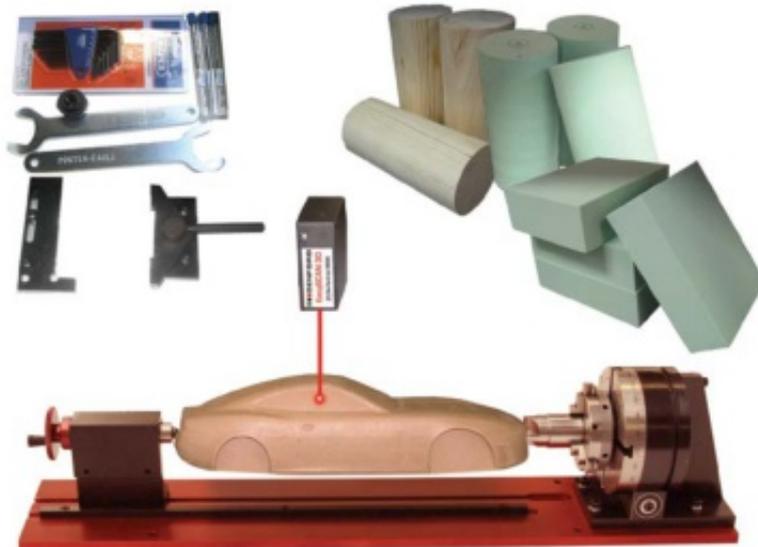
Scan



Edit



Make



CE
APPROVED

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About EasySCAN 3D Scanner

Denford's EasySCAN 3D Scanner attachment has full 360 degree scanning capability when used in conjunction with Denford's Programmable Rotary Fixture and is suitable for use with the entire range of Denford CNC Routers.

The EasySCAN 3D package incorporates user friendly, wizard based software for scanning, editing and saving 3D models, prior to manufacture on a Denford CNC Router.

EasySCAN 3D is ideal for Reverse Engineering applications.

Introduction

The aim of this guide is to take you step by step through the process of 3D Scanning with Denford's EasySCAN 3D Scanner and software.

This guide makes use of screen shots where possible and will use the following conventions:

Instructions will be in this format

Text to be typed will be in this format

Any software buttons to be pressed, a picture of the button will follow the instruction

This guide assumes that your software has already been installed and your machine has been commissioned.

If any of the features described in this guide are not operating as described please check that the version number you are using is the same as that shown on the front cover.

Version is written on the title bar of the main software window.

Denford provide machine training and it is recommended that you undertake the training and use this guide as a revision guide after completion of the machine training.

Installing EasySCAN 3D

EasySCAN 3D is accessed through VR CNC Milling 5 and is installed with it, ensure you have the latest version installed and refer to the VR CNC Milling 5 - Training Guide for instructions on how to use this software.

It may be necessary to install the drivers for the EasySCAN 3D Scanner manually though.

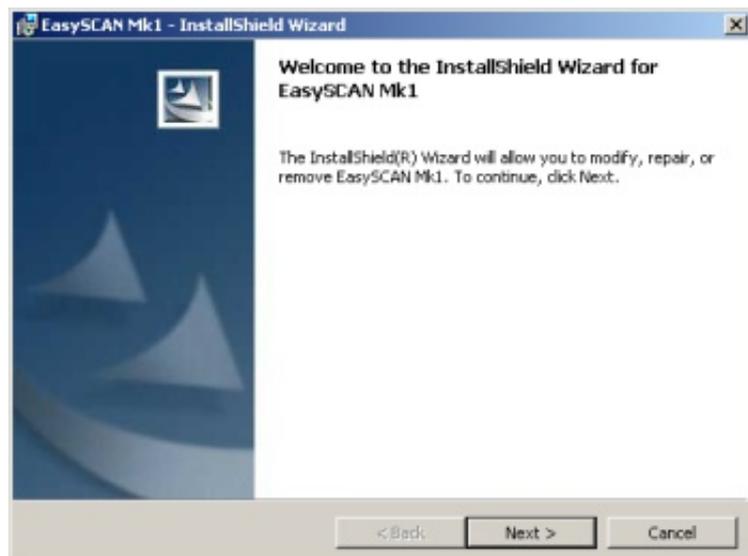
Install the Driver

The drivers for the EasySCAN 3D Scanner are included in the VR CNC Milling 5 software.

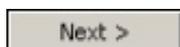
Insert the VR CNC Milling 5 installation disc and start the Autorun program.



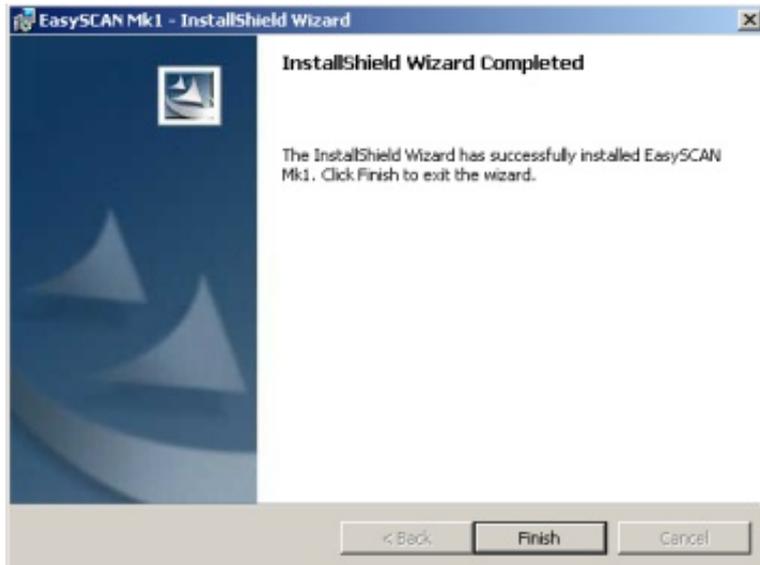
Select "Install EasySCAN Drivers"



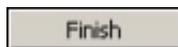
Click the "Next" button



When the screen below appears, the driver has been installed.



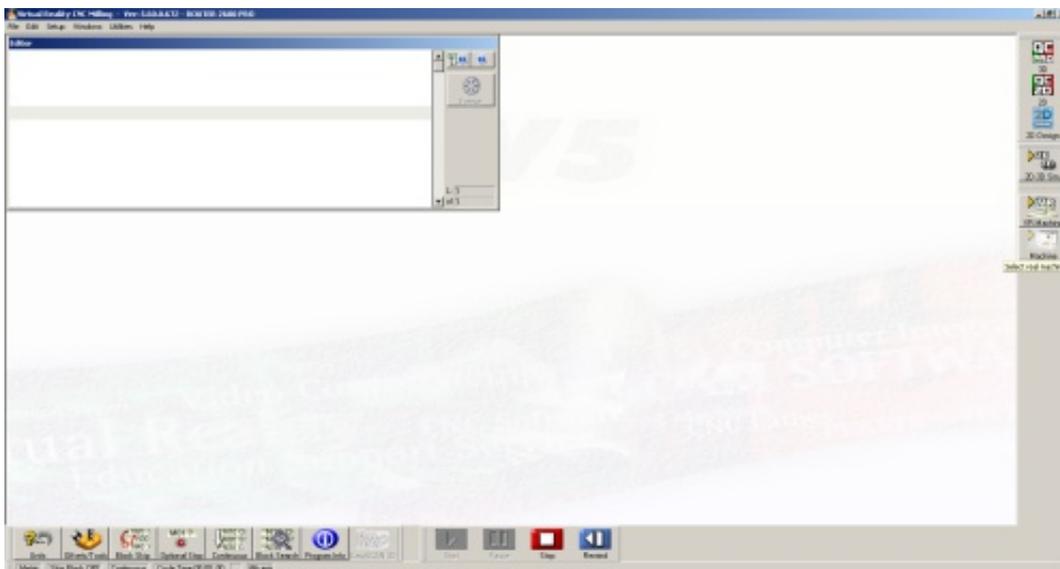
Click the "Finish" button



EasySCAN 3D Scanner should now be ready to use.

Opening EasySCAN 3D

Open VR CNC Milling 5



Ensure both USB cables are connected to both the CNC Router and your PC

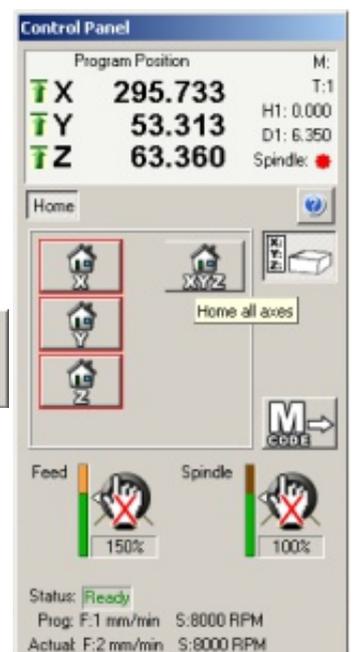
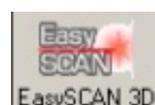
Click the "Machine" button to connect to your CNC Router



Click the "Home XYZ" button on the Control Panel

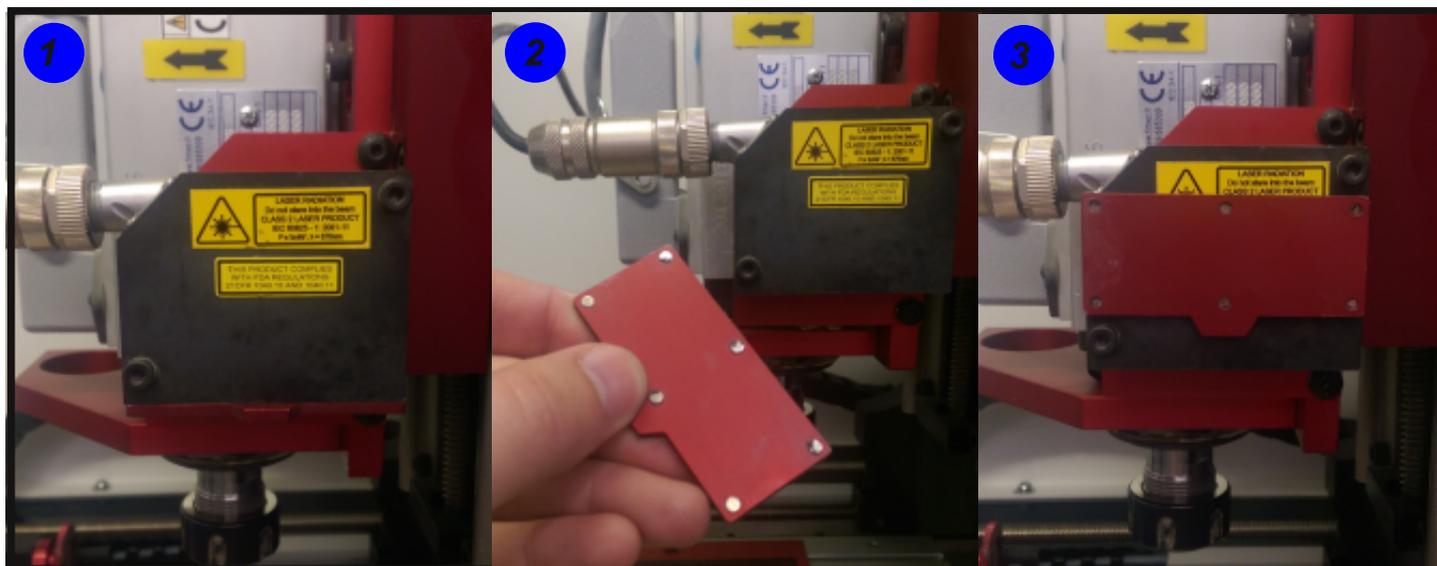


Click the "EasySCAN 3D" button on the options toolbar.



Preparing the EasySCAN 3D Scanner

The EasySCAN 3D Scanner has a dust cover, to keep it clean when using the CNC Router. The dust cover is held in place using magnets, it should be removed and placed on the body of the scanner as shown below



To prevent damaging your cutting tools, or risk damaging the part to be scanned, you may wish to remove the tool from the spindle.

Noisy Scans

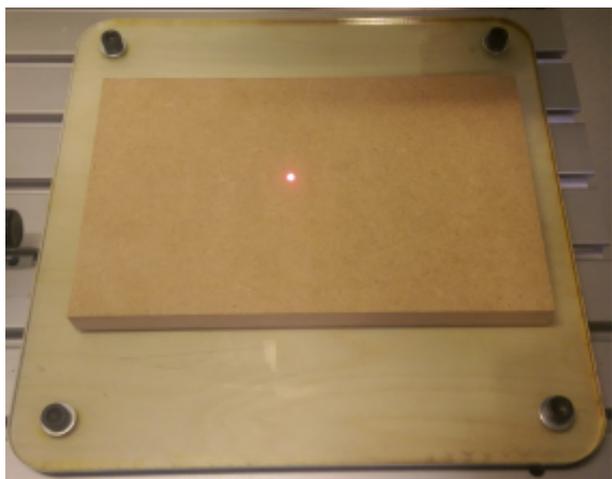
If the part to be scanned is glossy then reflections will cause noise in the scan.

Parts to be scanned should either have a matt finish or must be treated to remove the shine.

The most effective way to eliminate shine is to spray the part in grey primer, but you may not wish to permanently mark the part.

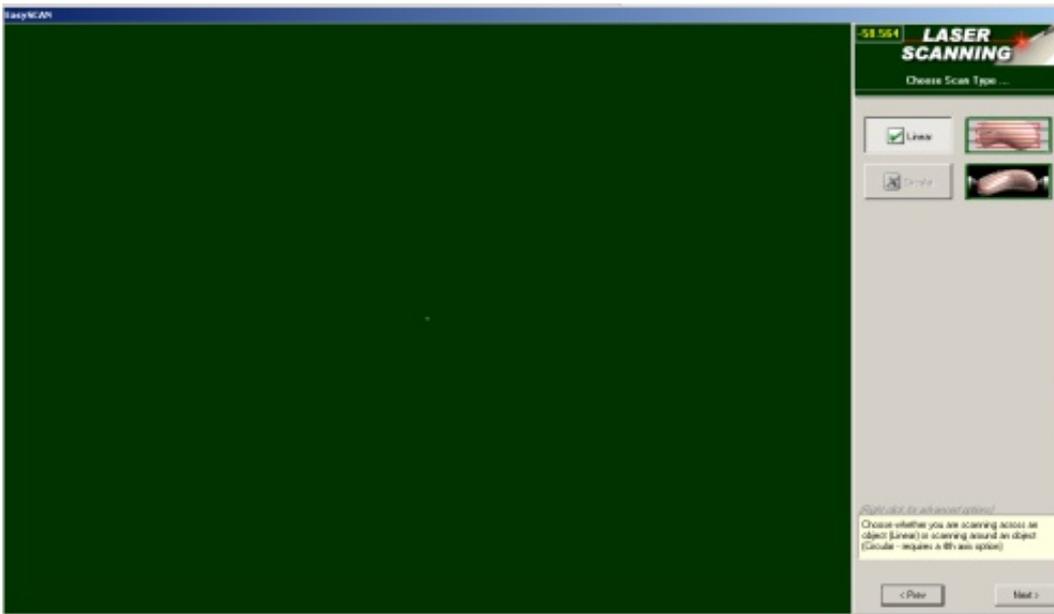
A less effective method that you may wish to try is applying Talcum Powder to the part using a soft brush.

It is also a good idea to place a non reflective object under the part to be scanned, in the image below a piece of MDF has been placed on the T-Slot bed to eliminate shine.



Using EasySCAN 3D

When EasySCAN 3D opens you should see the screen below.



Here you can select either a Linear or Circular scan, if you do not have a 4th axis programmable rotary fixture the Circular scan will be greyed out.

We will complete a Linear scan first, instructions for a Circular scan start on page 21.

Linear Scan

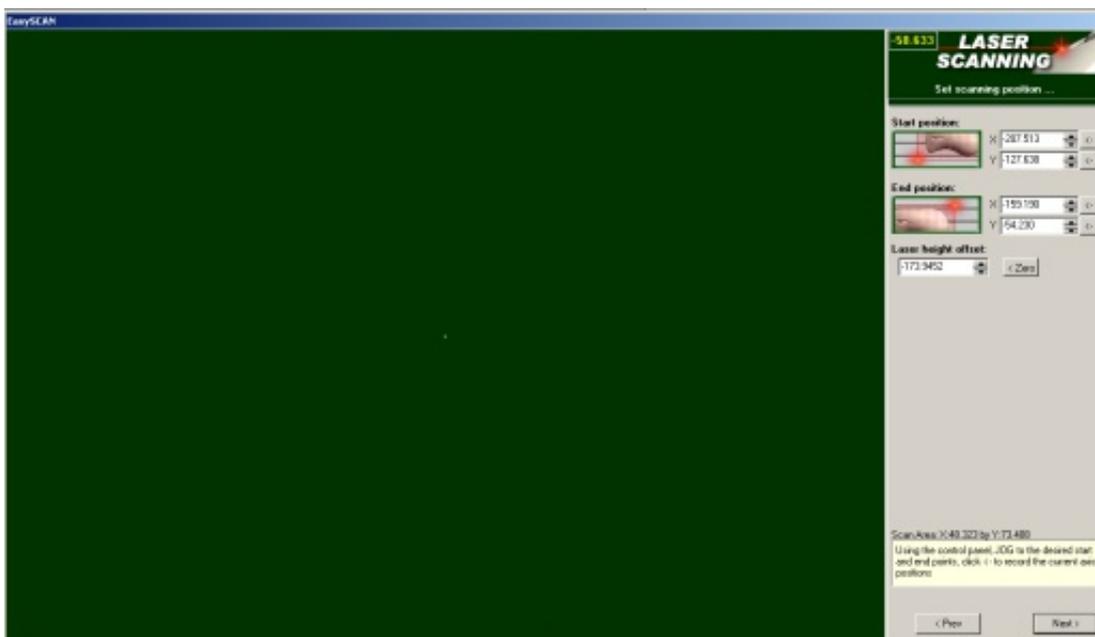
Select the "Linear Scan" button, if not already selected



Click the "Next" button



Your screen should now look like the one below

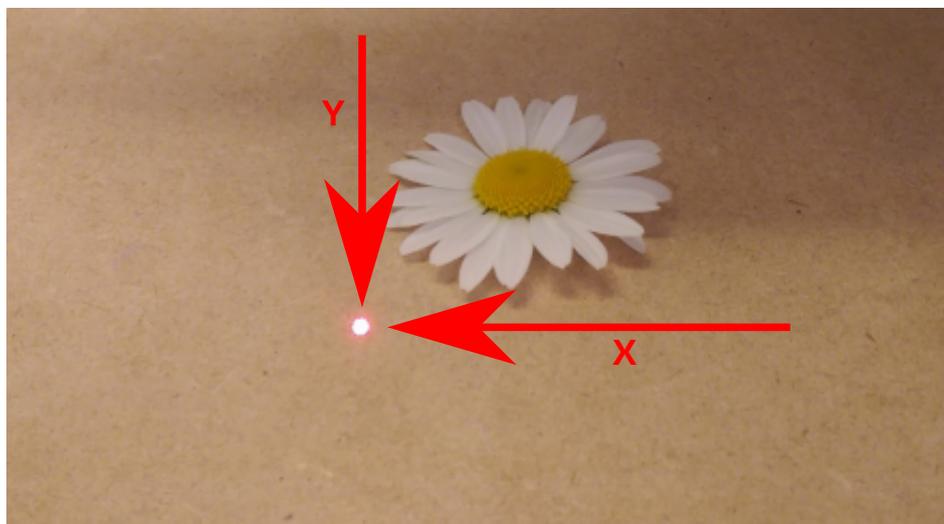


Setting Scanning Position

Before scanning, the CNC Router needs to be told where the part is.

To move the laser to the Start position use the Control Panel to Jog the routers axis.

The image below shows a recommended Start position.

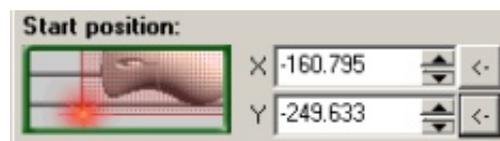


Jog the X and Y axis to the Start position

Click the "X Offset" button 

Click the "Y Offset" button 

The Start position is now set



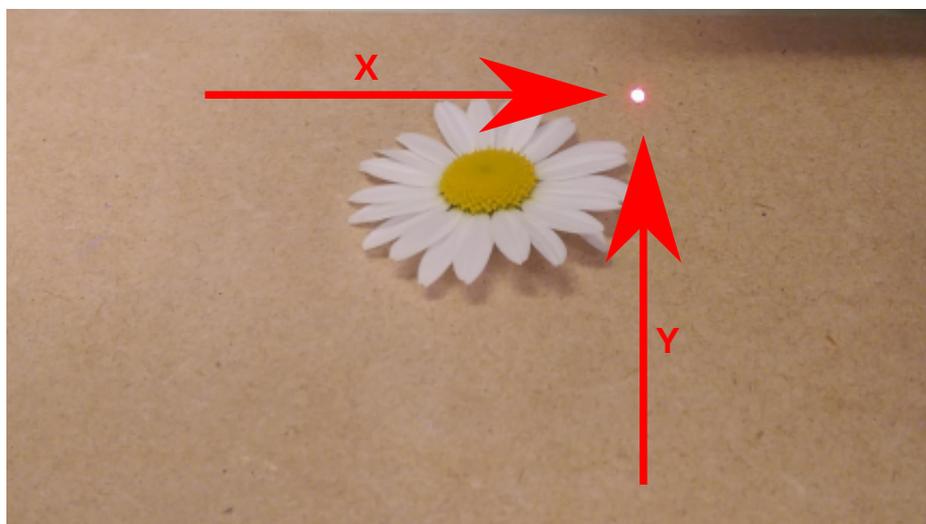
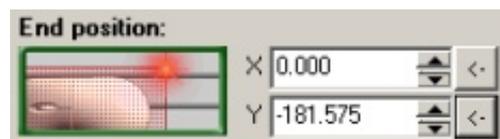
To set the End position, the process is the same

Jog the X and Y axis to the End position

Click the "X Offset" button 

Click the "Y Offset" button 

The End position is now set



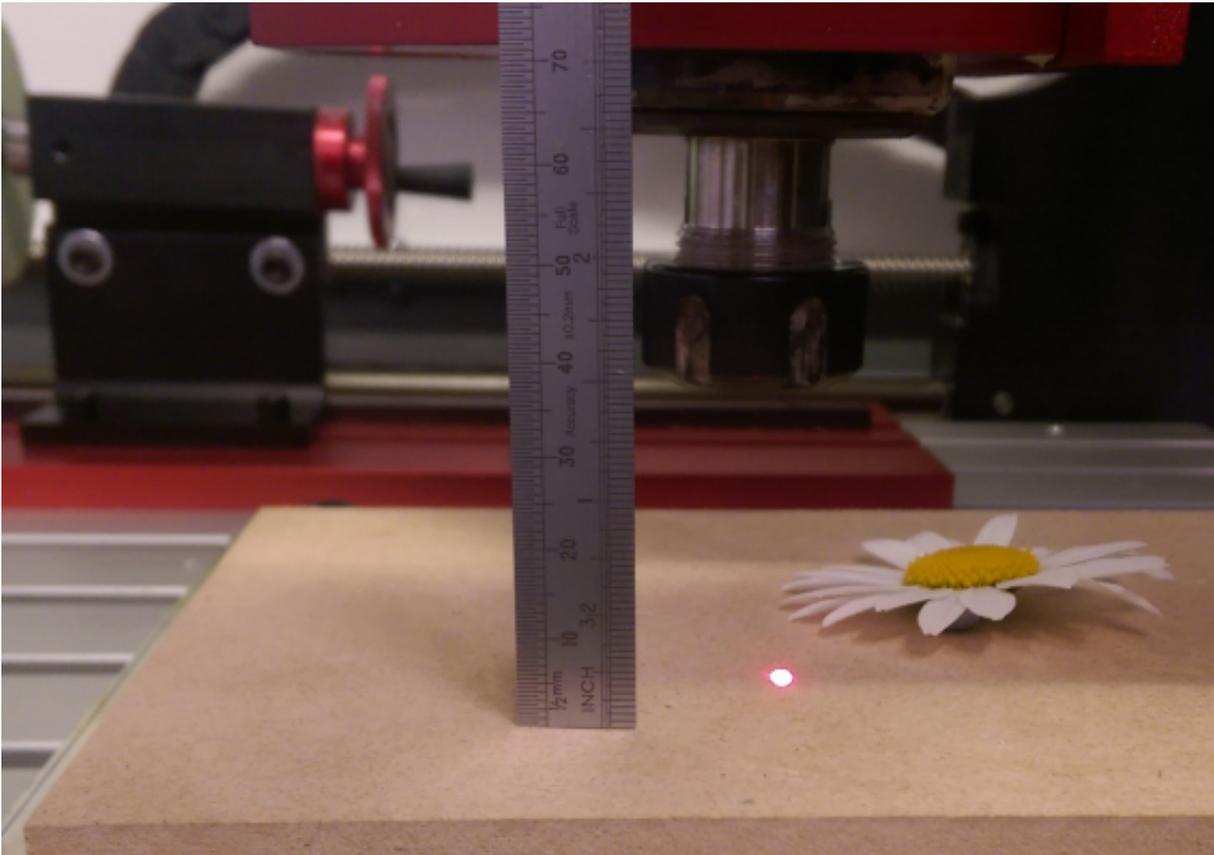
To set the Focal height we need to Zero the laser over the lowest part of the object to be scanned, in this case it is the MDF base.

Before Zeroing the laser over the base you will want to bring the laser into focus.

The laser will not take a reading if the object is too close, and if the object is too far away then the scan will be less accurate.

Within 50mm of the laser, no reading will be taken.

Use the Control Panel to Jog the Z axis down until the laser is close to the object, but not within 50mm of the highest point.

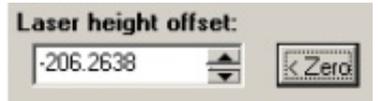


On the Router 2600 Pro the Spindle Nut is more than 55mm from the laser module, if you lower the Z axis until the Spindle Nut is just above the highest part of the object to be scanned you will get a good scan.

Click the "Zero" button

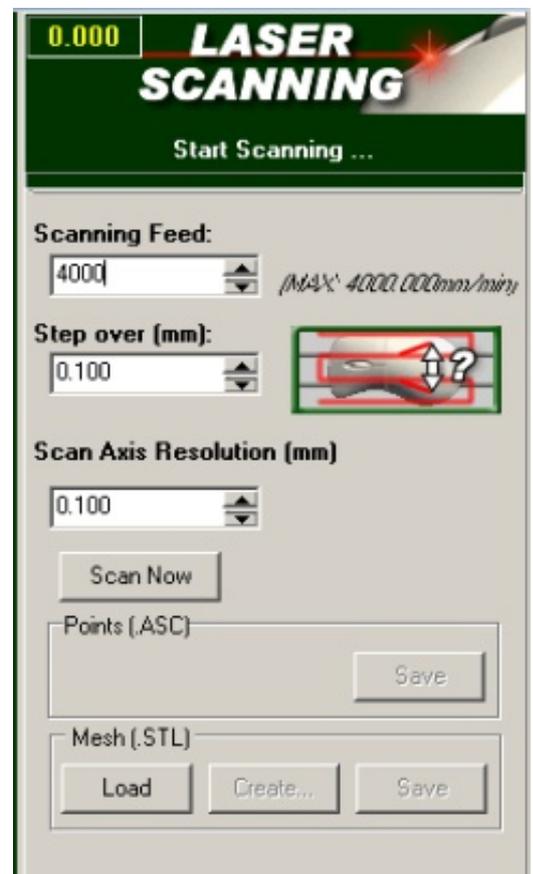
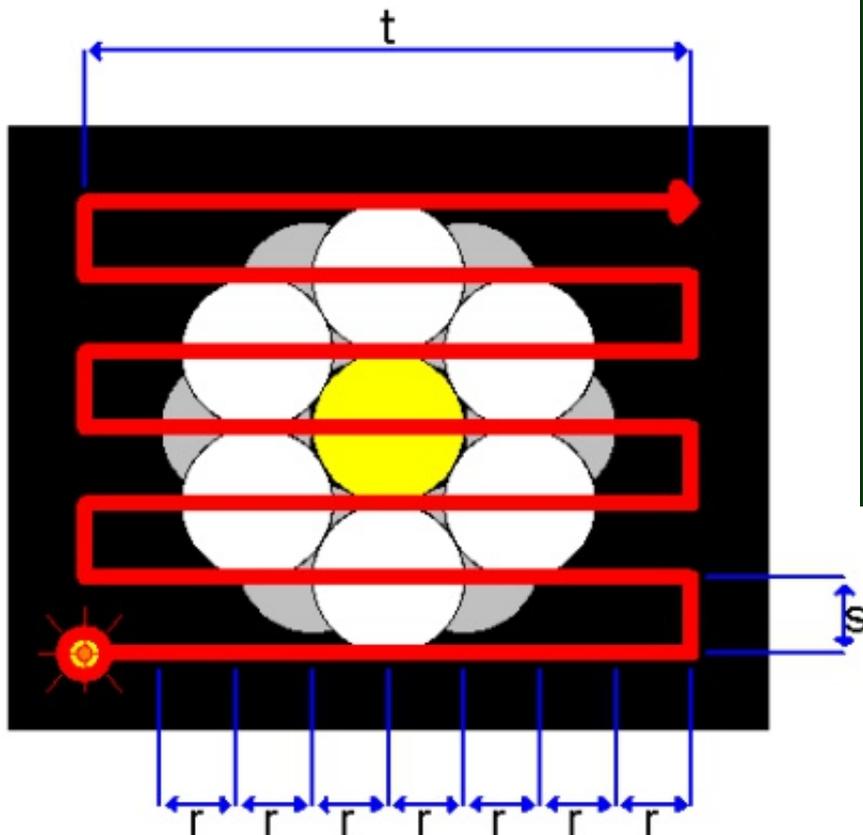


Coordinates at the top of the screen should now read zero



Setting the Scan Properties

EasySCAN 3D performs the scanning process by rastering, you can adjust how detailed the scan is by adjusting the properties of the menu shown on the right. The image below illustrates how these settings affect the quality of the scan.



t = Frequency (mm/min)

s = Stepover (mm)

r = Axis Resolution (mm)

Set the Step over and Scan Axis Resolution first.

Then set the Scanning Feed

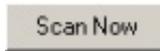
The maximum Scanning Feed available will vary depending on the Step over and Scan Axis Resolution

The quality of the scan will be better with a lower feed, but will take longer.

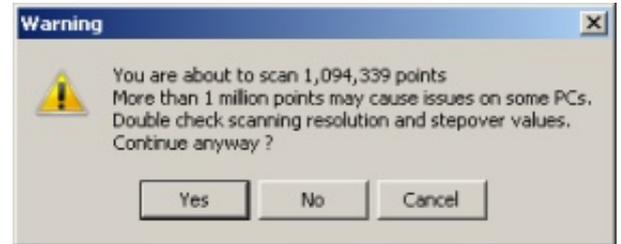
Any scan with more than 1 000 000 points will cause issues with graphics memory, use the calculation below to work out how many points your scan will have.

$$\left(\frac{\text{X Scan Distance}}{\text{Axis Resolution}} \right) \times \left(\frac{\text{Y Scan Distance}}{\text{Step Over}} \right) = \text{Points}$$

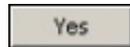
Once you have set your settings click the "Scan Now" button to begin scanning



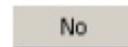
Should you choose settings which will create a scan with more than 1 000 000 points the warning to the right will pop up.



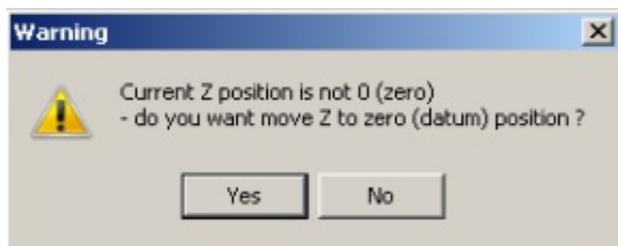
Click the "Yes" button to continue



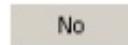
Click the "No" button to go back and edit your settings



If you have adjusted the Z axis and not set the zero position as an offset in VR Milling V5 then the warning below will pop up



Click the "No" button



EasySCAN 3D will now begin scanning without moving the Z axis.

If you were to click Yes the Z axis would move to whatever position the current offset in VR Milling 5 has set as Z0



As the CNC Router is scanning the object the points will appear in EasySCAN 3D.

This may take some time depending on the scanning feed and stepover.

As the points build up you should start to see your object form in the EasySCAN 3D window, like the image to the right.

Saving the Point Cloud

When the scan has completed you will be asked if you want to save scanned point cloud data.

It is recommended to do this if you wish to use another program for reverse engineering the scanned data, such as Meshlab [an open source program which can be downloaded from <http://meshlab.sourceforge.net/>]

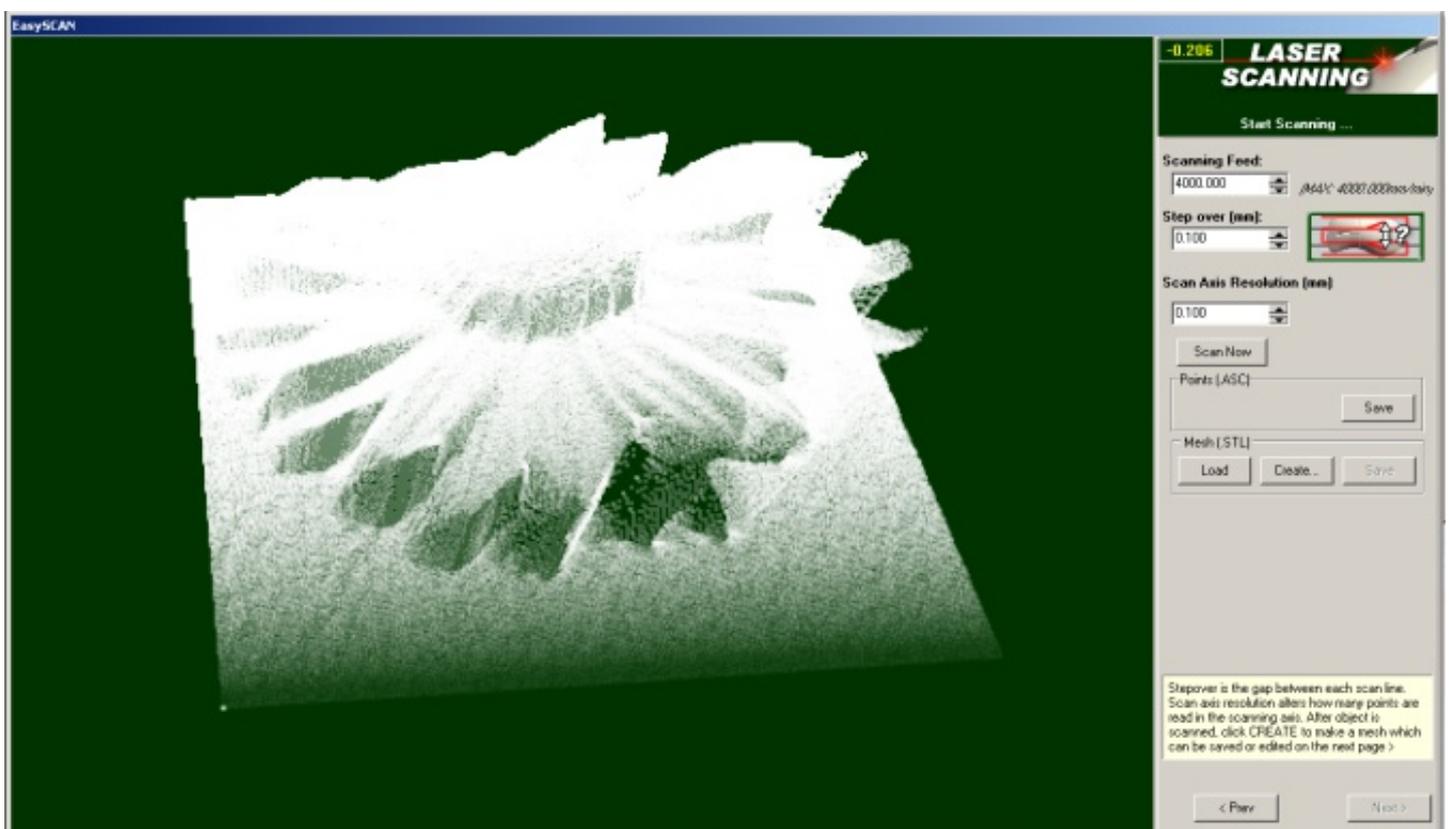
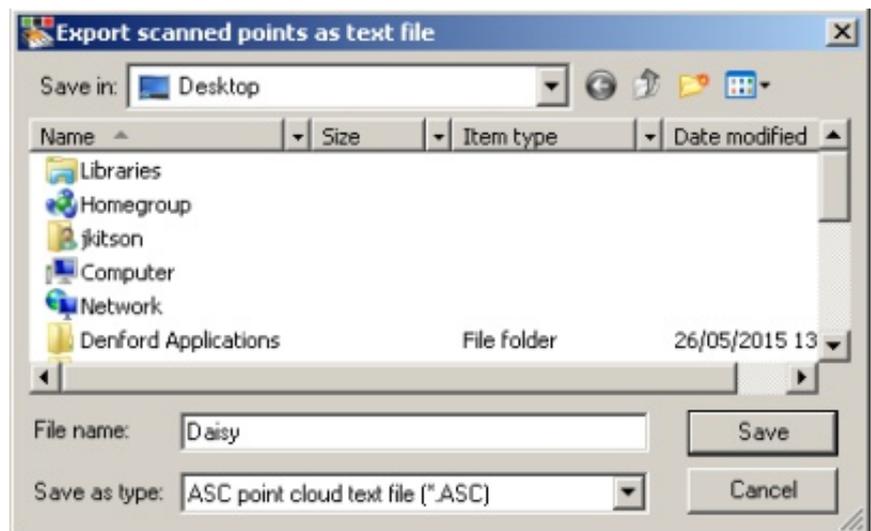


Click the "Yes" button

The window to the right will appear

Enter a name for the file

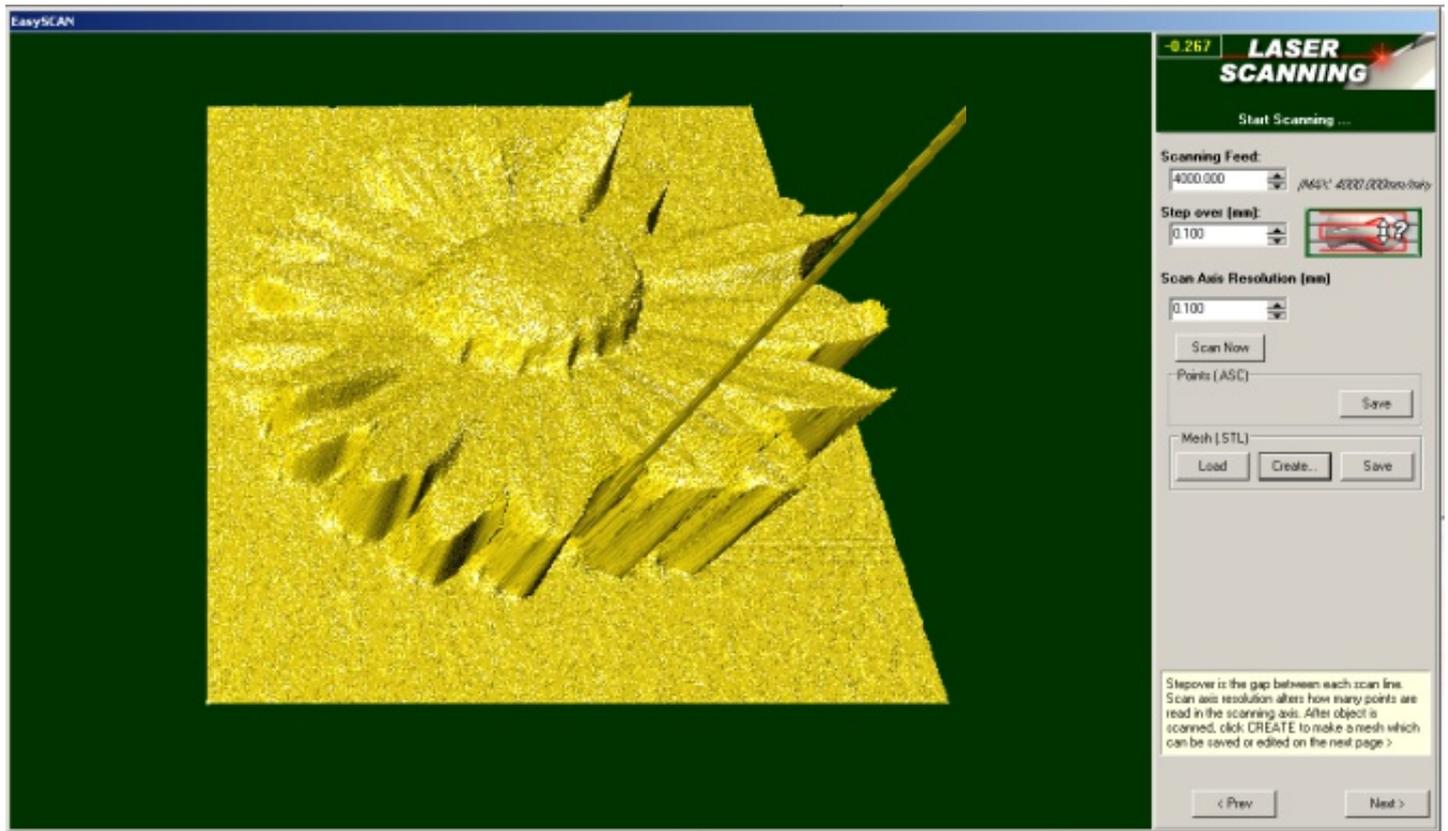
Click the "Save" button



If you want EasySCAN 3D to create an stl for you.

Click the "Create" button

Your screen should now look like the image below.

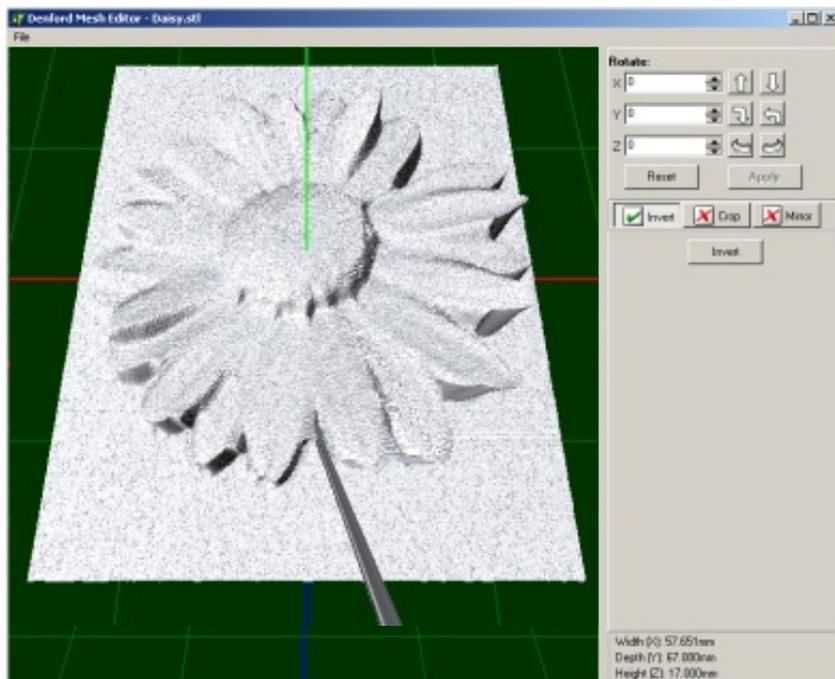


If you wish to save the stl at this stage you can click the "Save" button.

As you can see in the image above, the scan has some noise in the form of a spike (probably a small reflection), to clean the image click the "Next" button to open EasySCAN 3D mesh editing.

Click the "Next" button

Next >



EasySCAN 3D allows you to perform 3 very simple operations on the stl.

Invert will simply invert the mesh which is handy for mold making.

Crop allows you to crop above or below a line, we will use this for removing the noise.

Mirror creates a mirror of the scan, this is handy for a symmetrical part where you have only scanned half of the part to save time.

Mesh Editing

EasySCAN 3D provides some simple operations for editing your stl files, it allows you to do 3 operations.

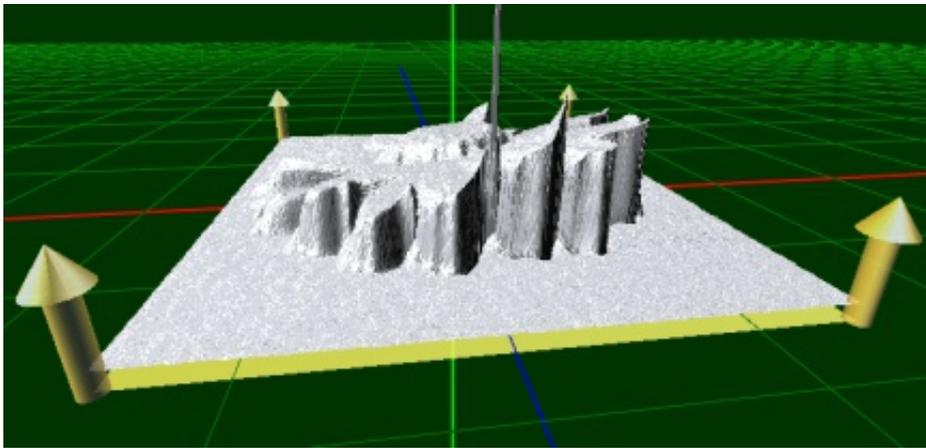
Invert will simply invert the mesh which is handy for mold making.

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Mirror creates a mirror of the scan, this is handy for a symmetrical part where you have only scanned half to save time.

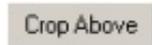
We are going to perform a crop to remove the spike caused by noise in the scan.

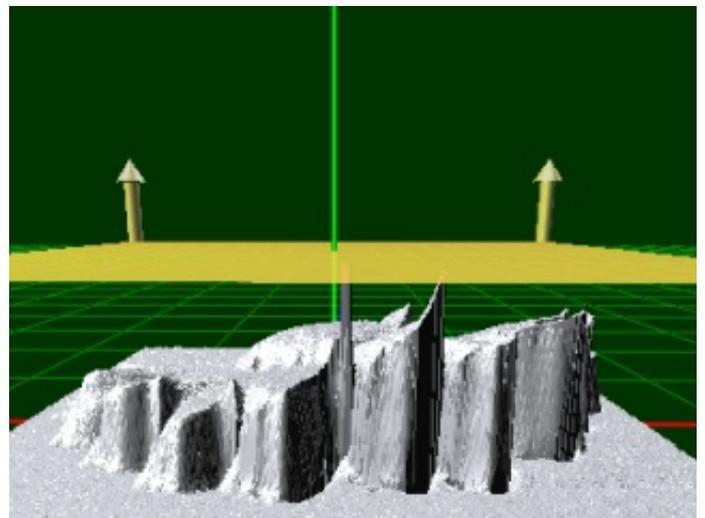
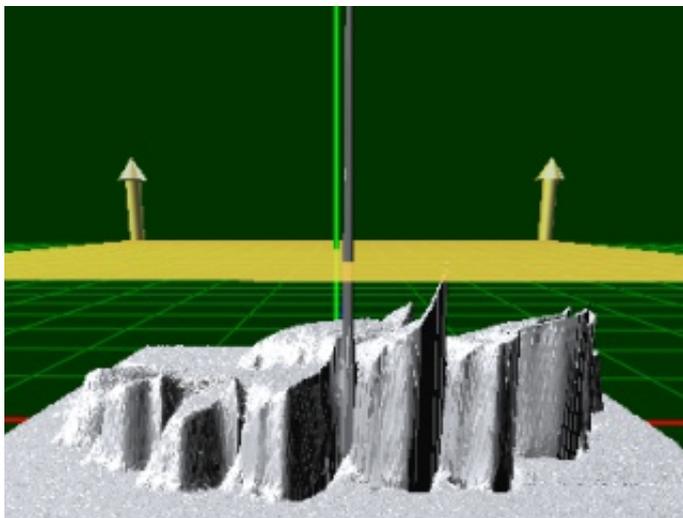
Click the "Crop" button 



As the images above show, a pane will appear below the mesh and some new controls have appeared below the Crop button

Adjust the Clipping Plane Position until the plane is just above the model 

Click the "Crop Above" button to remove the noise above the model 



As the images above illustrate, everything above the Clipping Plane has been removed.

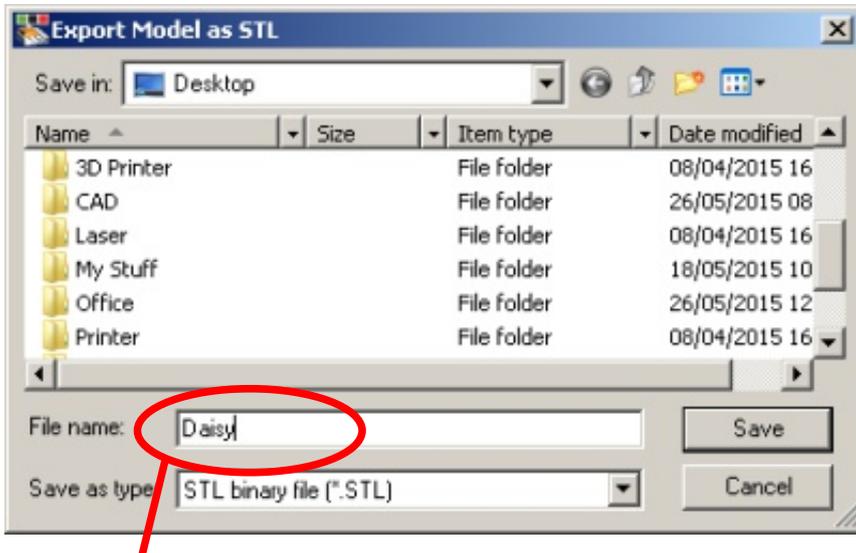
Save the Mesh

Having edited the mesh you will want to save the stl so it can be used in another program.

Click the "Save" button



The window below will appear



Enter a name for the stl

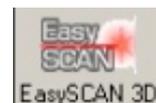
Click the "Save" button



Load a Saved Model

If you wish to edit a saved model at a later stage you should follow the instructions below

In VR CNC Milling 5, click on the EasySCAN 3D button



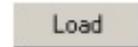
Click the "Next" button



Click the "Next" button again

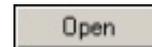


Click the "Load" button

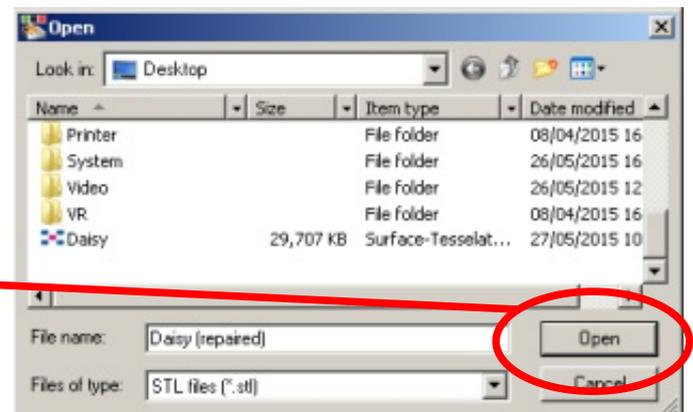


Select the stl you wish to edit

Click the "Open" button



Click the "Next" button



You are now back in EasySCAN 3D mesh editing and ready to make changes to your mesh

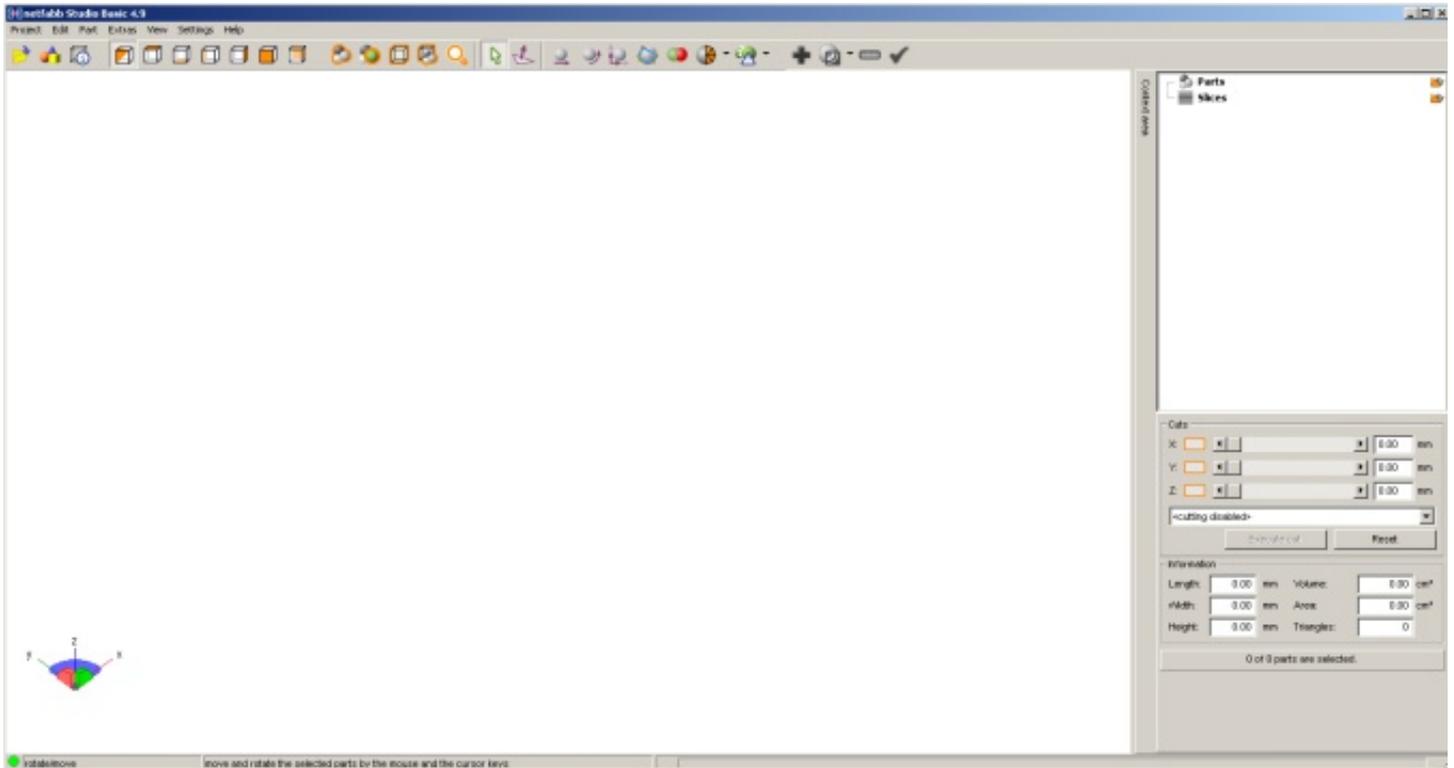
Netfabb

Netfabb is a very useful piece of software for fixing and editing meshes, the Studio Basic version is free and can be downloaded from

<http://www.netfabb.com/downloadcenter.php?basic=1>



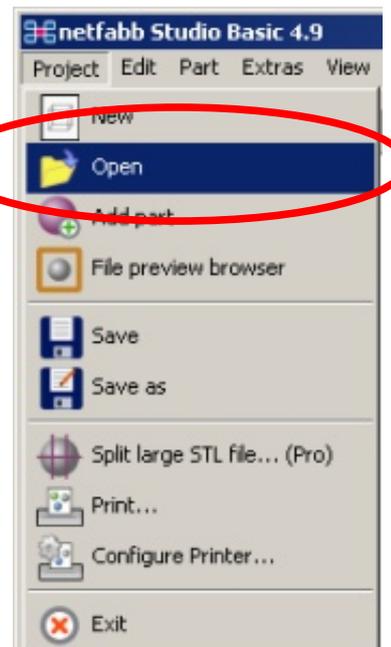
When launched you should see the screen below



Loading an STL

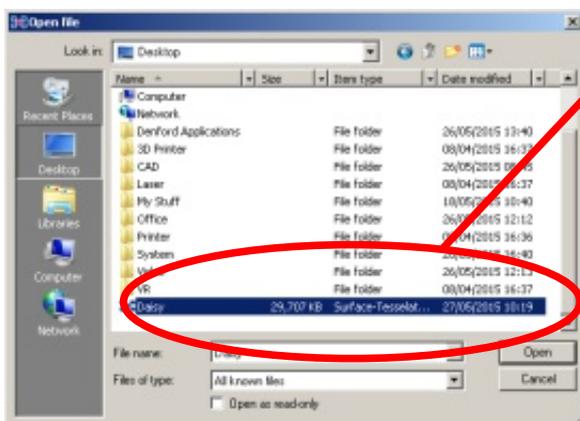
To load an stl into Netfabb follow the instructions below

**On the taskbar click on "Project", a dropdown will appear
Click on "Open"**



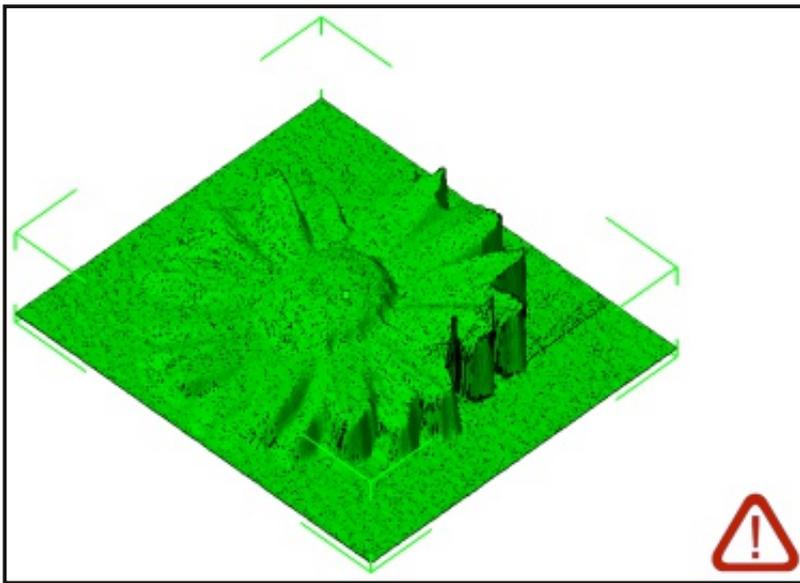
Select the stl you wish to edit

Click the "Open" button



Repairing an STL

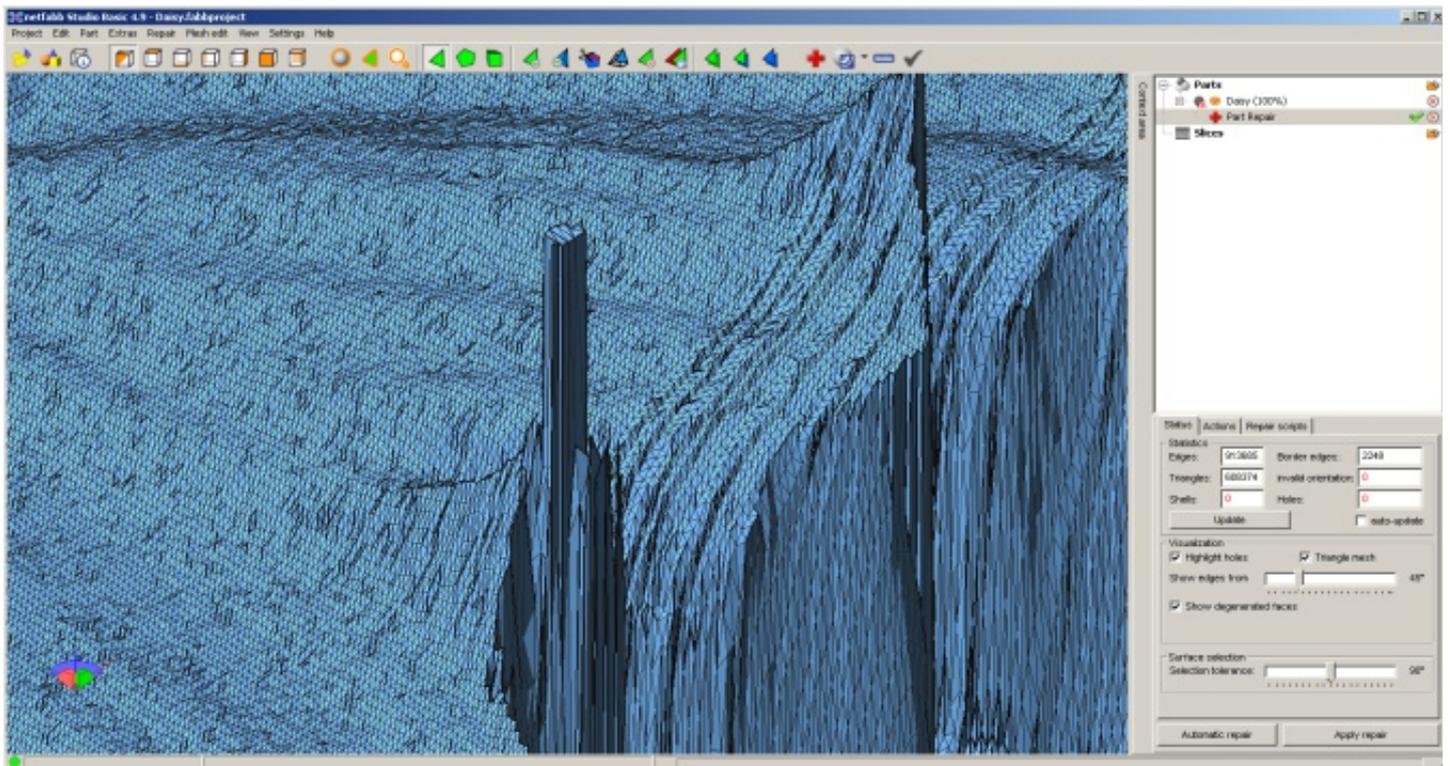
When Netfabb opens an stl file it will appear in the main viewer window, if there are errors in the file then a warning icon will be displayed next to the model as you can see in the image below.



To enter the repair environment you need to select the "Repair" button which is on the taskbar.



Click the "Repair" button



In the repair environment the screen will look like the image above, this screen illustrates how the stl model is built from a series of triangles.

Netfabb allows you to select and delete individual triangles to edit your stl.

Deleting Triangles

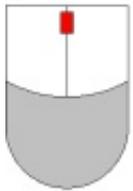
We want to delete the noise spike sticking up from the model, to navigate this software you need a mouse with a scroll wheel, the controls are shown below.



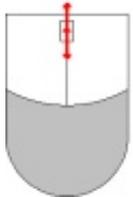
Select triangle, too select multiple triangles hold **Shift**



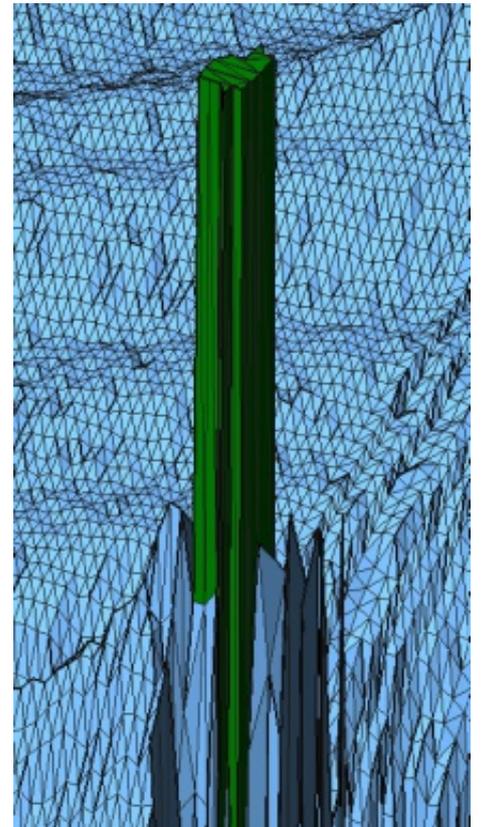
Rotate the stl model



Pan the model in the viewing area



Roll forward to zoom in
Roll back to zoom out



When selected the triangles will turn green, when you have selected all the triangles you wish to remove, simply press the delete key.

Press the "Delete" key

The spike has been removed from the stl model, but it now has a hole in it. Fortunately, Netfabb is very good at filling holes and we can use the automatic repair function for this.

Click the "Automatic repair" button

Automatic repair

Select "Default repair"



Click the "Execute" button

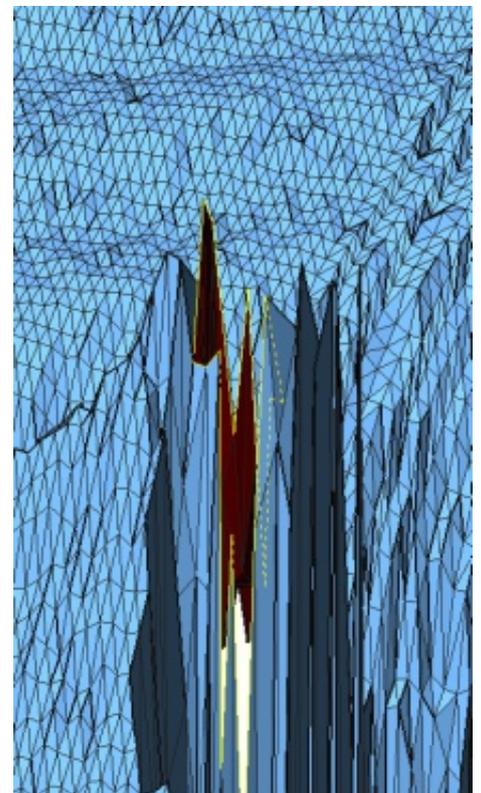
Execute

Now click the "Apply repair" button

Apply repair

Click the "Yes" button to remove the old part

Yes

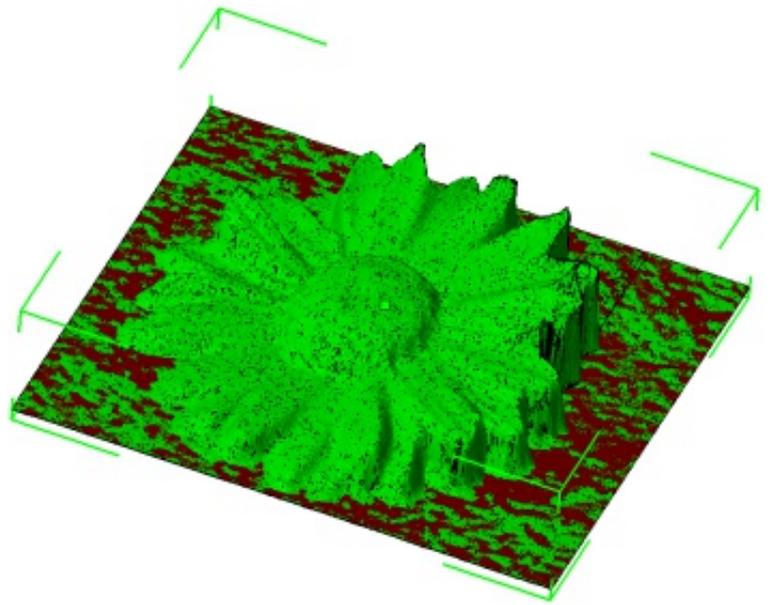


The model will now be hole free and look like the image to the right.

The base of the model has no thickness to it and as such the software was unable to tell which is inside of the model and which is outside.

Red indicates the inside of a model and green indicates the outside, the base is a mixture of the 2 and should be deleted.

Rather than selecting each and every triangle on the base and deleting them it is easier to save the stl as it is and crop it in EasySCAN 3D.



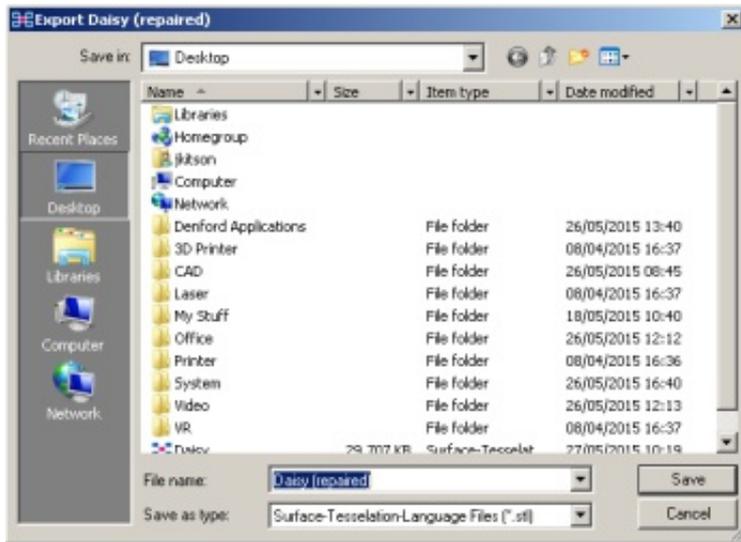
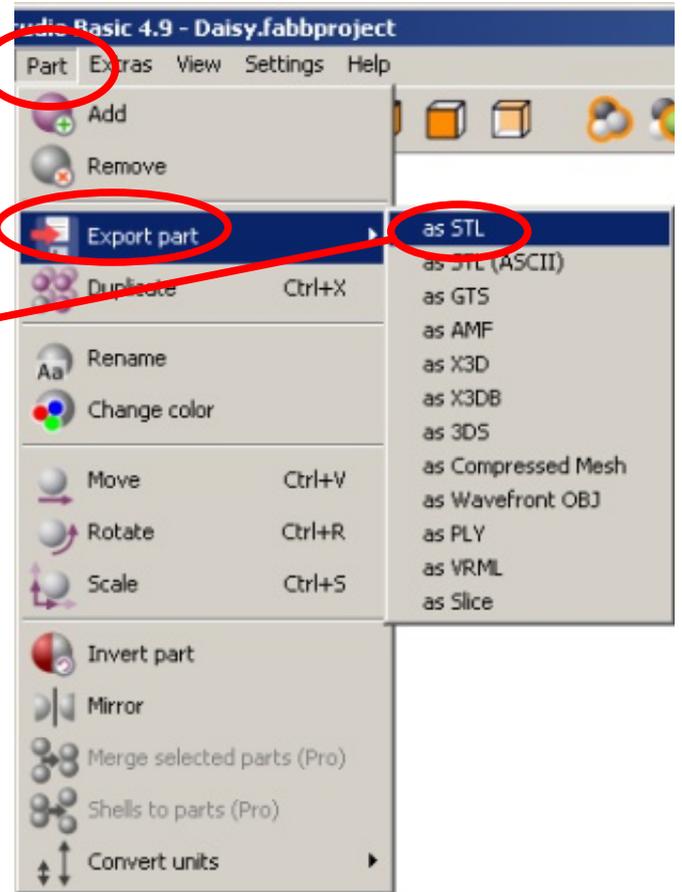
Exporting an STL

To export an stl from Netfabb follow the instructions below.

On the taskbar click "Part", a drop down will appear

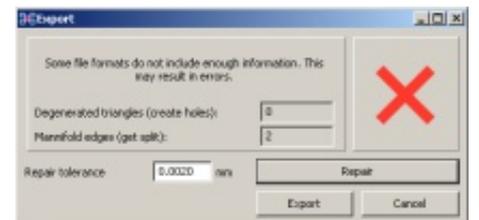
Scroll down to "Export part, this will extend to the right

Click "as STL"

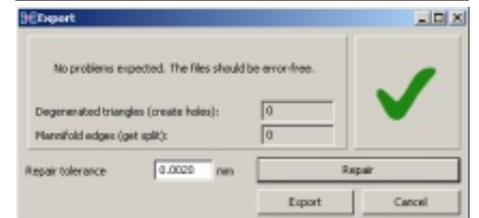


Enter a name for the stl, click the "Save" button

If window on the right appears, click the "Repair" button until the red cross is replaced with a green tick



Click the "Export" button

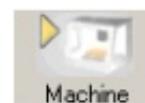


Circular Scanning

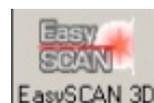
To produce a circular 360 degree scan of an object you will also require the Denford 4th Axis Programmable Rotary Fixture.

Provided you have the 4th axis the circular scan option will be available to you when you open EasySCAN 3D.

Open VR CNC Milling 5 and click the "Machine" button to connect



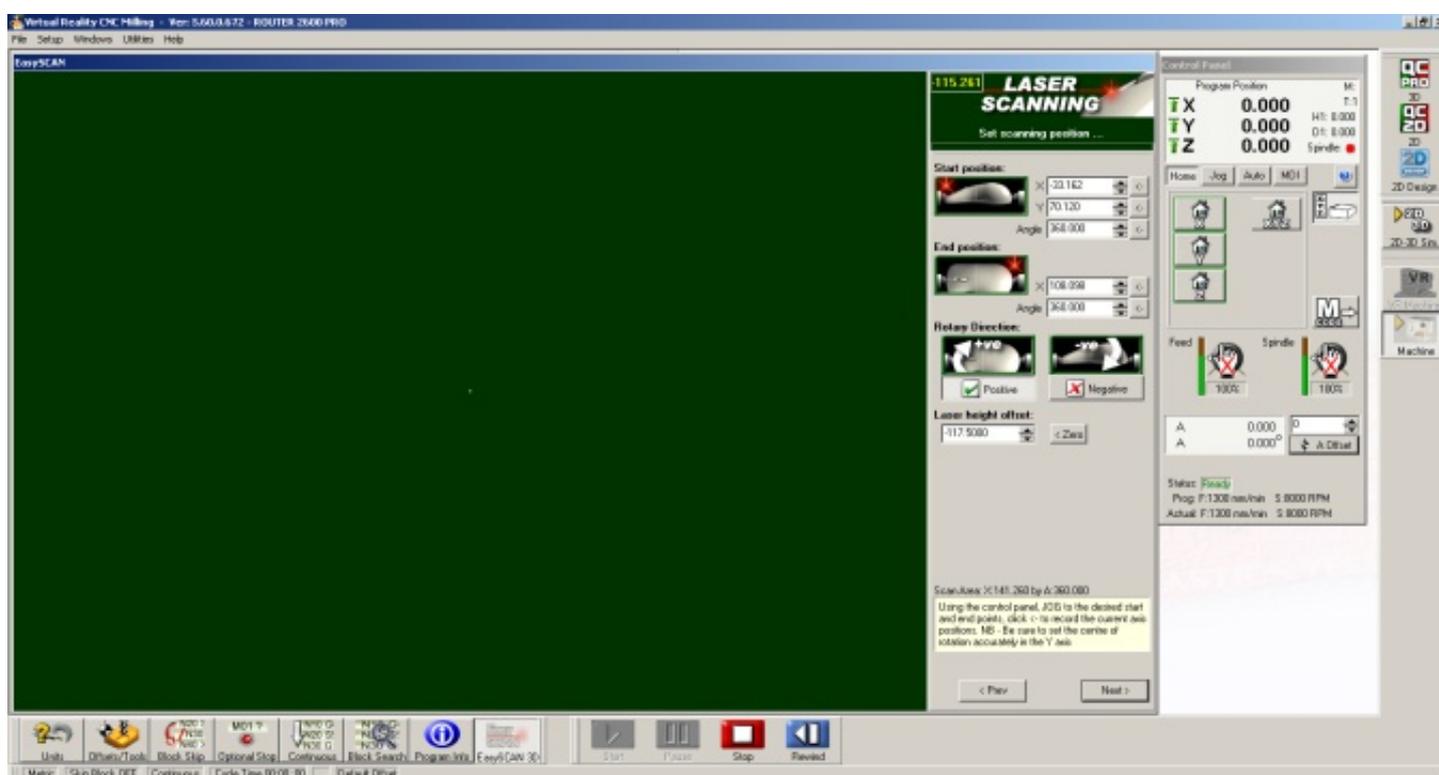
Click the "EasySCAN 3D" button to open EasySCAN 3D



Click the "Circular" button



Click the "Next" button



Your screen should now look like the image above.

Setting Scanning Position

Setting up EasySCAN 3D for a circular scan is not as simple as a linear scan.

We have to zero the Y axis on the axis of rotation for the 4th axis.

We have to zero the Z axis on the axis of rotation for the 4th axis.

We have to set the X axis Start and End position.

We can also set the rotary angle and the rotary direction.

Setting the Y Offset

For the circular scan the Y axis needs to be fixed on the centre line of the axis of rotation for the 4th axis, to do this follow the instructions below

Select "Jog" on the control panel and move the laser so it is over the round bar in the chuck of the 4th axis 

It is a good idea to place masking tape over the drive to eliminate reflection

Click on the "Zero" button 



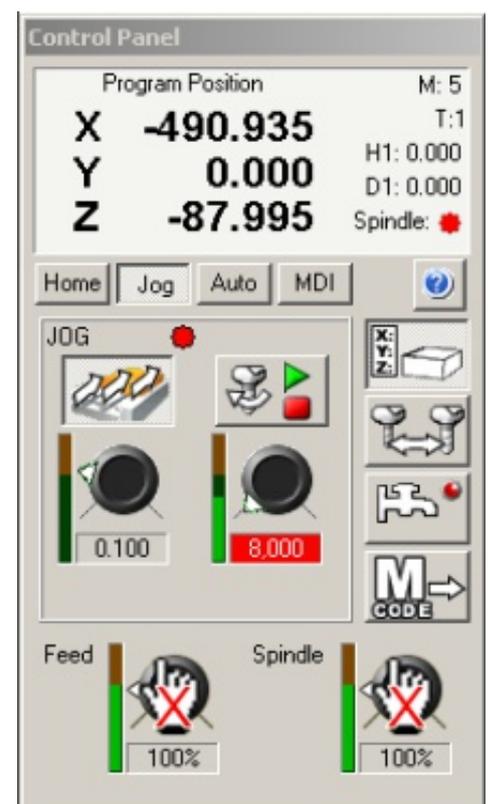
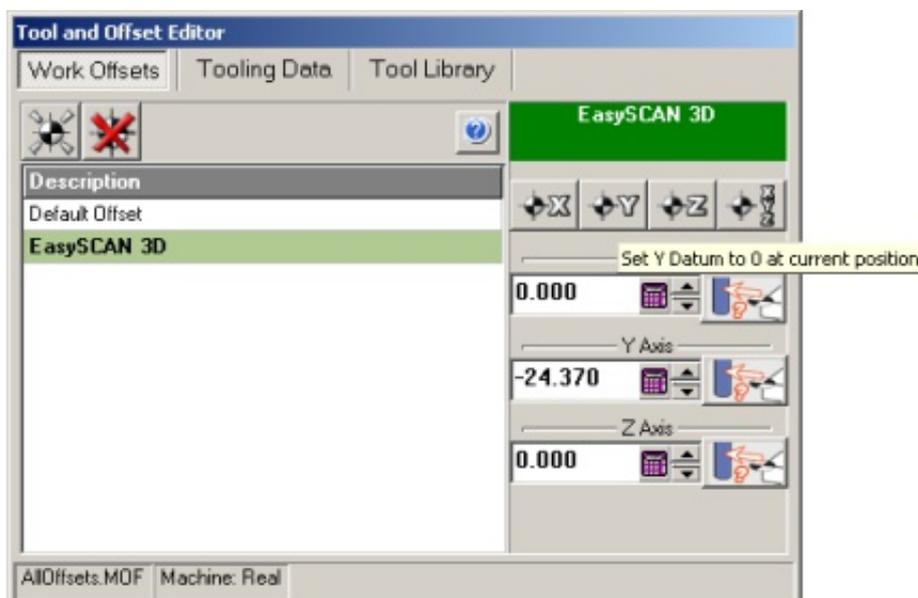
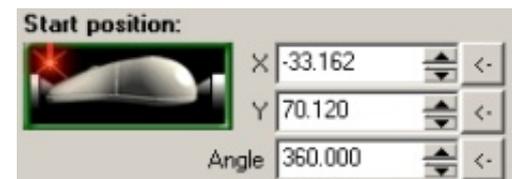
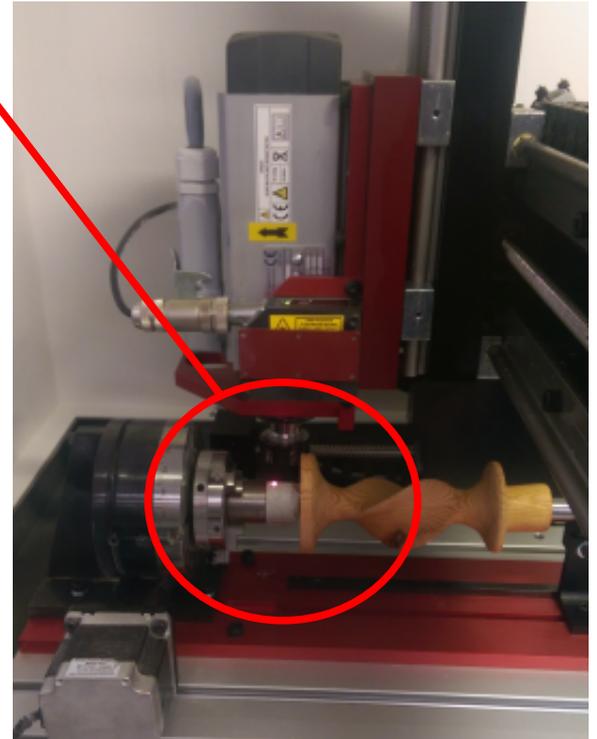
The laser reading will now be zero, as you jog the Y axis + or minus this value should rise or fall.

You are trying to find the highest value as this will be the centreline.

Adjust the Y axis until you find the highest point

Click the "Y Offset" button, which is under the Start Position 

It is a good idea at this stage to open the Offset/Tools window in VR CNC Milling 5 and create a new offset for EasySCAN 3D and save the YO position. Then in future you can use MDI to move to YO and speed up the process of carrying out a circular scan.



Setting the Z Offset

For the Z axis we need to make sure that the laser scanner is at least 55mm from the highest part of the object as the laser cannot see anything closer than 50mm, but if we are too far away the scan will be less accurate.

As we are scanning a round object we also need to set the axis of rotation for the 4th axis to be zero, follow the instructions below to achieve this.

Select "Jog" in the Control Panel and position the laser over the highest part of the object to be scanned.



Jog the Z axis down until the laser module is just over 55mm from the highest point of the object to be scanned.

Care should be taken here to ensure that you have removed the tool from the spindle and that the spindle nut will not crash into anything, the X axis will move from left to right during the scanning process.

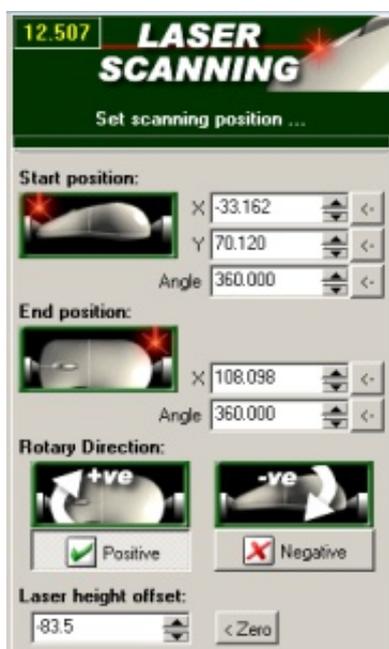
Jog the X axis so that the laser is over the round bar in the chuck of the 4th axis

Click on the "Zero" button



The laser reading will now be zero, the round bar is 25mm in diameter so the laser reading should be +12.5. We will adjust the Laser height offset to achieve this.

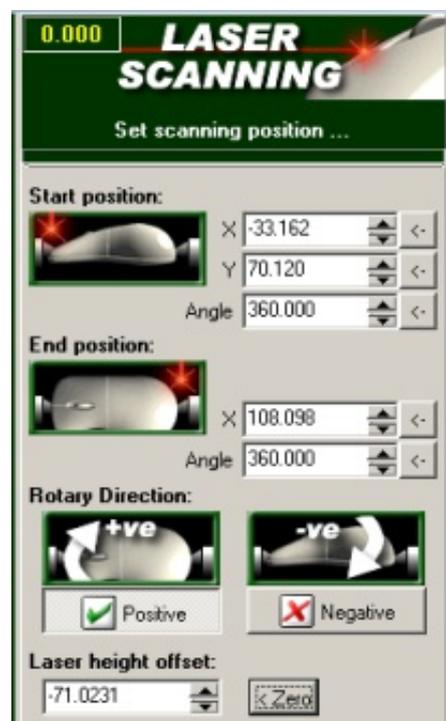
As you can see in the image to the right, when my laser reading is zero the Laser height offset is -71. If I minus 12.5 from this I get -83.5, entering this value into the Laser height offset will change the laser reading to 12.5 as you can see in the image below.



Deduct the radius of the bar from your Laser height offset and type this new value into the Laser height offset box.

Your laser reading should now be equal to the radius of the bar.

It is a good idea to save the current Z axis position as Z0 in the EasySCAN 3D offset you created when setting the Y axis offset.



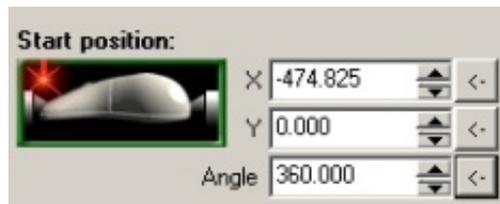
Setting the X Offset

We need to set the X Start Position and the X End position

Jog to the far left of the object so the laser is just touching the left most point of the object.



Click the "X Offset" button under the Start position.



Jog to the far right of the object so the laser is just touching the right most point of the object.



Click the "X Offset" button under the End position.



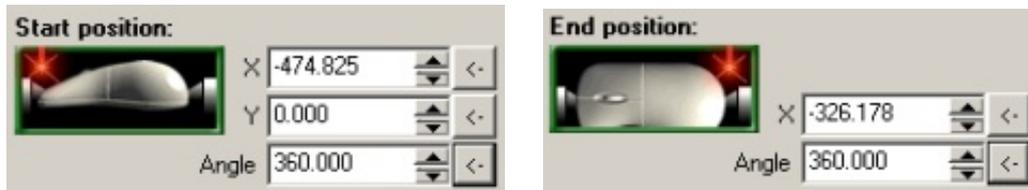
The X axis offsets are now complete.

Other Settings

Rotary Angle

You can set the rotary angle at the Start and the rotary angle at the End if you are not wanting to complete a full 360 degree scan.

By default both the Start and the End are set to the 360 degree position so a full circular scan will be completed.



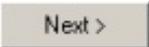
Rotary Direction

You can set the direction of the programmable 4th axis to be positive or negative, the direction will be positive by default.



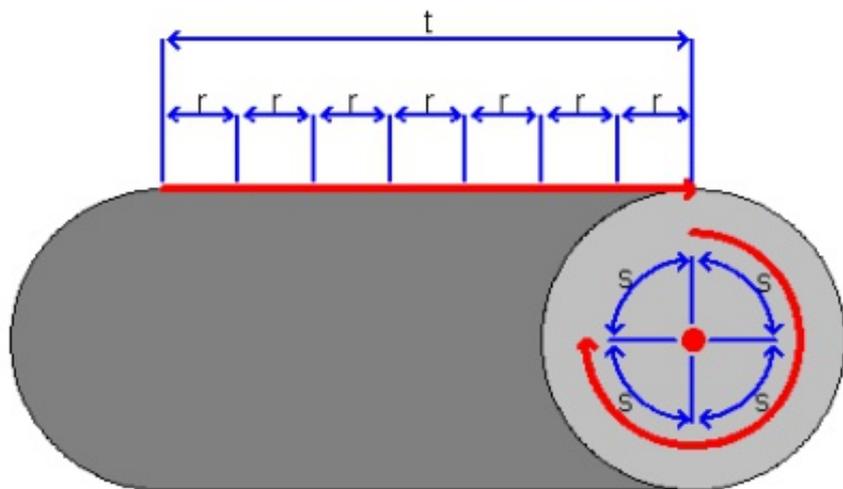
Scanning Position Set

All settings for the scanning position are now complete.

Click the "Next" button 

Setting the Scan Properties

EasySCAN 3D performs the scanning process by rastering, you can adjust how detailed the scan is by adjusting the properties of the menu shown on the right. The image below illustrates how these settings affect the quality of the scan.



t = Frequency (mm/min)
 s = Stepover (deg)
 r = Axis Resolution (mm)

Set the Step over and Scan Axis Resolution first.

Then set the Scanning Feed

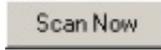
The maximum Scanning Feed available will vary depending on the Step over and Scan Axis Resolution

The quality of the scan will be better with a lower feed, but will take longer.

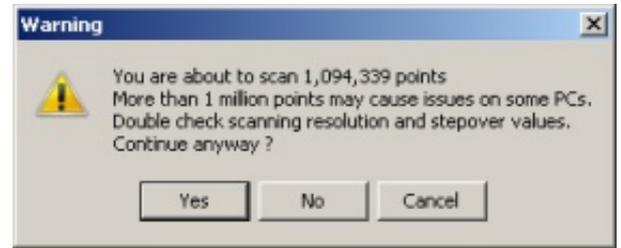
Any scan with more than 1 000 000 points will cause issues with graphics memory, use the calculation below to work out how many points your scan will have.

$$\left(\frac{\text{X Scan Distance}}{\text{Axis Resolution}} \right) \times \left(\frac{\text{Total Angle}}{\text{Step Over}} \right) = \text{Points}$$

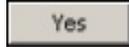
Once you have set your settings click the "Scan Now" button to begin scanning



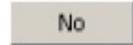
Should you choose settings which will create a scan with more than 1 000 000 points the warning to the right will pop up.



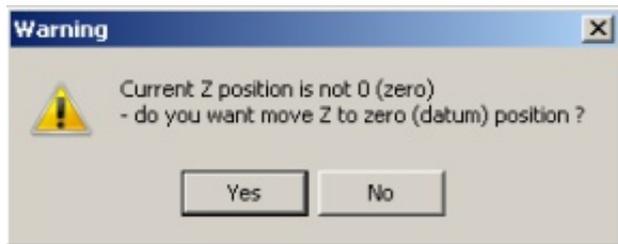
Click the "Yes" button to continue



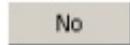
Click the "No" button to go back and edit your settings



If you have adjusted the Z axis and not set the zero position as an offset in VR CNC Milling 5 then the warning below will pop up



Click the "No" button



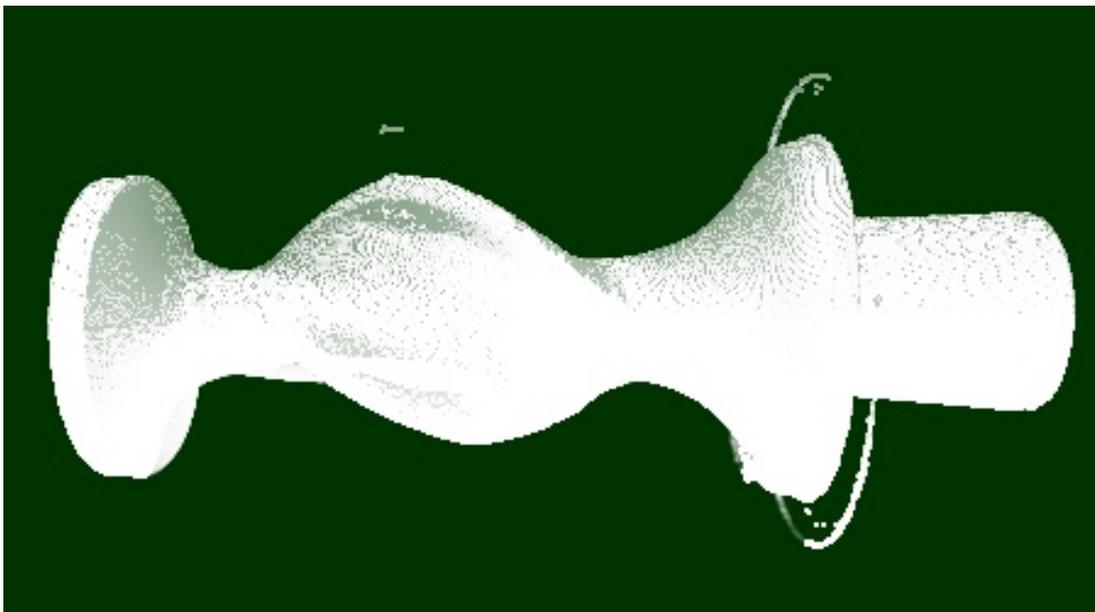
EasySCAN 3D will now begin scanning without moving the Z axis.

If you were to click Yes the Z axis would move to whatever position the current offset in VR CNC Milling 5 has set as Z0

As the CNC Router is scanning the object the points will appear in EasySCAN 3D.

This may take some time depending on the scanning feed and stepover.

As the points build up you should start to see your object form in the EasySCAN 3D window, like the image to the below.



The rest of the process is the same as the linear scan, refer to page 13 for what to do next.

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"The technical forum has provided a wealth of information and support for our 20-year-old Denford CNC machine, in fact just as good as the support we receive for our brand new CNC Router!"



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A multitude of topics relating to Denford machines and software (both new and old) are covered within the forum, which is simple to search, and easy to use.

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The On-Line Technical Forum has proved to be hugely popular with customers. One recent user posted a note to inform us that the Technical Forum has "provided a wealth of information and support for our 20-year-old Denford CNC machine, in fact just as good as the support we receive for our brand new CNC Router!"

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DENFORD
T: +44(0)1484 728000

F: +44(0)1484 728100 Email: info@denford.co.uk
Denford Limited, Anmytage Road, Brighouse, West Yorkshire HD6 1GF, England