DENFORD

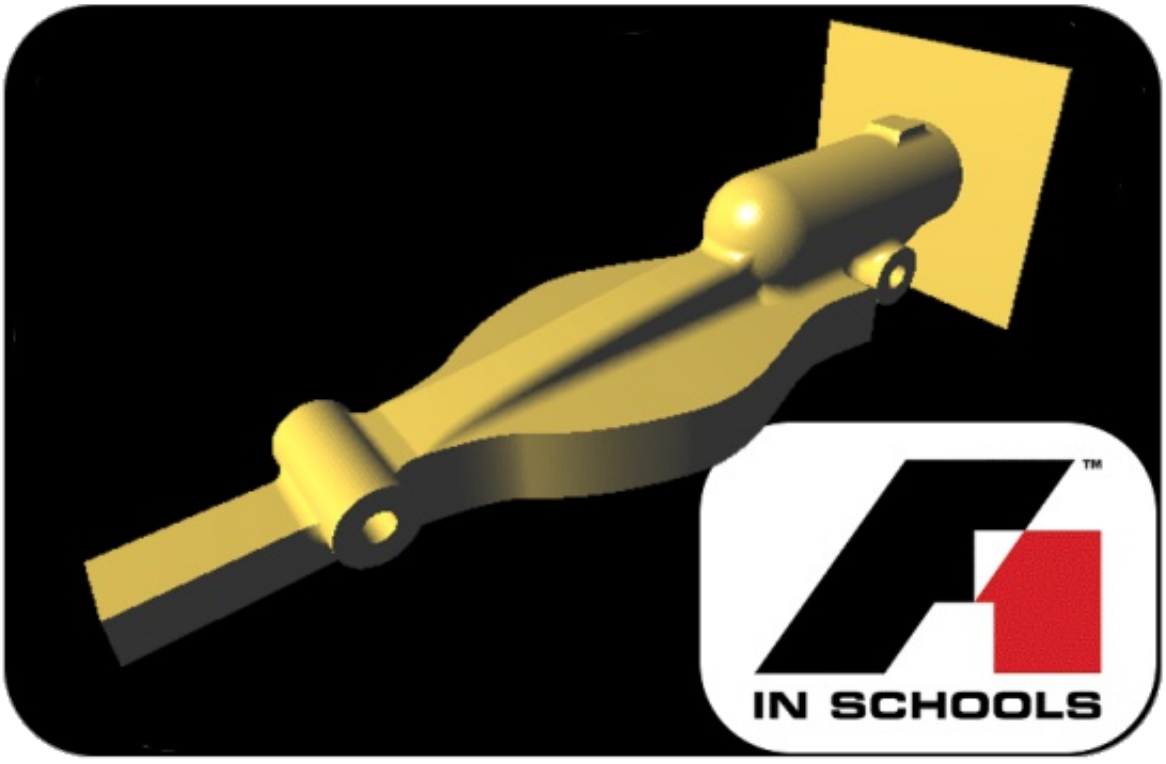
CAD/CAM Solutions & Projects for Education

QuickCAM Pro

Advanced Milling CAM Software

F1 in Schools™ Training Guide

QuickCAM Pro (V1.13)
VR Milling (V5.61)



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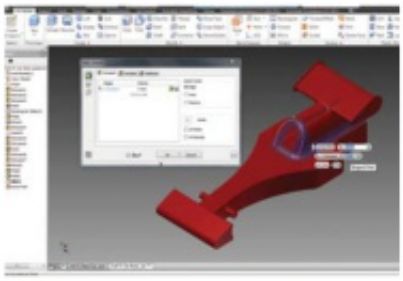
F1 Consumables

F1 IN SCHOOLS EQUIPMENT & CONSUMABLES



DESIGN

3D Design Software AUTODESK.

Design your car using Autodesk® 3D Design Software. Autodesk and F1 in Schools™ partnered to offer design tools to help prepare next-generation designers. Students and schools participating in F1 in Schools™ can access an extensive portfolio of Autodesk® 3D design software free of charge. To get your software please visit: www.f1inschools.com/autodesk

QuickCAM Pro

An advanced, yet simple to use, wizard-based CAM package, which is used to create cutter paths for machining 3D parts on a milling machine or router.

Site Licence	BID1806P

ANALYSE

Virtual Wind Tunnel

F1 VWT Analysis Software

Single Seat	BID1841
5 User Licence	BID1841A
Site Licence	BID1841C

MAKE

CNC Machine Options for F1 Car Manufacture:

MRC 40	MRC004000
Compact 1000 Pro (Metal Cutting)	MRC003000
Router 2600	MRP002000
Router 2600 Pro (Metal Cutting)	MRP003000
Router 6600	MRF002000
Router 6600 Pro (Metal Cutting)	MRF003000

F1 in Schools Car Fixture

Comes as standard with two clamping systems to enable the manufacture of Bloodhound SSC & Formula 1® Class cars. The fixture clamps directly to the T-slotted table on the MRC 40 (T-slotted table not standard equipment with MRC 40), Compact 1000 Pro and Router 2600/ Pro and is also suitable for use on the VMC 1300 (it is necessary to remove the tool changer to fit the fixture)

NR1/0400UA

Contents

About QuickCAM Pro

QuickCAM Pro is an advanced, yet simple to use, wizard based CAM package, which is used to create cutter paths for machining 3D parts on a milling machine or router. Both STL files and image files can be imported into QuickCAM Pro, and a comprehensive set of machining plans can be used individually or in combination to produce complex 3D surfaces and lithophanes.

Introduction

The aim of this training guide is to show you how to navigate your way around QuickCAM Pro and instruct you how to operate this software to manufacture an F1 in Schools car using the Official F1 Model Block
This guide will cover all the steps required to convert the STL file of your car into a machined car body.

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.

Launching QuickCAM Pro

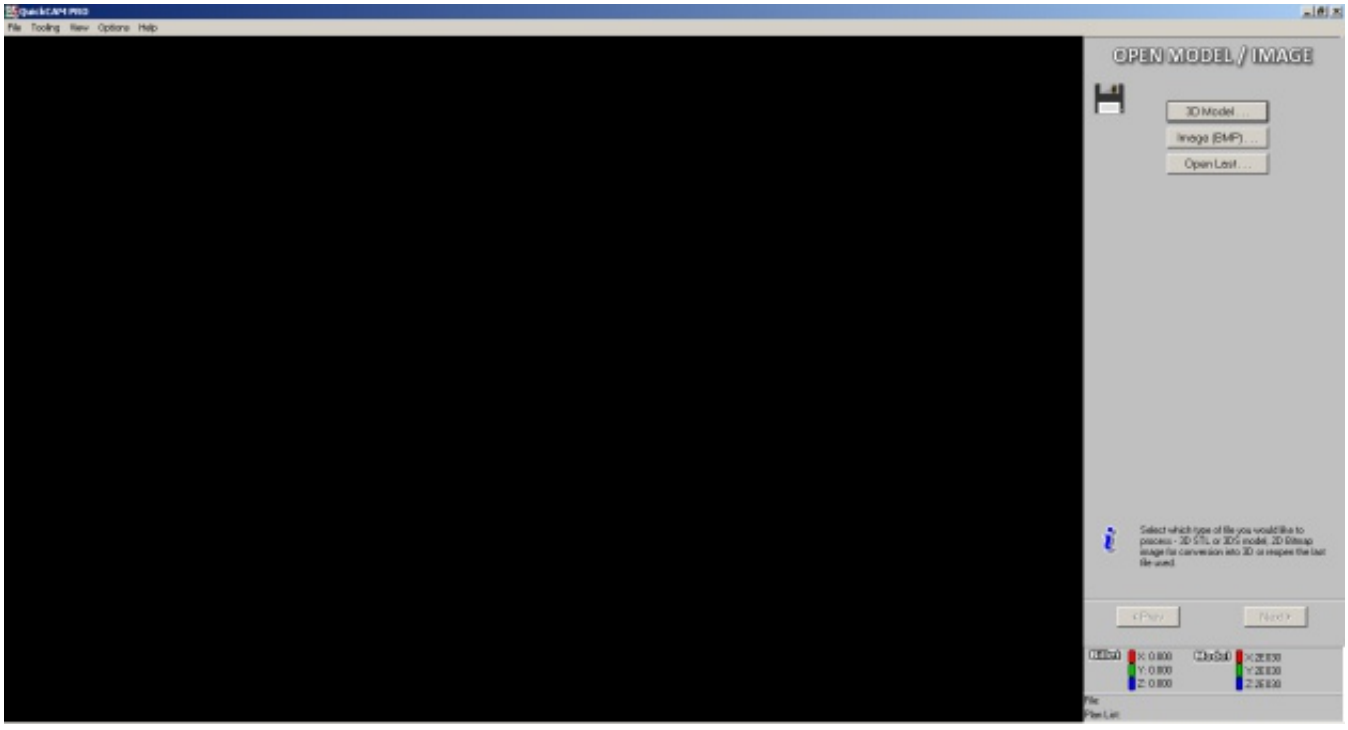
Open the "Denford Applications" folder.

"Double click" on the QuickCAM Pro icon.

The screen shown on the right will be displayed and the software will take a minute or 2 to open.
You can force the software to open quicker by following the next instruction.

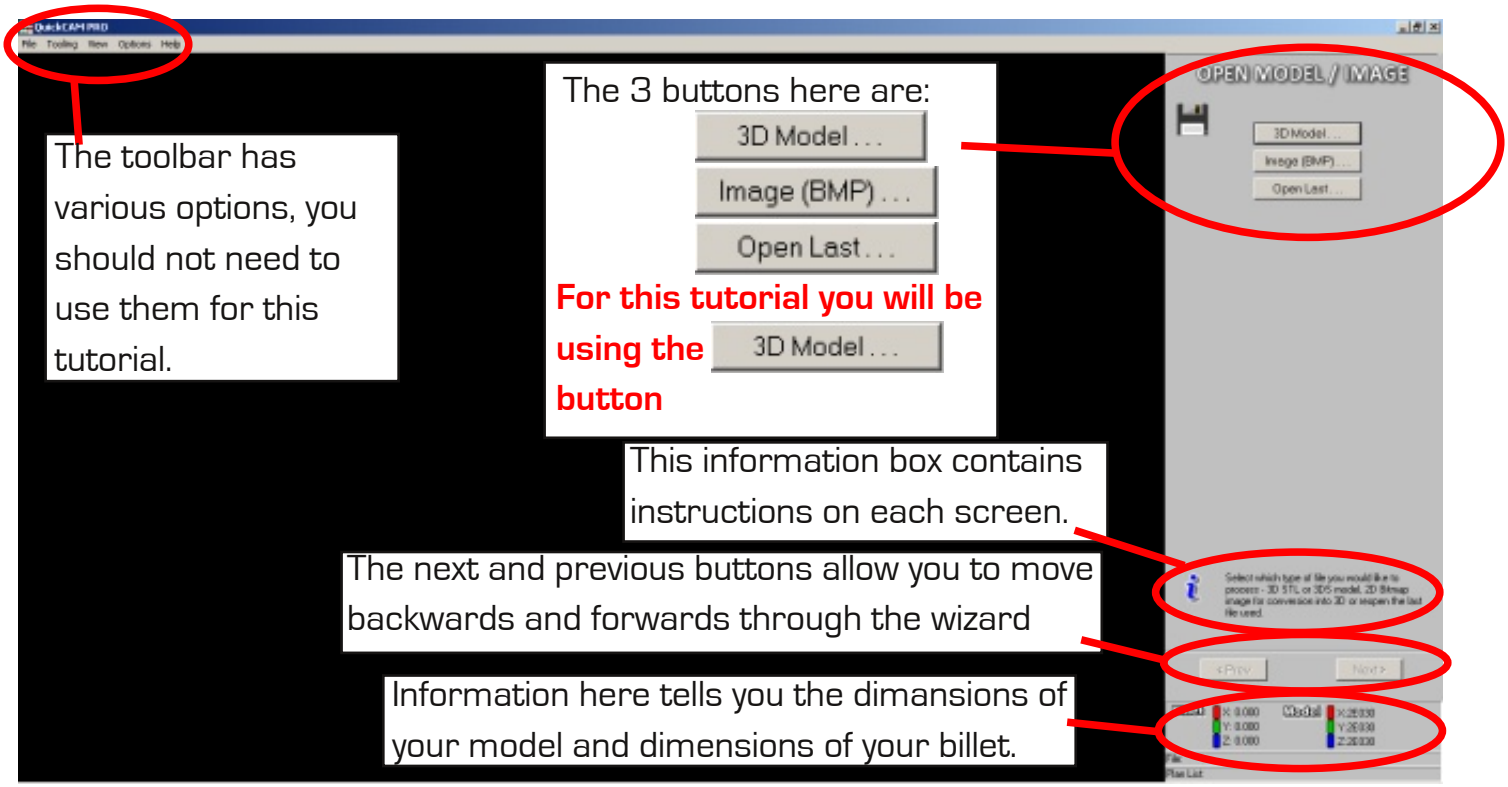
"Double click" on the area circled below.

The software will open and you will be greeted with the screen below.



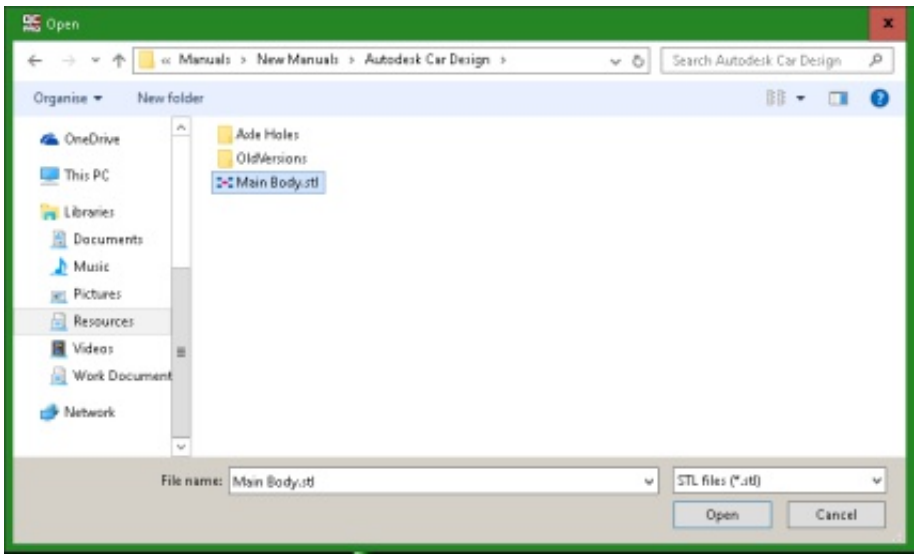
Navigating QuickCAM Pro

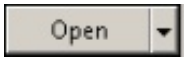
QuickCAM Pro is very easy to use, the main screen displays what is going on and the navigation panel on the right is how you select options and move around this wizard based program.
The left mouse button allows you to rotate the main display and the right mouse button allows you to zoom in and out.



Opening your Model

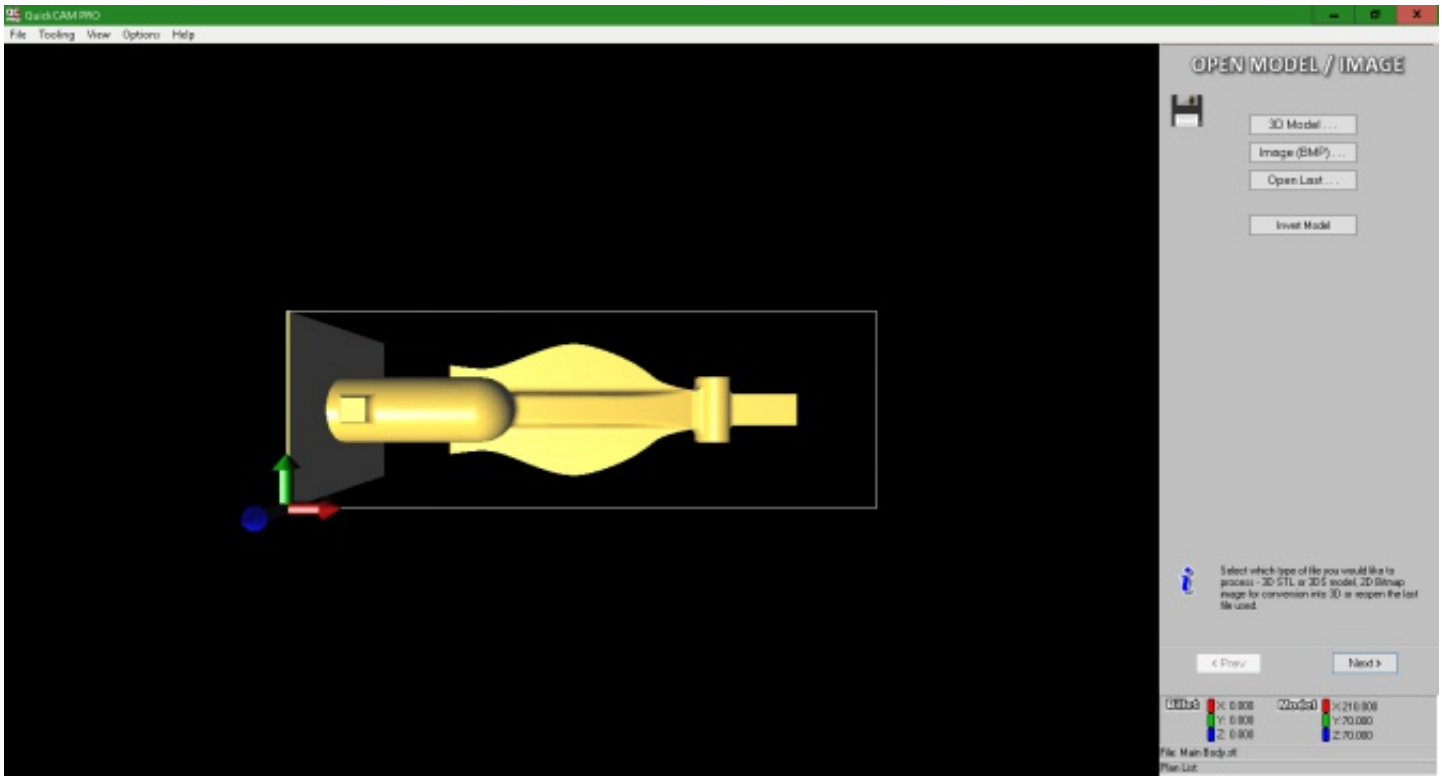
Select the "3D Model" button 



Select the .STL file you wish to machine and click the "Open" button 

Your model will now be displayed in the main screen.
You can hold the left mouse button to rotate your model, holding the right mouse button zooms in and out.
A new button has appeared, this is the "Invert Model" button 

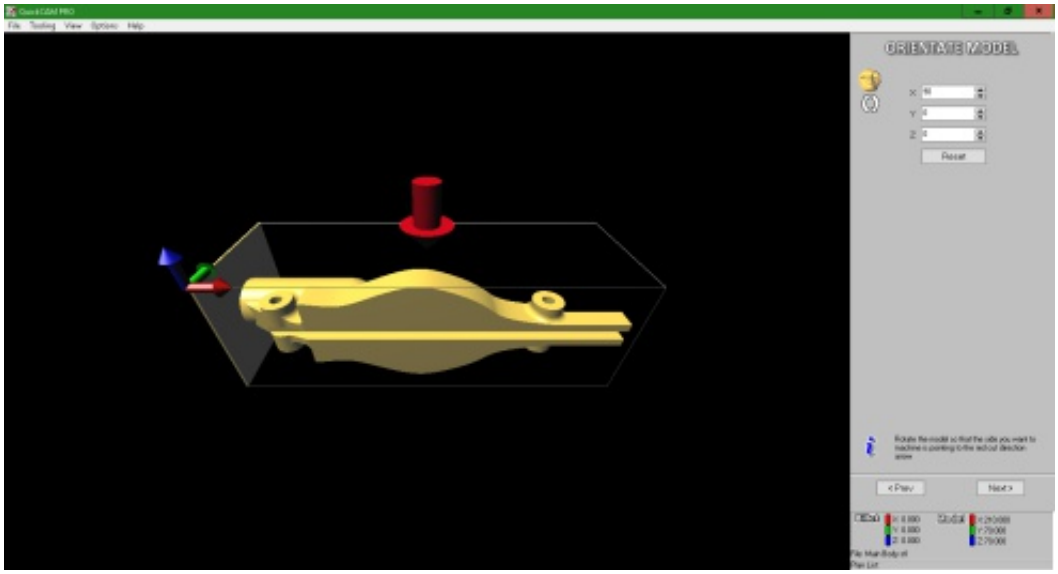
We do not use it for this tutorial.



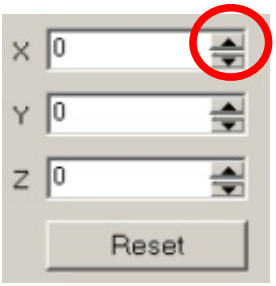
Click the "Next" button 

Orientate Model

For this tutorial we will orientate the model so that the cartridge hole is on the left and the bottom of the model is facing us.
In the illustration below you can see a large red arrow has appeared in the main display, this represents the direction that the cutting tool will be coming from.
We need to rotate the model 90 degrees along the X axis to orientate the model correctly.



Click on the "X axis +90" button once



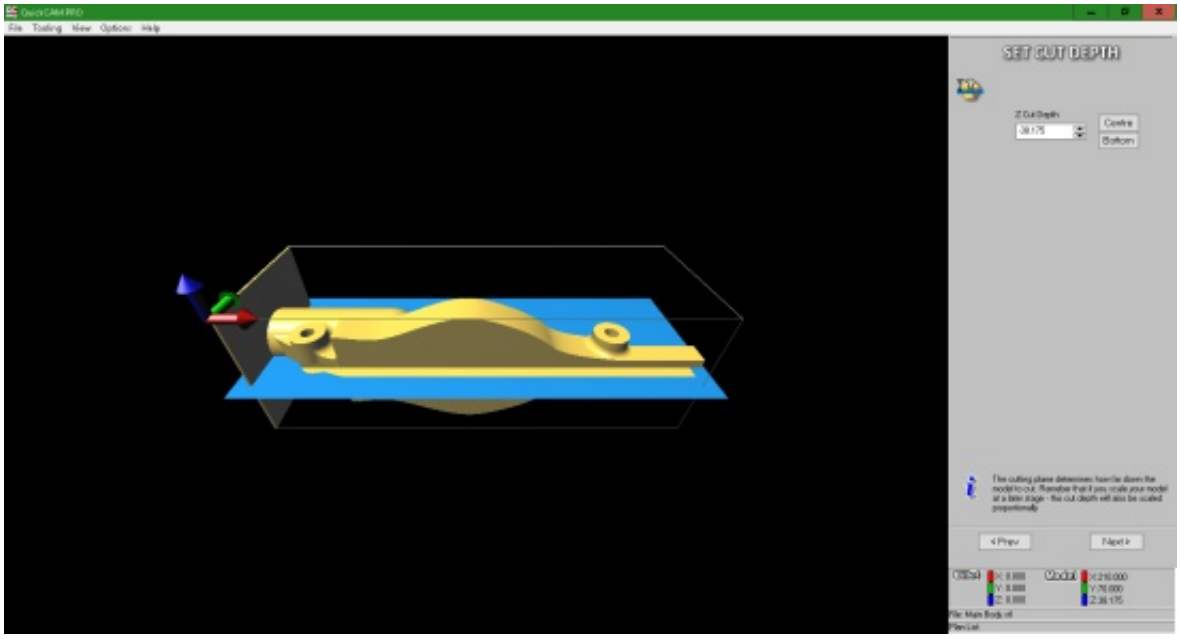
As you can see these buttons rotate the model in 90 degree increments

Whether or not the model will need rotating will depend on which planes you used when creating the model.

When your model is correctly orientated, click the "Next" button

Set Cut Depth

This screen allows you to set the cut depth



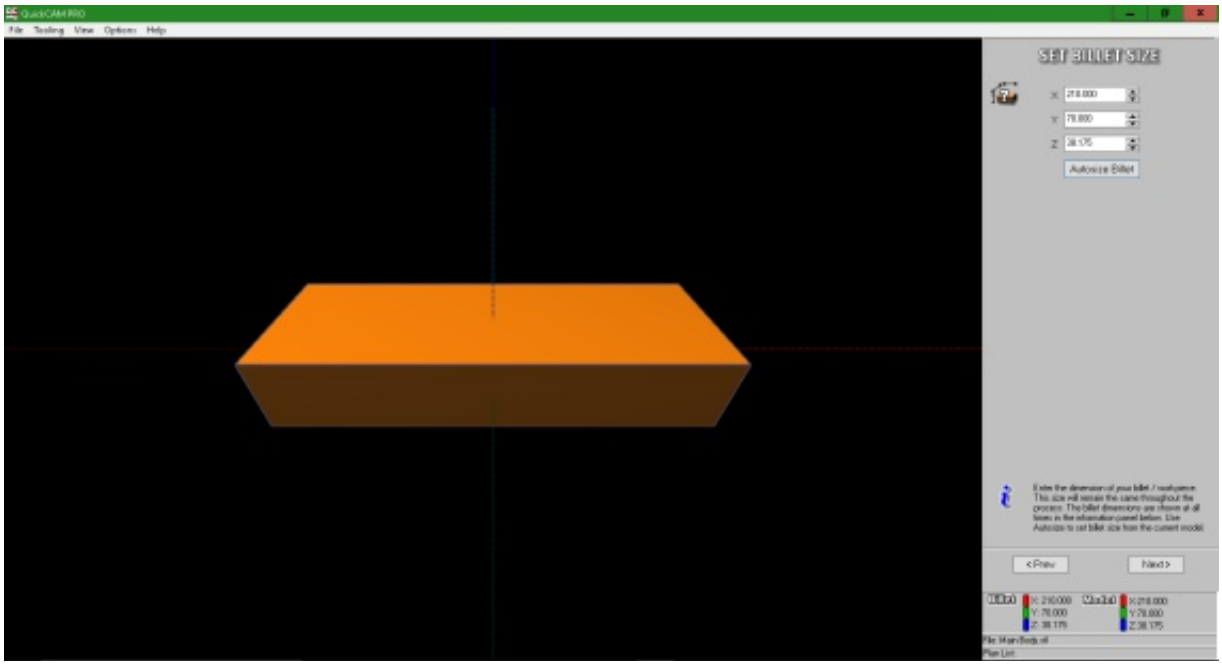
We will be machining the car from the left and the right hand sides, we could set the cut depth to the centre, but as we are using a ball-nose cutter this would leave a ridge down the centre of the model.
The cutter has a radius of 3.175mm so we must cut beyond the centreline by the tool radius.
For this tutorial set the cut depth to -38.175mm.

Enter a Z Cut Depth of -38.175

Click the "Next" button

Set Billet Size

This screen is where we set the size of the billet.



Whilst the Official F1 in Schools Model Block is 223mm x 50mm x 65mm, we can just use the "Autosize Billet" button here.

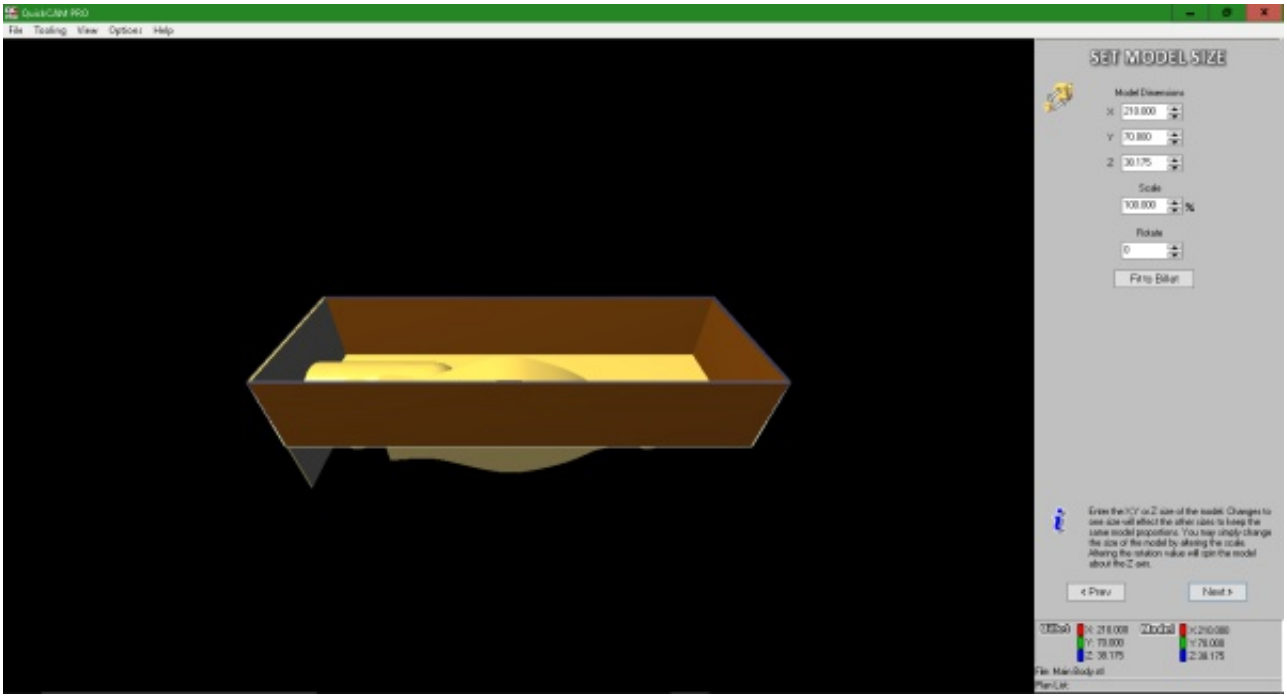
IMPORTANT : If your model is longer than 210mm do not proceed any further of you will cause damage to the machine and fixture.

Click the "Autosize Billet" button 

Click the "Next" button 

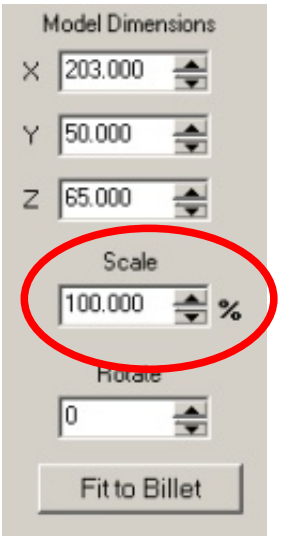
Set Model Size

This screen allows you to set the size of the model.



Having designed your model to a certain size you should cut it out the same size.

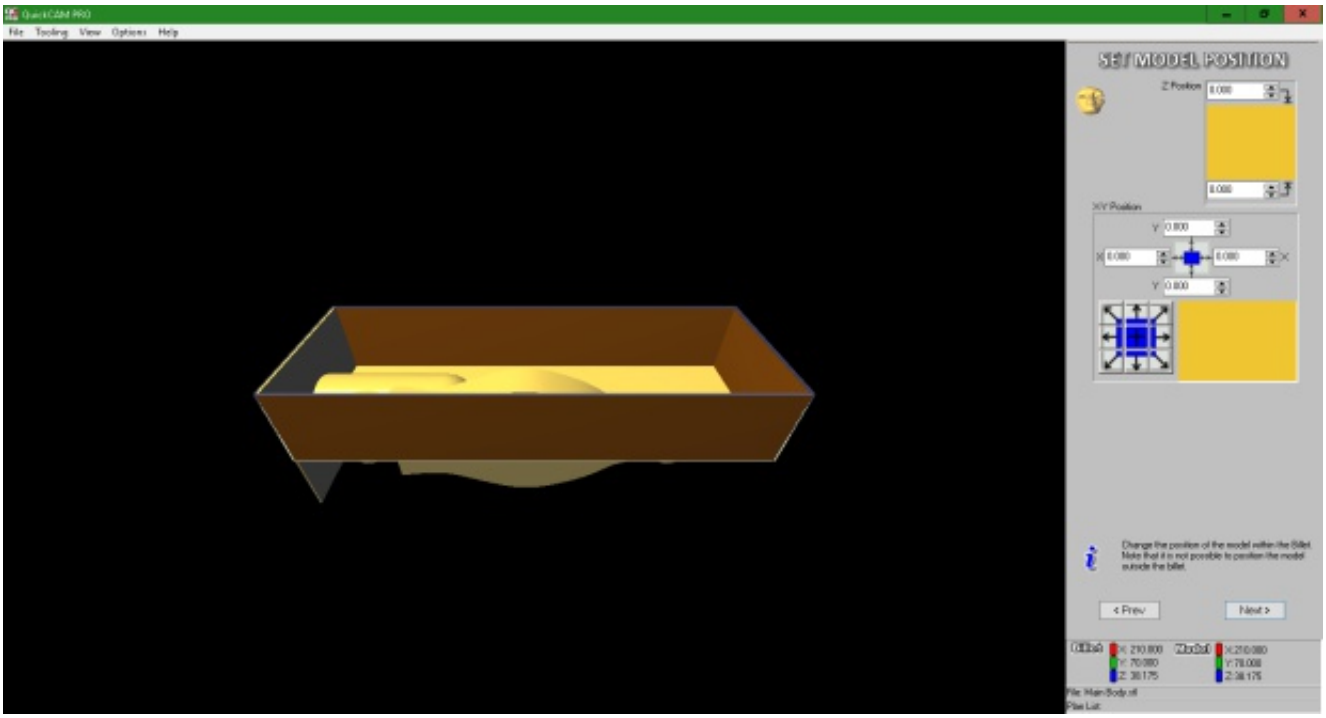
Check that the scale is set to 100%



Click the "Next" button 

Set Model Position

This screen is where you set the position of your model within the billet.

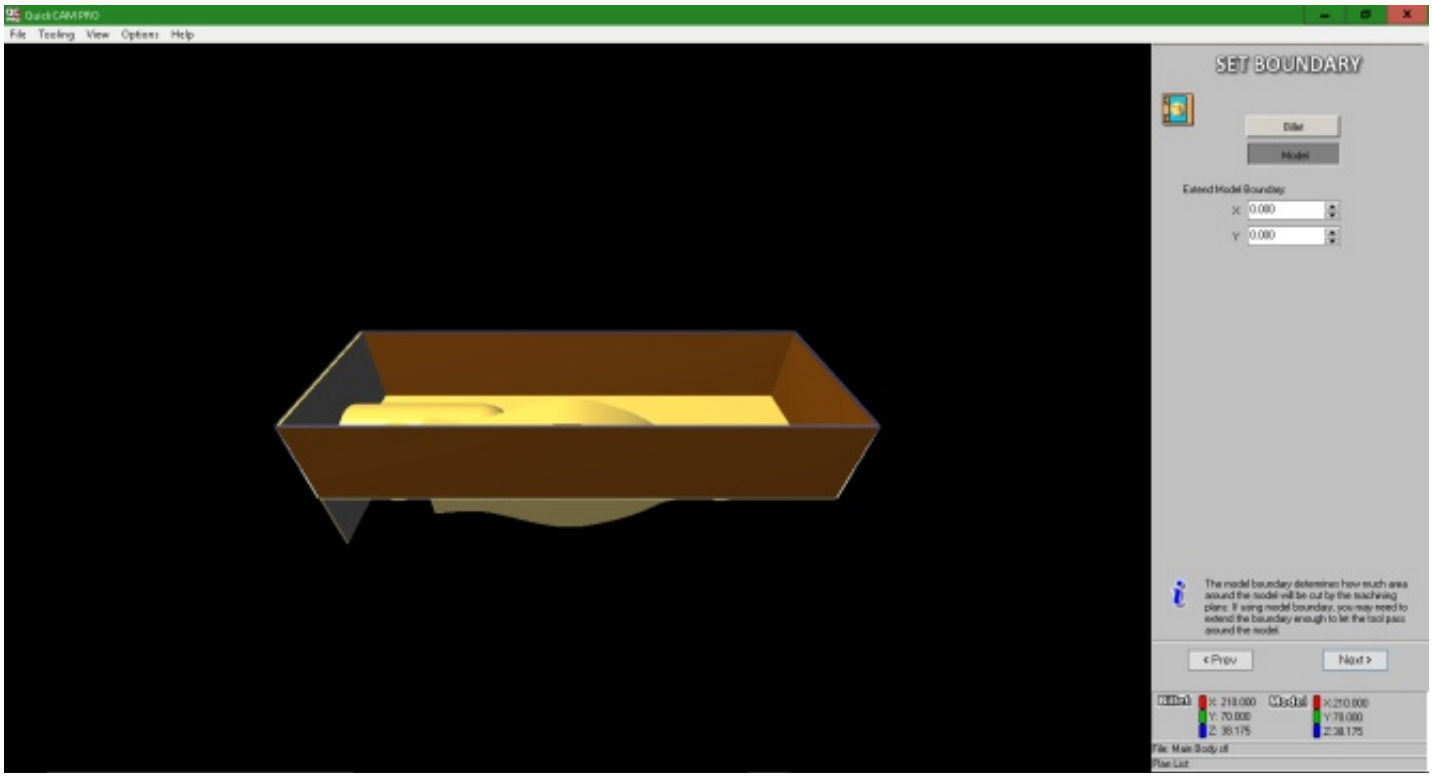


It is very important to get this correct as the cartridge hole is already in the billet and has an aluminium post inserted into it, getting the model position wrong may cause damage to the fixture and possibly break a tool.
Fortunately for us, the model and the billet are set to the same size.
We cannot change the position of the model in the billet.

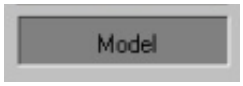
Click the "Next" button 

Set Boundary

This screen is where you can set the boundary.



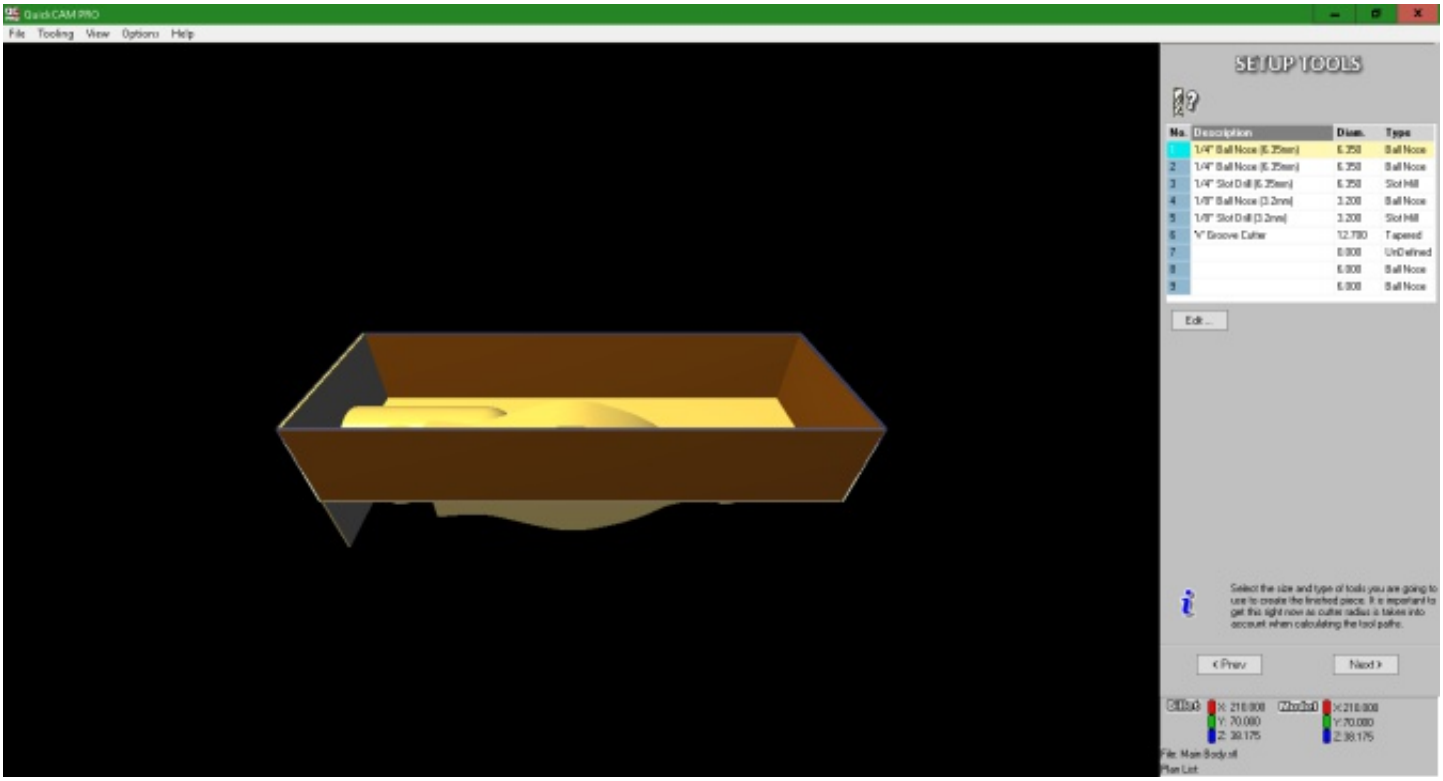
For this tutorial we do not change anything, just check that the "Model" button is selected

Click the "Model" button 

Click the "Next" button 

Setup Tools

Manufacture of the F1 in Schools cars is best done with the 1/4" (6.35mm) Long series Ball-nose cutter as it has a 40mm flute and will have about 50mm of length sticking out from the spindle nut. Using this cutter should prevent any clearance issues, the last thing you want to do is run the spindle nut into either your billet or the F1 fixture.
The screen below is where you set-up tools.

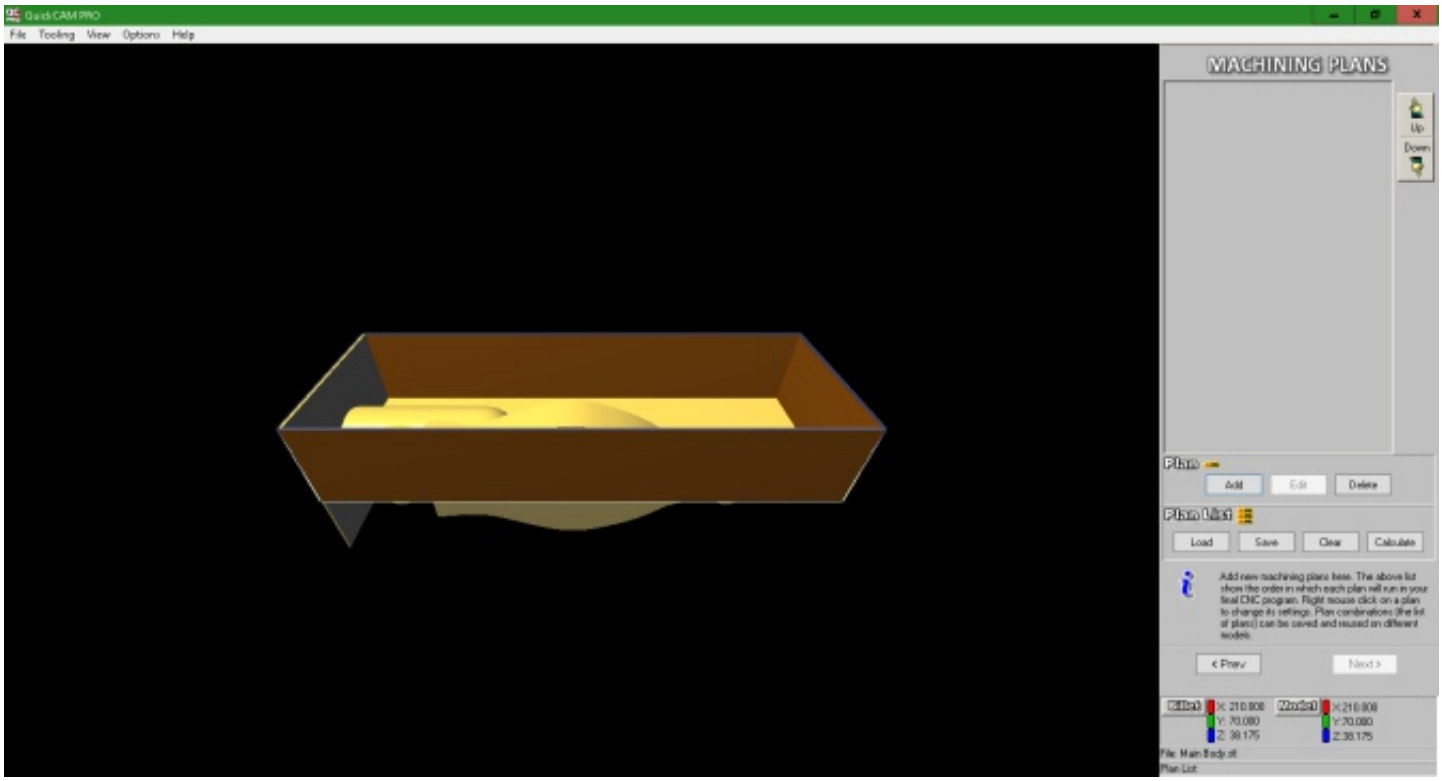


This screen takes the tooling information from VR Milling V5, as long as you have set the 1/4" Ball-nose in VR Milling V5 it should be showing here.

Click on the 1/4" (6.35mm) Ball-nose
The tool number should highlight in light blue
Click the "Next" button

Machining Plans

The screen below is where you create your machining plans, having already instructed QuickCAM Pro on the size of your billet and the position and orientation of your model within the billet.



Click the "Add" button 

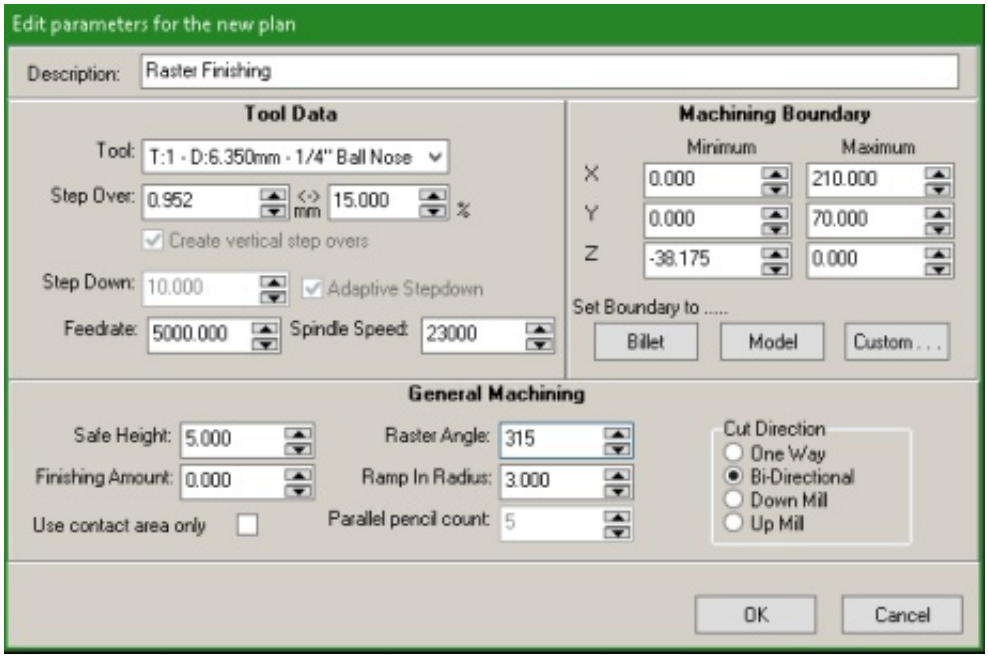
The window on the right will appear

Here you have a choice of 3 roughing plans, 6 finishing plans, and 3 fine finishing plans. For this tutorial we are going to use a Raster roughing and a Raster finishing plan.

Click the "Raster Finishing" button 

Raster Finishing

The window below will appear, this is where you set the parameters for Raster Finishing.



Enter the details shown below

Raster Finishing Parameters

Tool Data		
Tool	**1/4" Ballnose**	This should already be selected
Step Over	**15%**	This is a percentage of the tool diameter, it wants to be low to give a good finish. Between 20% and 5% is recommended, this is a trade off between quality and time.
Step Down	**N/A**	This will be greyed out as it is a finishing plan
Feedrate	**5000mm/s**	Feedrate for balsa is 5000mm/s
Spindle Speed	**23000rpm**	Spindle speed for balsa is 23000rpm
General Machining		
Safe Height	**5mm**	This is the height above the billet the cutter moves to when not cutting, 5mm should miss the fixture
Finishing Amount	**0mm**	This is the finishing plan so set this to 0mm
Raster Angle	**315**	You should raster accross the grain, 270 degree will start on the left where the cartridge hole is. As your model likely comes to a point it is not a good idea to start on the right as it may break away when machining the 2nd side
Ramp in Radius	**3**	CNC tools are designed to cut sideways and not straight down, to get to the desired cutting height the tool moves down in a spiral motion and this is the radius of that spiral
Parallel pencil count	**N/A**	This option is for fine finishing only and will be greyed out here
Cut Direction	**Bi-Directional**	When rastering from front to back this will cut in both directions
Machining Boundary		
Do not edit the Machining Boundary		

Click the "OK" button 

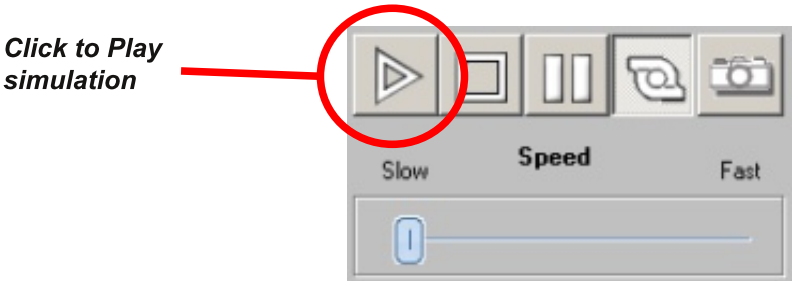
This may also take some time to calculate depending on the speed of your PC.

Once the calculation has completed.

Click the "Next" button 

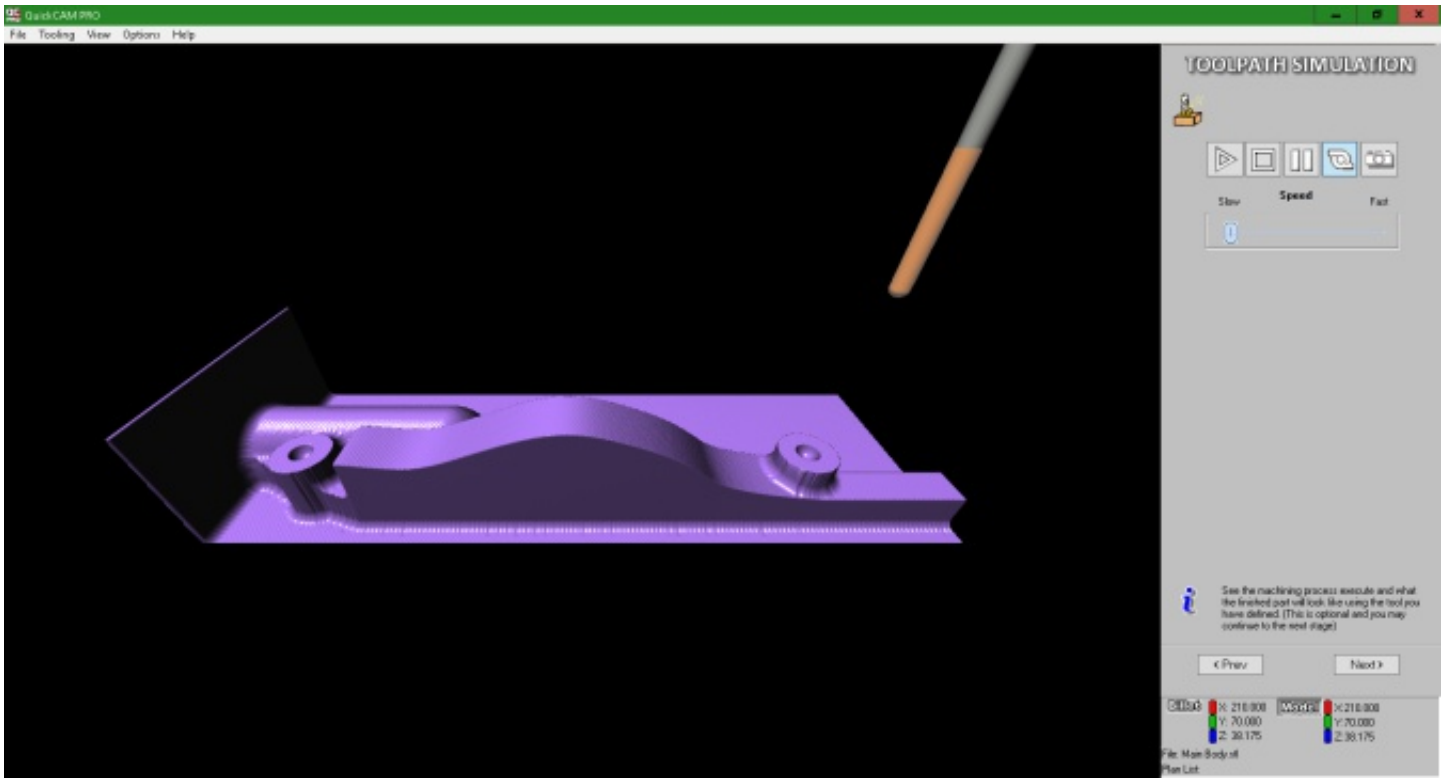
Toolpath Simulation

The Navigation panel on the right of your screen now has the video control buttons shown below



Click the "Play" button to run a simulation of your toolpath 

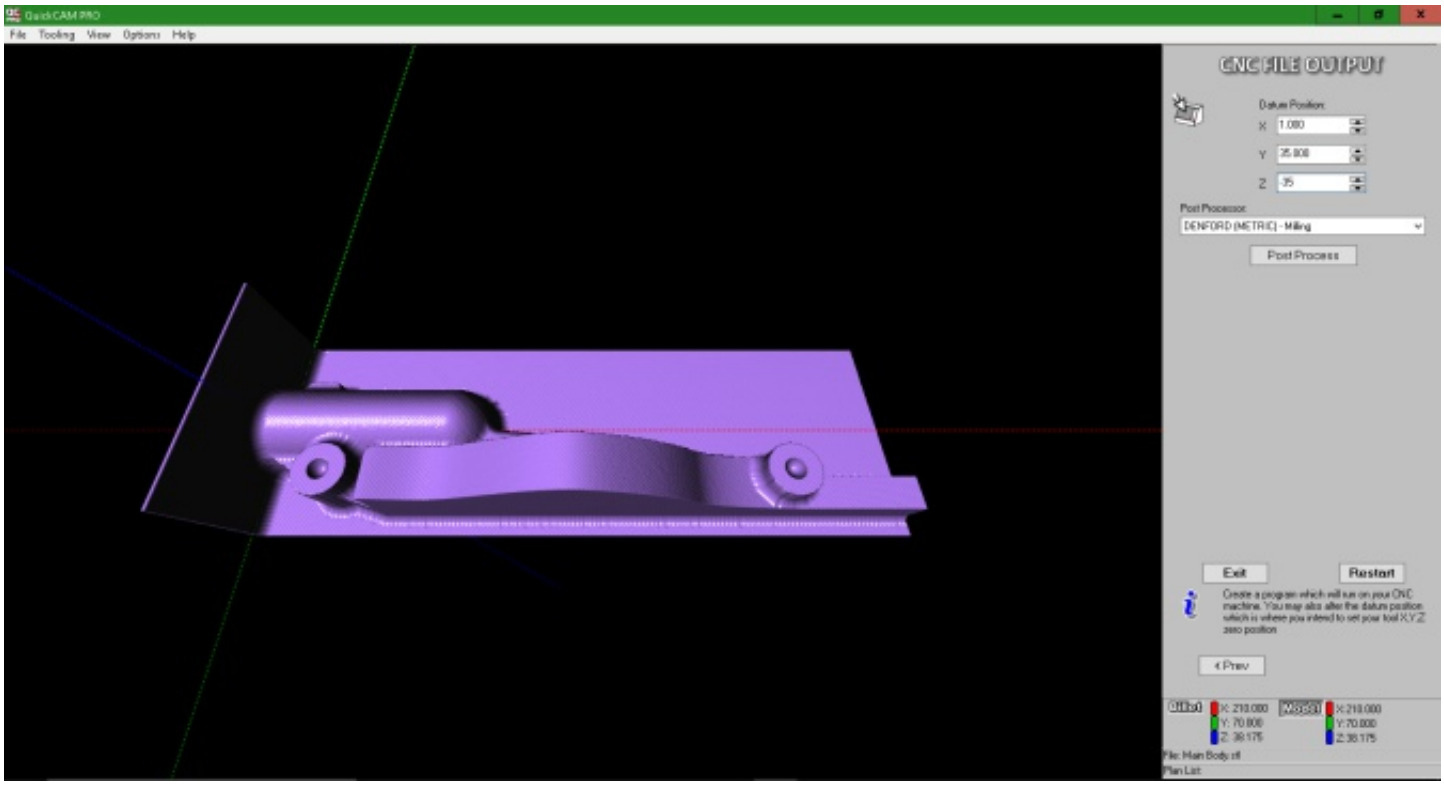
It should look something like the one image below.



Click the "Next" button 

CNC File Output

This is the final screen where we create the CNC file which is a .FNC file.



Setting the DATUM

For the F1 in Schools models we set the DATUM as the axis of rotation which is in this case the centre of the cartridge hole.

As the plate on the back of the model is centred around the cartridge hole and is 1 x 70 x 70mm it is easy to find the centre

Set the DATUM to the values below

X1

Y35

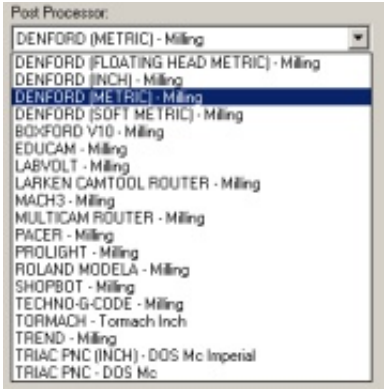
Z-35

Post Processor

QuickCAM Pro includes a number of Post Processors.

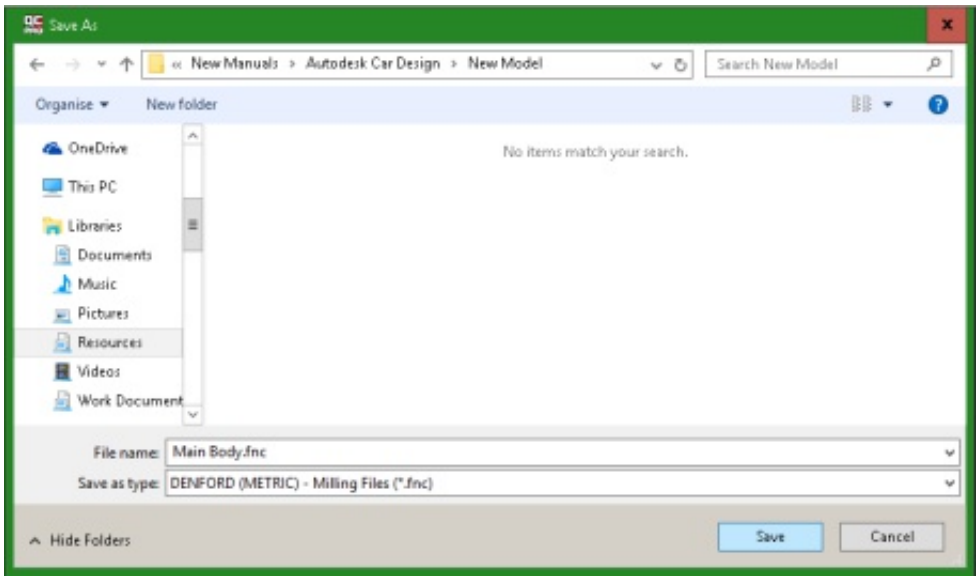
Select Denford (Metric) - Milling

Click the "Post Process" button



Saving the CNC File

A "Save As" dialogue box will have popped up.
As you will be machining your model from at least 2 sides it is a good idea to create a new folder with the name of your model, as you can see from the image below I have created a folder called "New Model".



Type a name for your program

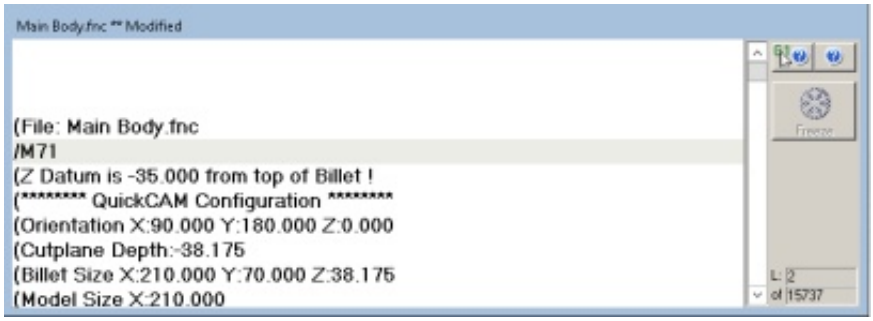
Click the "Save" button 

Wait while VR Milling V5 opens

Your CNC file is now showing in the editor window, we are going to make some changes.

Click on the start of line one and hit the "Enter" button to create a new line
Type "/M71"

M71 is a miscellaneous function which mirrors the Y axis.
The "/" instructs the machine to skip the rest of the line when "Block Skip" is turned on.

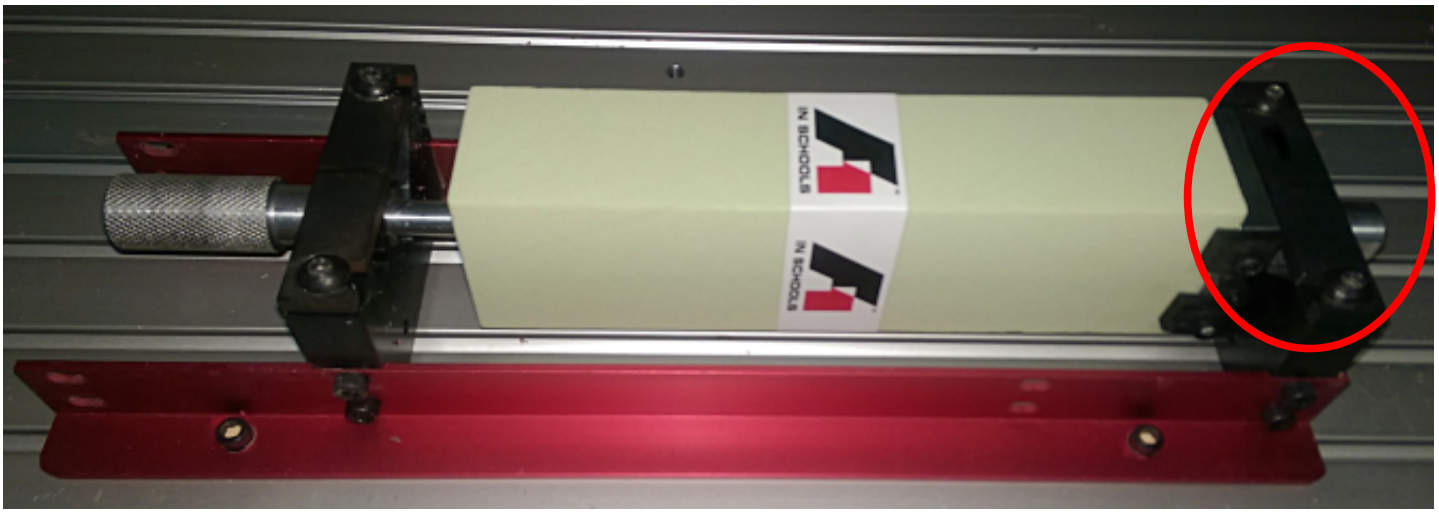


From the Toolbar select >File>Save

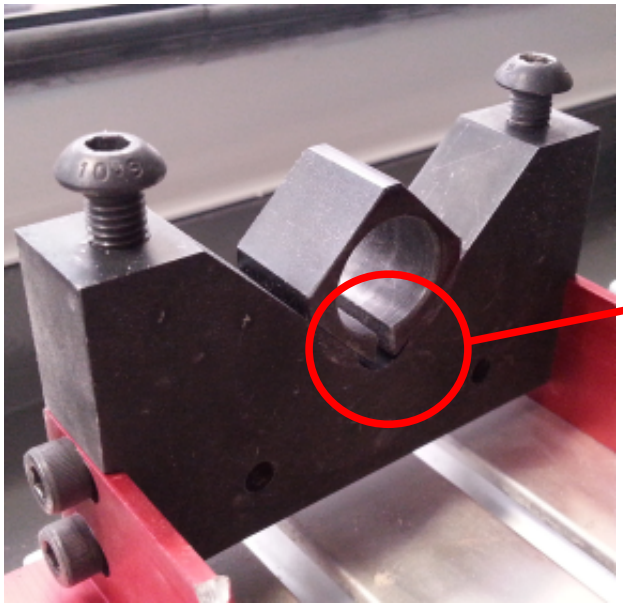
You have now created the CNC program for your model and are ready to start machining

F1 in Schools Car Manufacturing Fixture

The billet should be positioned in the machine as shown in the image below.
Note that the tether line guide slot is facing away from you, this is set up for theleft hand side to be machined



When tightening the bolts circled in the image above always tighten the right hand side before the left to prevent the billet from being twisted.
On the left hand side the bar which is inserted into the cartridge hole has an aluminium block around it with a cutout, ensure the cutout is to the bottom as shown in the image below.
Set the datum to the left hand side of the billet with Y and Z on the centreline of the aluminium bar as shown on the next page.

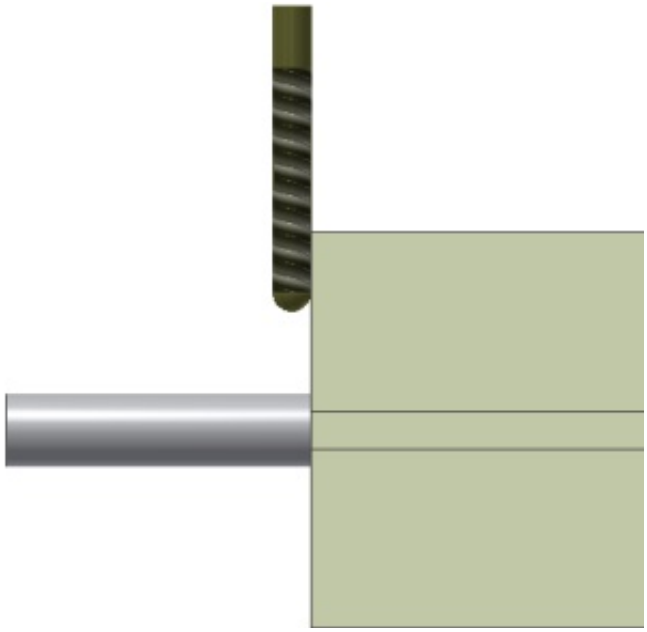


Ensure that this cutout is at the bottom. As the bolts are tightened onto the aluminium bar that goes over this bracket the cutout closes up and secures the aluminium post which is inserted into the cartridge hole.

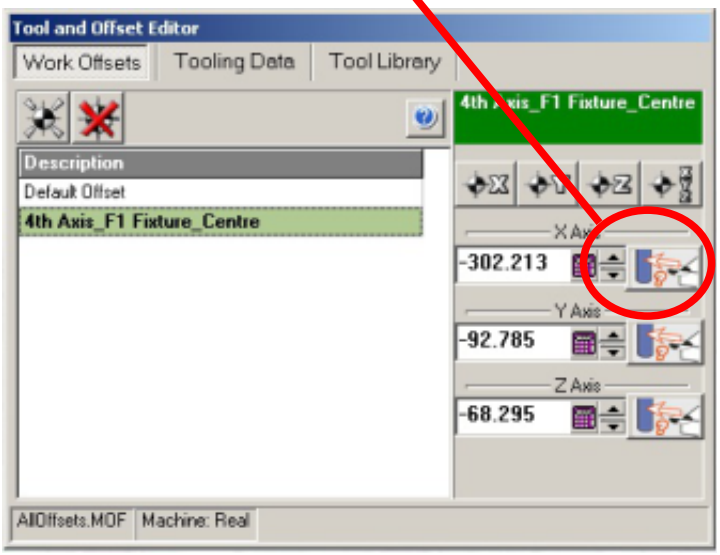
Setting the Machine Offsets

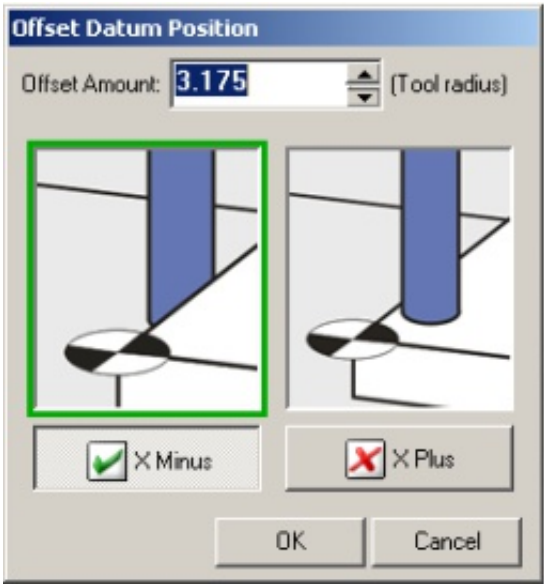
X Axis

Touch the tool onto the left hand side of the billet as shown in the image below



In the Tool and Offset Editor window select the "X axis datum offset" button





Type the value shown below into the offset amount

3.175

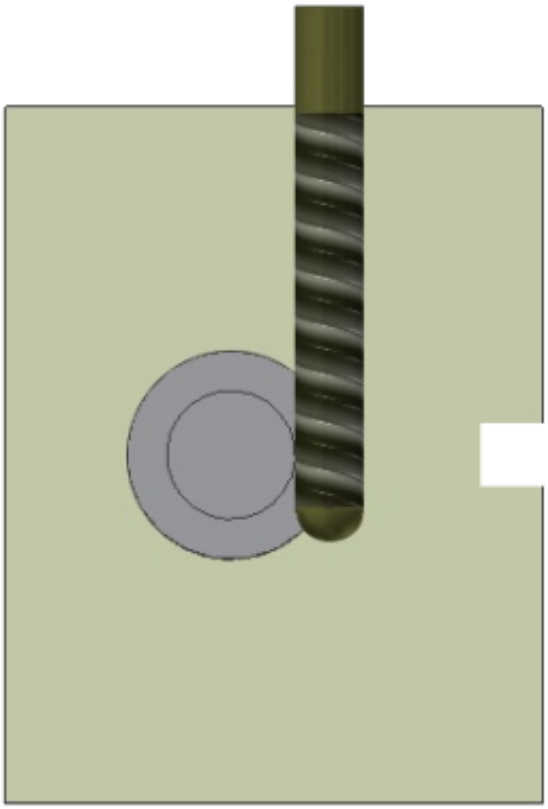
Click the "X Minus" button 

Click the "OK" button 

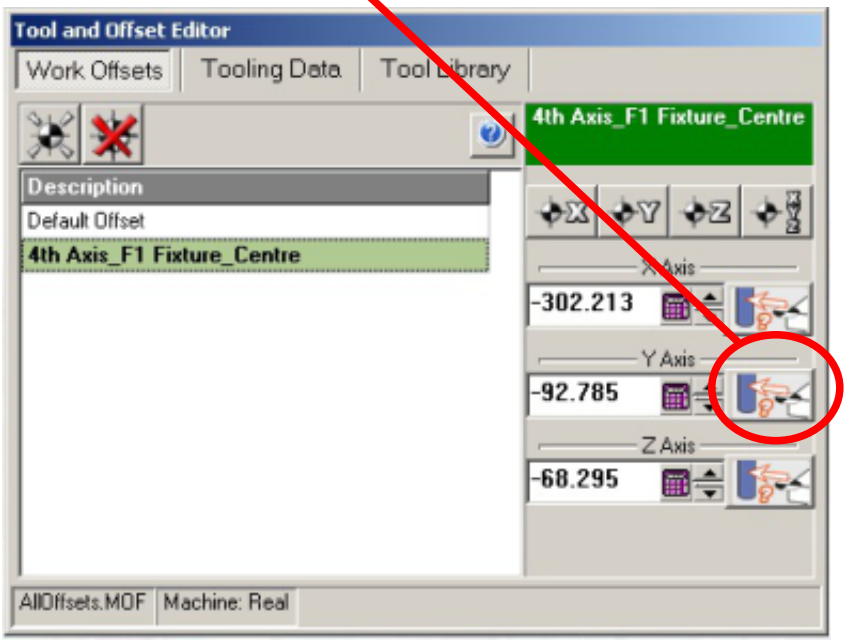
You have now set the X axis

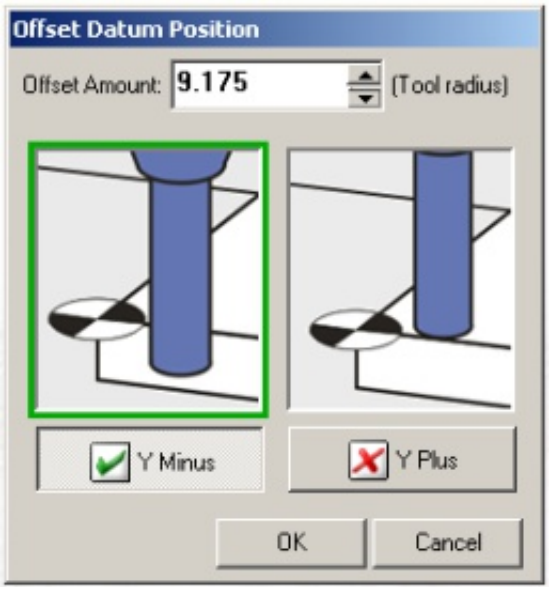
Y Axis

Touch the tool onto the front of the aluminium bar as shown in the image below



In the Tool and Offset Editor window select the "Y axis datum offset" button



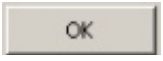


Type the value shown below into the offset amount.

9.175

This is the radius of the tool and the radius of the bar

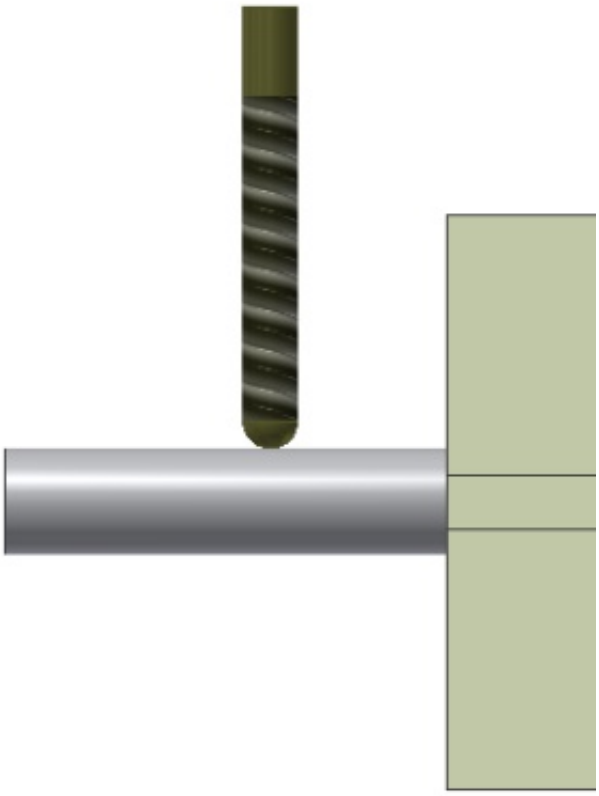
Click the "Y Minus" button 

Click the "OK" button 

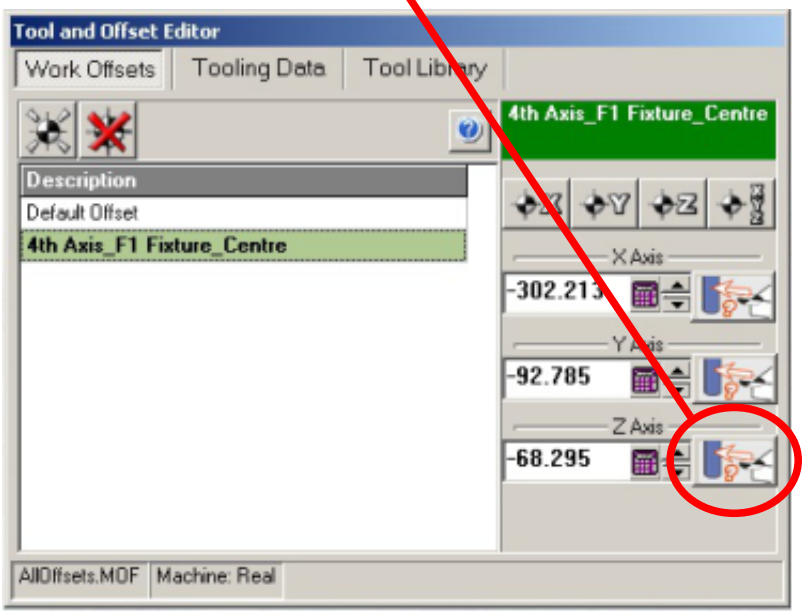
You have now set the Y axis

Z Axis

Touch the tool onto the top of the aluminium bar as shown in the image below.



In the Tool and Offset Editor window select the "Z axis datum offset" button

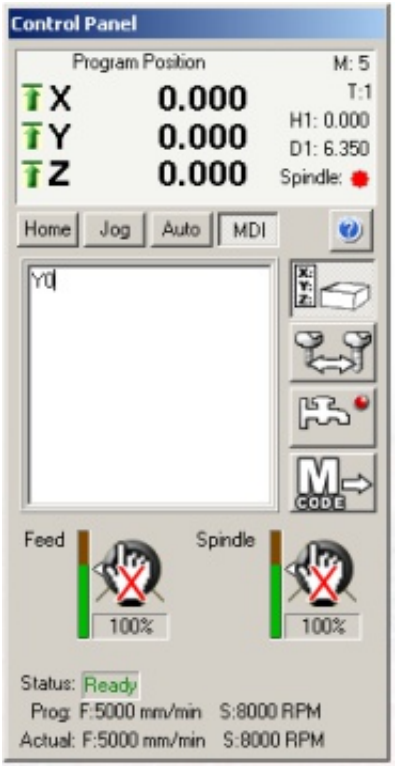


To do this the Y axis must be at 0

Go to the "MDI" tab in the Control Panel

Type "Y0"

Press the "Start" button

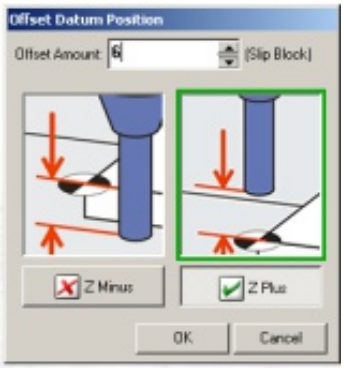


Go to the jog tab and lower the tool onto the top of the bar

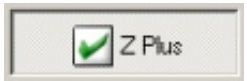
Type the value shown below into the offset amount.

6

This is the radius of the bar



Click the "Z Plus" button



Click the "OK" button

You have now set the Offsets for all 3 axis and are ready to machine your design.

Drilling Axle Holes

In the F1 in Schools Autodesk Inventor 2016 Design Guide there are instructions on how to create a program for drilling the axle holes.
Wouldn't it be easier though if we only had to run one program?
Follow the instructions below to add some lines of code to the program we have just created so that you do just have one program to run.

The text below is the program for drilling the axle holes.
If we are adding this code to the program we have just created in QuickCAM Pro we only need the lines highlighted in yellow.

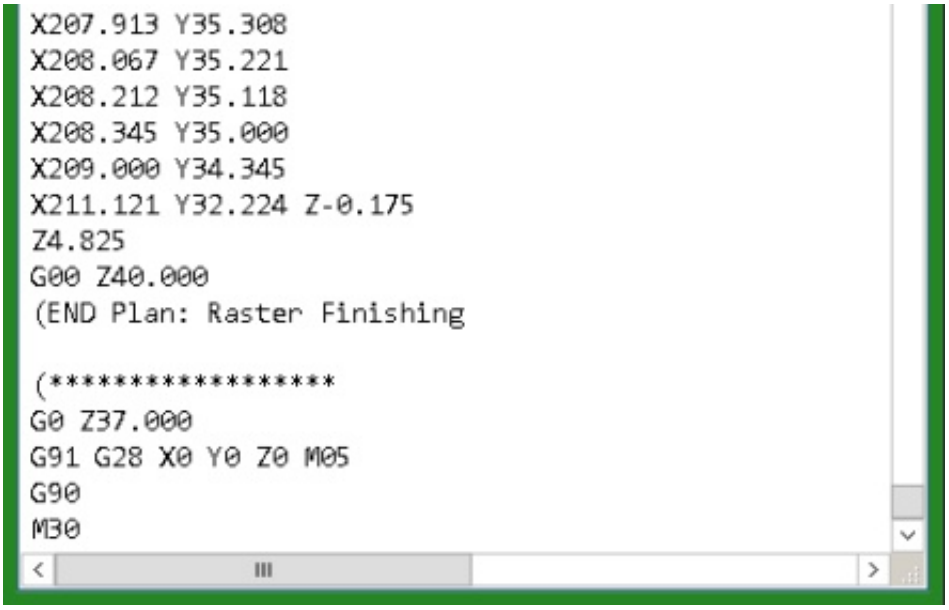
(Use a 6.35mm ball nose and make sure at least 35mm is protruding from the spindle nut
(Tool is number 1 in this instance
(Measure axle holes from the centre of the cartridge hole
G21
G90
G91 G28 X0 Y0 Z0 M05
M5
G90 M6 T0101
M03 S23000
(Rear Axle is 25mm from rear of car and -18.5mm from centre line of cartridge hole
G00 X25 Y-18.5
(Make sure Z is above the billet during rapid move
G00 Z35
(Drill to 2.5mm below centre line
G01 Z-2.5 F1250.0
G00 Z35
(Front axle is 167.5mm from the rear of the car and -18.5mm from the centre line of the cartridge hole, Y is already at -18.5mm from cartridge hole so we don't need to move it
G00 X167.5
G01 Z-2.5 F1250.0
G00 Z35
G0 Z35
G91 G28 X0 Y0 Z0 M05
G90
M30

In the folder where you saved the program for the main body of your design you will find the .fnc file

Open the .FNC file in a text editor (notepad)

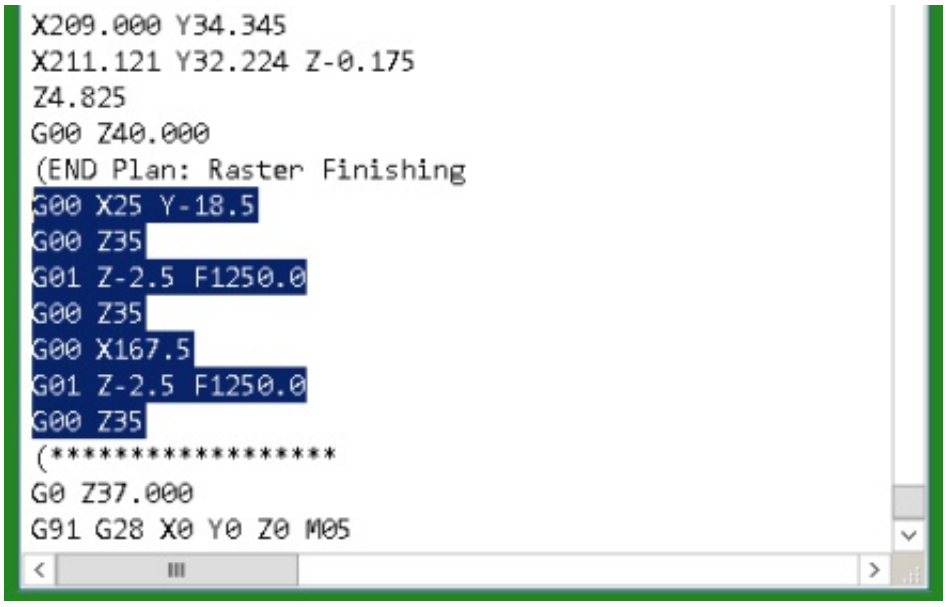
Move to the bottom of the text file

Create a new line after the "(END Plan: Raster Finishing" comment



Type the text which is highlighted on the previous page

Your X and Y values may differ from the ones shown, read the F1 in Schools Autodesk Inventor 2016 Design Guide for an explanation of these



Save the .FNC file

Running the Program

Make sure are in the VR Milling V5

Open the .fnc file that you created on page 19 of this guide.

On the Control Panel, ensure that you are in Auto mode 

Be sure that Turbo Mode is turned on 

Make sure that Material Overide is turned off 

Chek that the Feed Rate Overide on the front of the router is set to 100%

With the file control buttons select "Stop, Rewind, then Start"

Whilst you could just press "Start", the above method is safer as it will ensure that you do not start a program part way through which could cause damage to the fixture and the tool.

When the first side has finished turn the billet over

Click the "Block Skip" button 

This will disable the "M71" (Mirror in Y) command

With the file control buttons select "Stop, Rewind, then Start"
When the program has finished remove the finshed design

Congratulations, you have manufactured your first F1 in Schools Technology Challenge design.

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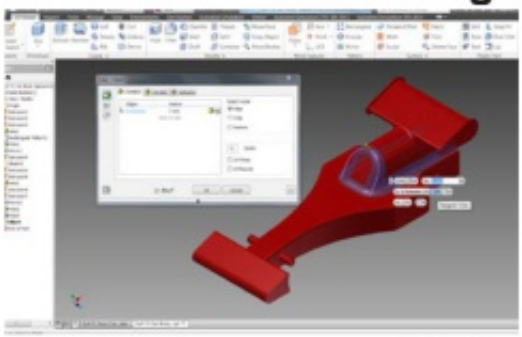
Plan

Design



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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!"

Denford's On-Line Technical Forum is a free of charge service that can be accessed 24 hours a day, 7 days a week.

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Denford's On-Line Technical Forum opens up the traditional communication channels that can restrict customer and technical support, due to availability of staff, teaching commitments or different time zones.

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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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