



CAD/CAM Projects

Passive Speaker Dock Project



CAD SUPPORT BOOKLET



Denford: Passive Speaker Dock Project - Denford CNC Router CAD Support Booklet

To draw this product in QuickCAM 2D, we will be designing in the following order. This is to ensure that all bodies will relate to each other, and will be fit for manufacture on the Denford CNC Router.

The process will be as follows:

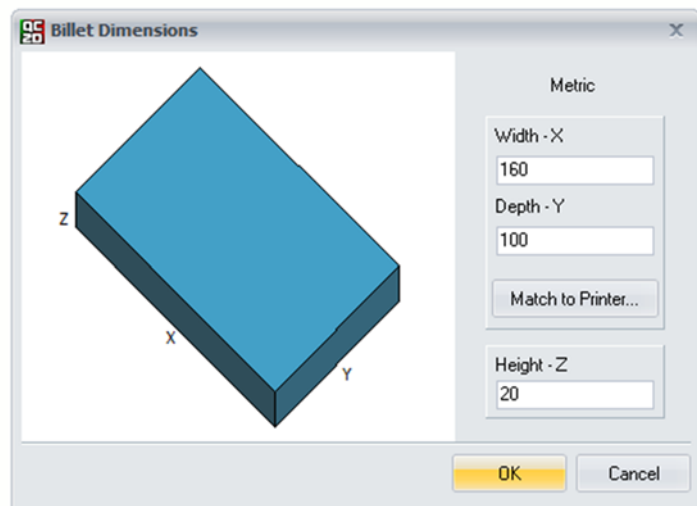
1. Creating the front end
2. Shaping the outside of your dock
3. Adding your speaker outlet
4. Creating the cut-out for holding the device
5. Working on the front face
6. Post-processing your design for manufacture

Creating the Front End

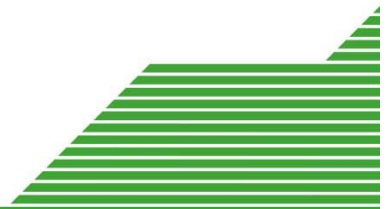
In QuickCAM 2D:

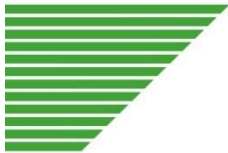
Start by making a billet size.
Size of maple block:

Width- 160mm
Depth- 100mm
Height- 20mm



Select to draw a rectangle and draw the rectangle anywhere on the sheet. The sizes will be changed at the next stage.





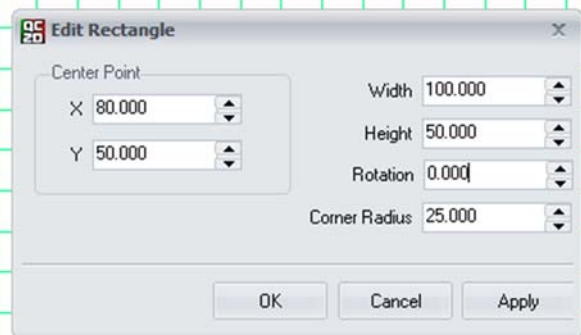
Creating the Front End

Click this button as this allows you to change the size of the rectangle.



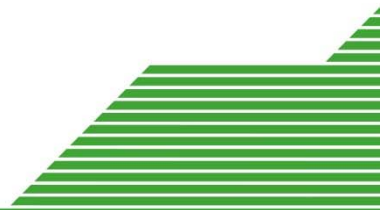
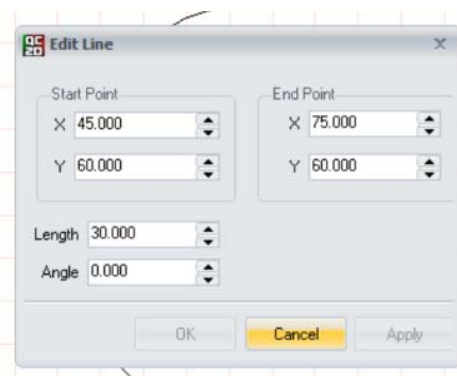
Once you have selected the arrow tool, double-click on the rectangle which you have drawn and input these values:

Centre point:
X= 80 Y=50
Width= 100 Height= 50
Rotation= 0 Corner Radius= 25



Now, using the line tool, draw 2 lines 30mm long.

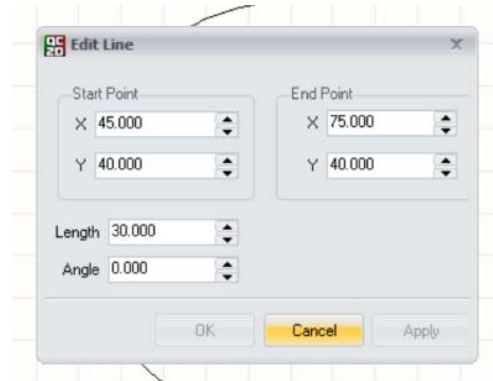
Then, using the arrow tool, again double-click on the first line and input these figures.



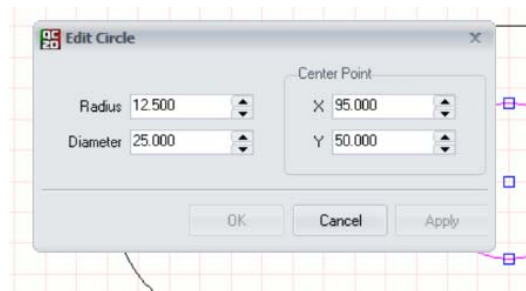


Creating the Front End

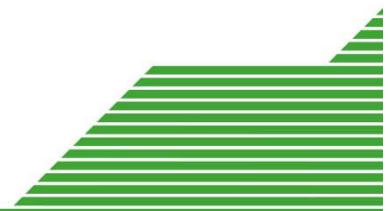
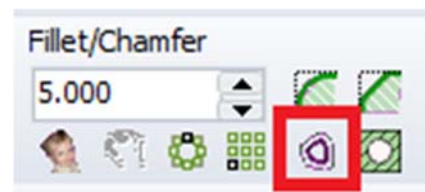
Using the arrow tool again double-click on the second line and input these figures.



After this, draw a circle to the right of the 2 lines and enter these figures.



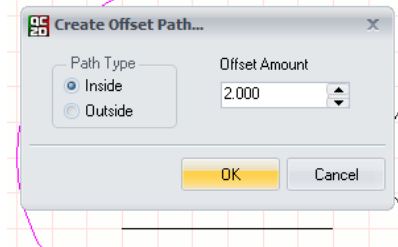
Using the arrow tool, select the rectangle which was drawn first, then select 'Create an offset path'.



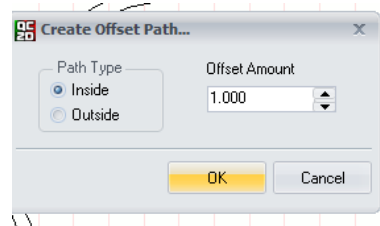


Creating the Front End

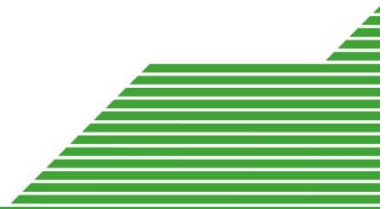
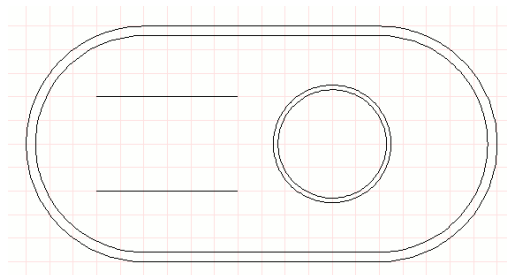
Then a box will appear and these figures need inputting for the model being created (your design could be different).



Repeat the last steps for the circle and create an offset path of 1 mm on the inside of the circle.



The end product for the first side of the speaker dock is complete.





VR Milling Tool Setup

In VR Milling:

Open up the Offsets and Tooling window.



Input the Denford Recommended tooling package Tool 1 to Tool 6.

No.	Description
1	1/4" Ballnose LS (6.35 mm)
2	1/4" Ballnose (6.35 mm)
3	1/4" Slot Drill (6.35 mm)
4	1/8" Ballnose (3.175 mm)
5	1/8" Slot Drill (3.175 mm)
6	V Cutter
7	
8	

Data for Tool 1

Tool 1
1/4" Ballnose LS (6.35 mm)

Diameter:

Tool offset:

Ball Nose

Length: Flute Length:

Data for Tool 2

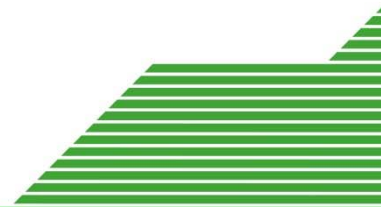
Tool 2
1/4" Ballnose (6.35 mm)

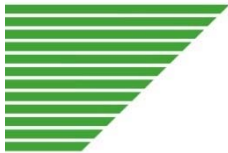
Diameter:

Tool offset:

Ball Nose

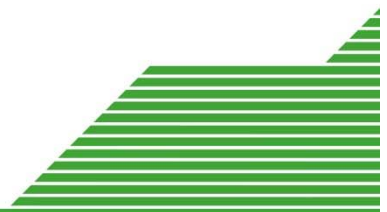
Length: Flute Length:

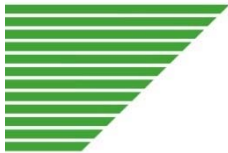




VR Milling Tool Setup

Data for Tool 3		<div><div>Tool 3 1/4" Slot Drill (6.35 mm)</div><div>Diameter: <input type="text" value="6.350"/></div><div>Tool offset: <input type="text" value="35.000"/></div><div>Slot Mill</div><div>Length <input type="text" value="50.000"/> Flute Length <input type="text" value="40.000"/></div></div>	
Data for Tool 4		<div><div>Tool 4 1/8" Ballnose (3.175 mm)</div><div>Diameter: <input type="text" value="3.175"/></div><div>Tool offset: <input type="text" value="30.000"/></div><div>Ball Nose</div><div>Length <input type="text" value="50.000"/> Flute Length <input type="text" value="40.000"/></div></div>	
Data for Tool 5		<div><div>Tool 5 1/8" Slot Drill (3.175 mm)</div><div>Diameter: <input type="text" value="3.175"/></div><div>Tool offset: <input type="text" value="30.000"/></div><div>Slot Mill</div><div>Length <input type="text" value="50.000"/> Flute Length <input type="text" value="40.000"/></div></div>	
Data for Tool 6		<div><div>Tool 6 V Cutter</div><div>Diameter: <input type="text" value="12.700"/></div><div>Tool offset: <input type="text" value="25.000"/></div><div>VCutter</div><div>Length <input type="text" value="50.000"/> Flute Length <input type="text" value="40.000"/></div><div>Angle <input type="text" value="60.000"/></div></div>	





Front Side CAM

Before we proceed, save your design.

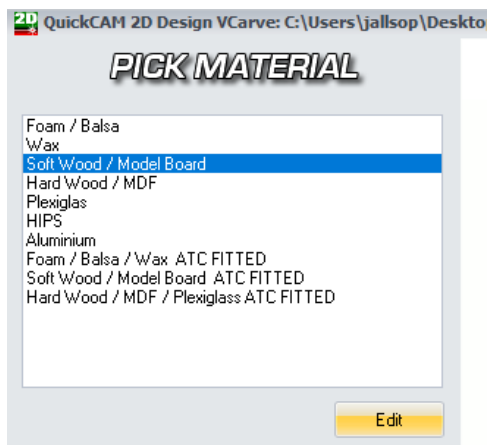
Now we are going to start the CAM side for the first side of the speaker and to do this you need to click on the CAM Wizard.



This will then take you into the CAM side of the software to create a program to machine the speaker.

A materials list page will be the first screen that pops up, once the CAM Wizard has been opened.

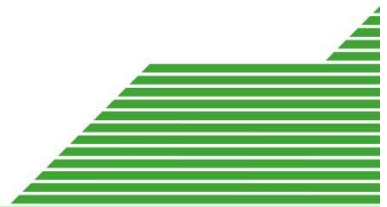
Select soft wood and then click on the edit button at the bottom of this bar.



This then opens up a window, which allows you to edit the speeds and feeds for the different materials.

The speeds and feeds are ok in this section. All that needs changing is the step down % which needs to be set at 30% to reduce the depth of cut. Once the step down has been altered, you can press 'OK' and then click the 'next' button at the bottom of the bar.

Material Name	Feed Rate	Spindle Speed	Step down (% of tool diam)
Foam / Balsa	5000.000	23000	300
Wax	1500.000	23000	150
Soft Wood / Model Board	2000.000	23000	30
Hard Wood / MDF	1000.000	23000	100
Plexiglas	800.000	23000	75
HIPS	1500.000	23000	150
Aluminium	400.000	18000	30
Foam / Balsa / Wax ATC FITTED	3000.000	23000	100
Soft Wood / Model Board ATC FITTED	1200.000	23000	60
Hard Wood / MDF / Plexiglass ATC FITTED	800.000	18000	50

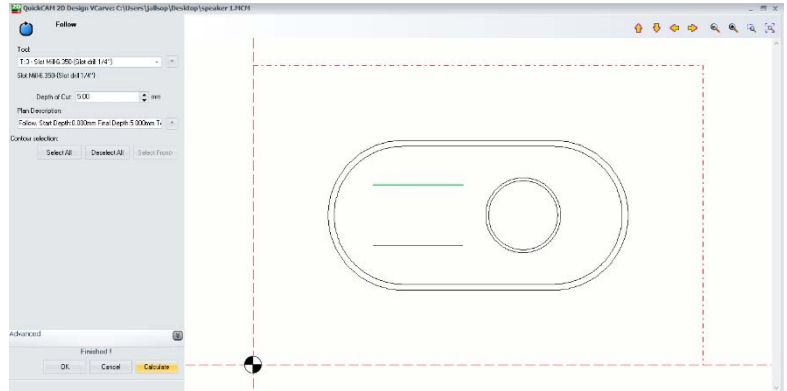




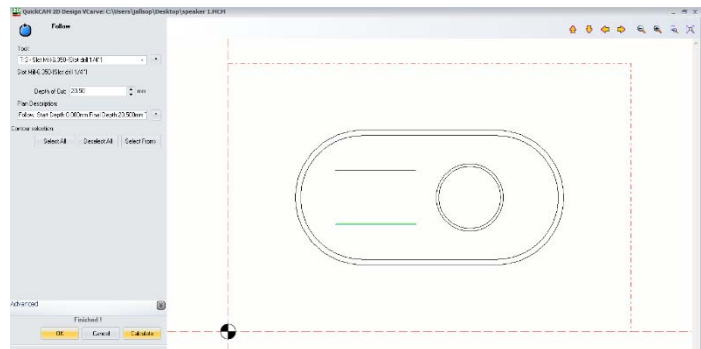
Front Side CAM

To start off we are going to use the 'Follow' option on the 'Machining Plan' window.

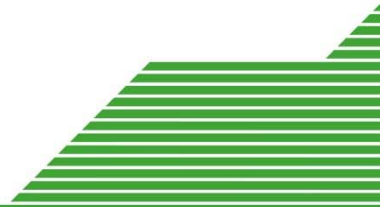
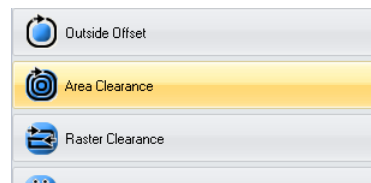
Once you have clicked 'Follow' your screen should look like the one opposite. You then need to select the part of your design which you intend the cutter to follow. In this case it is the top 30mm line. Once it is selected it will turn green. Then select the tool, which you wish to machine with. We have used tool 3, which is a 6.35mm Slot Drill (1/4"). Alter the depth of cut to suit your design. For this design we have changed it to 5mm, as this slot is just for show. Then click 'Calculate' and the line should turn blue.



The process will be copied for the second 30mm line. The only difference being that this slot will be all the way through, so the depth of cut needs to be changed to 20.5mm, to ensure that the cutter breaks through the material.



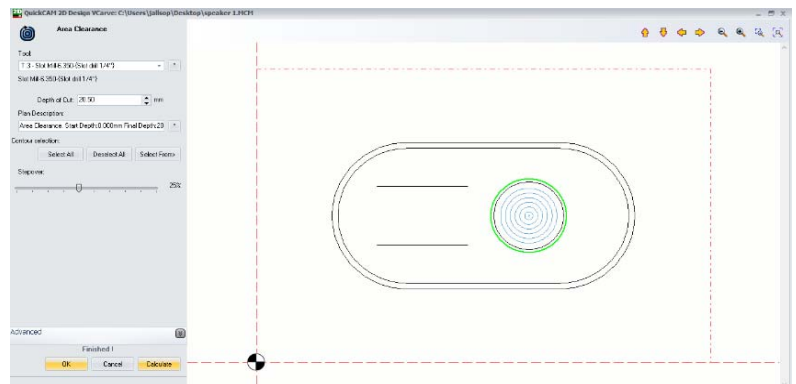
Now these lines are complete. The next step is to remove the material from the outer circle. This is done as an 'Area Clearance'.



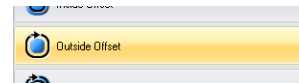


Front Side CAM

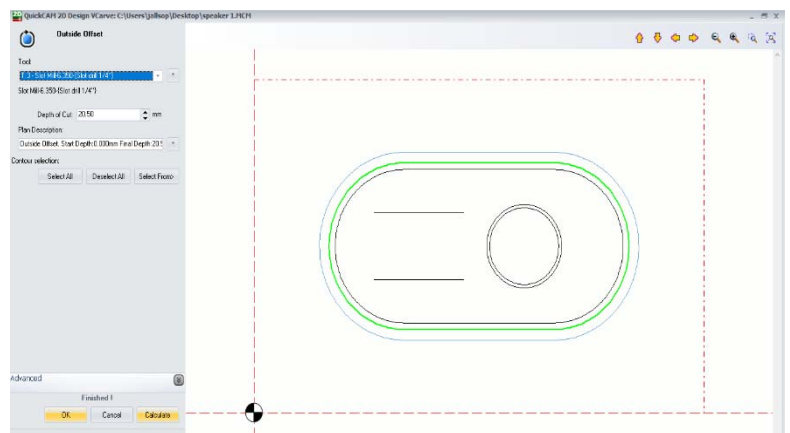
Using tool 3 again, with the depth at 20.50mm, as we are cutting through the material again, select the outer circle which will then turn it green and alter the step over to 25%. Click 'Calculate' and this will then put a blue cutter path on the inside of the circle. Click 'OK'.



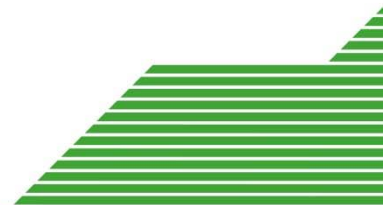
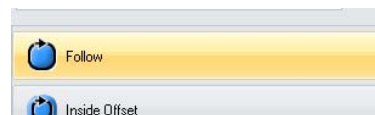
For our next Machining Plan, we will use the Outside Offset path.



Select the outer side of the rectangle produced, using tool 3 and change the depth of cut to 20.50mm. Then click 'Calculate' and a blue line should appear offset from the green line, half of the cutter diameter. Then click 'OK'.



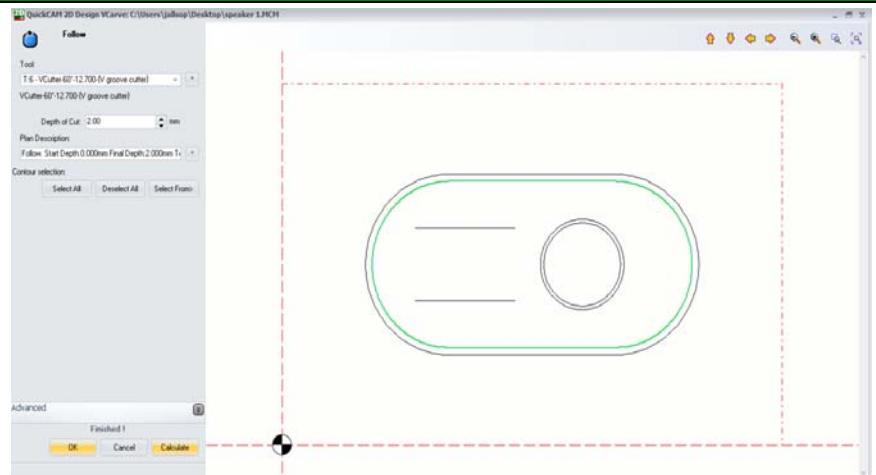
Our next Plan will be to 'Follow' again.



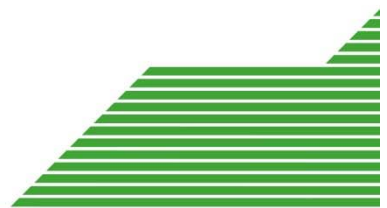
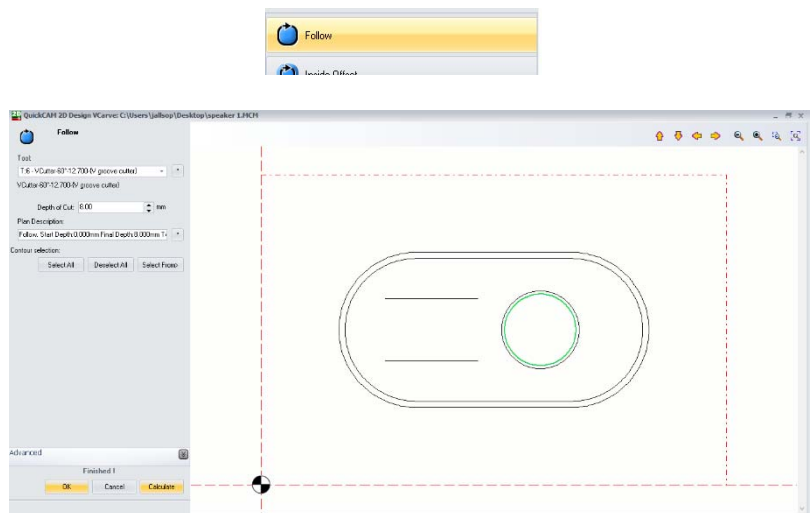


Front Side CAM

This time we are going to follow the inside line of the rectangle. We have changed the tool to tool 6, which is a V-Cutter-60 12.70mm. Also, the depth of cut needs changing to 2mm, as this is only for effect.



The last path we are going to take is to chamfer the inside of the circle. To do this we use the follow 'Machining Plan again'.

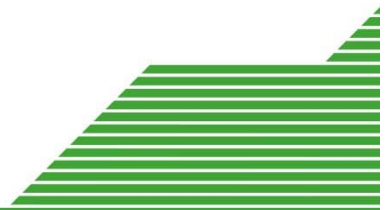
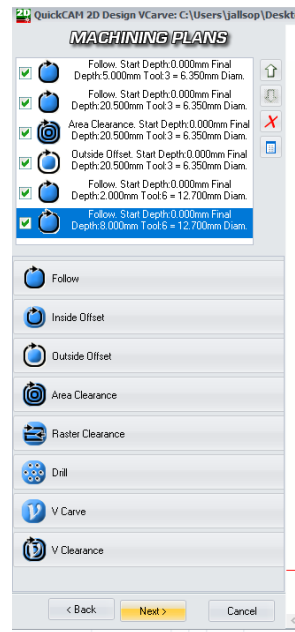




Front Side CAM

This time we are using tool 6 again, but the depth of cut is being changed to 8mm to suit the chamfer size we require on our design (yours could be different). Once complete, click 'Calculate' and it will turn blue again and then click 'OK'.

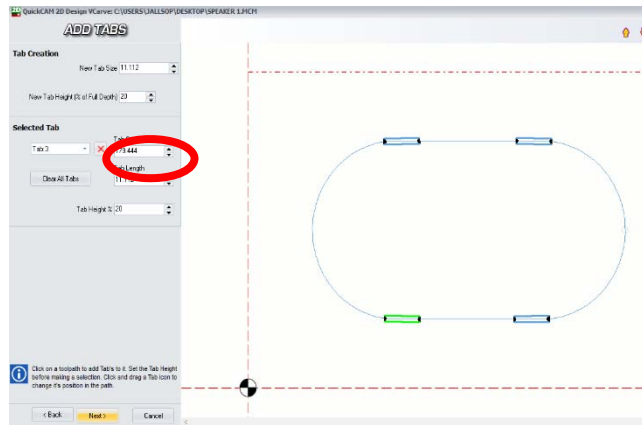
Now all the Machining Plans are complete and they look like the image to the right, we can click the 'Next' button at the bottom.



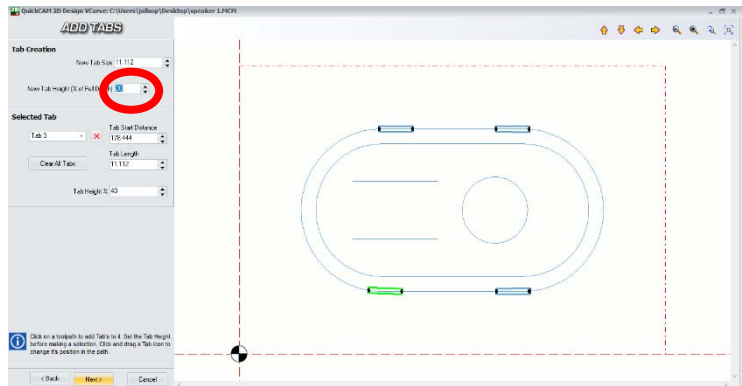


Creating the cut out for holding the Device

Once we have clicked 'Next' a screen will appear asking if we would like any tabs adding to the design. We would, otherwise the design would fall straight through and would damage the end product and the cutters.

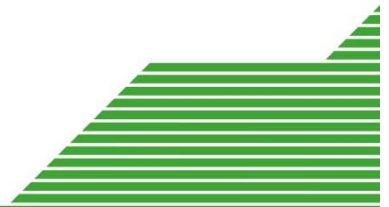
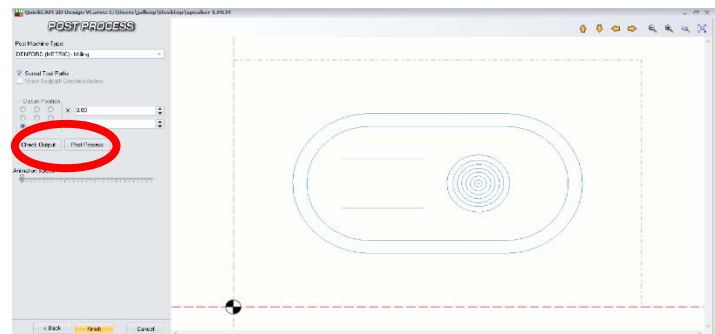


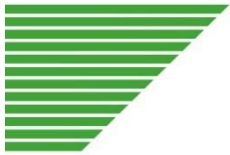
So, to add tabs just click on the outside line in 4 places like the image on the right. Then on the left-hand side change the 'Tab Height' to 20. And then click 'Next'.



Once 'Next' has been clicked this image should be the next screen, which allows for us to check the cutter paths. If you click 'Check Output' it will show the program from start to finish.

Once you are happy with this it is complete, and you can click 'Post Process'. It will ask you to save the program, so save it somewhere you will remember.

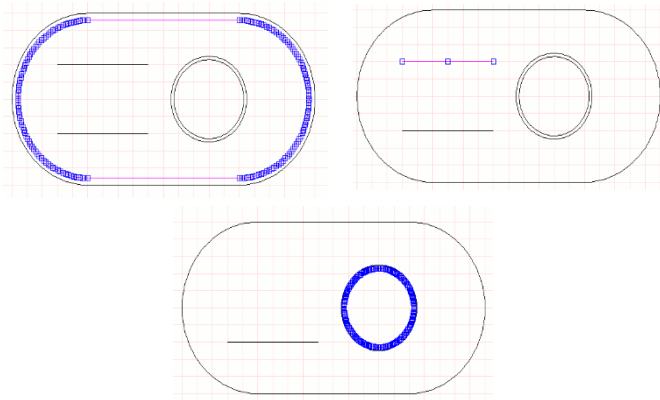




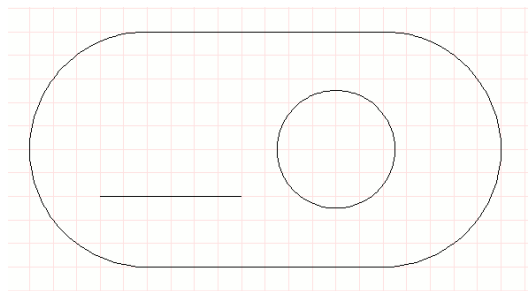
Back End

The starting point for the second side would be to re-open the first side and re-save it as "speaker2". This way we know the slots and holes will be in the exact same position as previously.

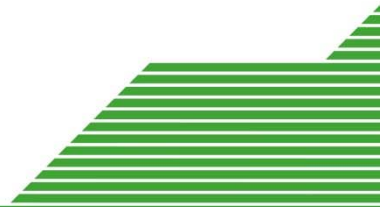
Now we start by deleting some of the bits we don't need from the first end, by using the 'Arrow' tool and selecting the parts that need deleting. For my design I have deleted the inner rectangle, the inner circle and the top 30mm line.



This is what I am left with after all the parts I didn't need were deleted.



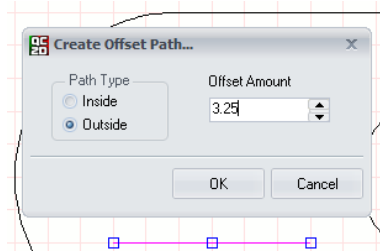
Now we are going to make some alterations. Firstly, we are going to select the line and click 'Create an offset path'.



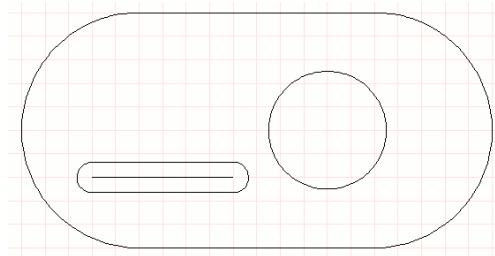


Back End

Then, when the box appears, click outside and change the offset amount by 3.25mm. This is so that it can slot together with the first end to make the 2 halves one complete item.



My design now looks like this. The next step is to delete the inside line which has been used to create the offset path.

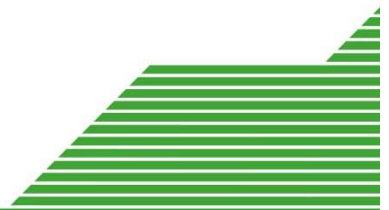
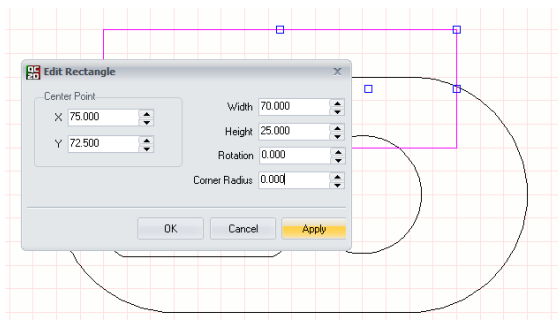


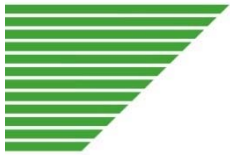
Once the line has been deleted, the next step is to draw a rectangle to overlap the design. This is for the phone to sit in (so the width of the rectangle will vary depending on the size of the phone). This is designed around an iPhone.

Edit the rectangle so it is centralised with the design in 'X'

So, the centre point in X= 75.00

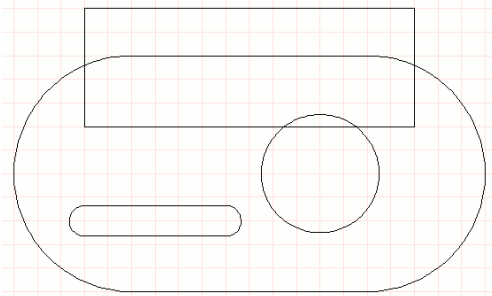
The width of the rectangle is 70.00mm (measure your device).



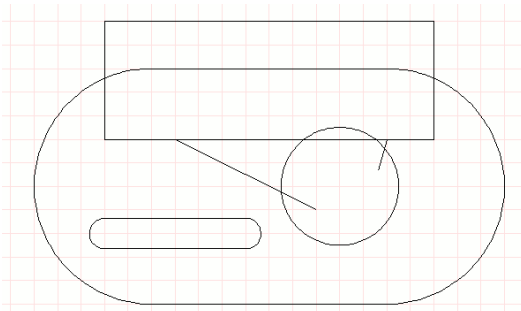


Back End

Your design should look something like this one.

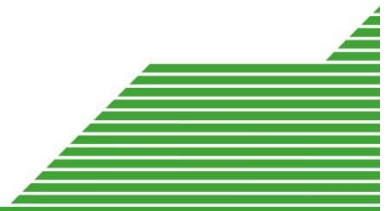
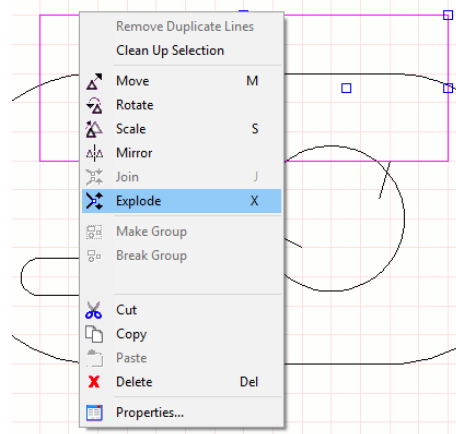


The next step is to draw 2 lines to link the hole to where the phone sits for the music to be heard.
Lines something like this:



The next step would be to trim the lines that aren't required, but for us to do that we need to 'Explode' the rectangle.

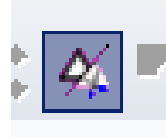
This is done by using the 'Arrow' tool, selecting the rectangle and then right clicking. Then drop down to where it says 'Explode' and left click on that.
This process may need repeating, The way of checking it is whether you can select individual lines rather than a full rectangle.



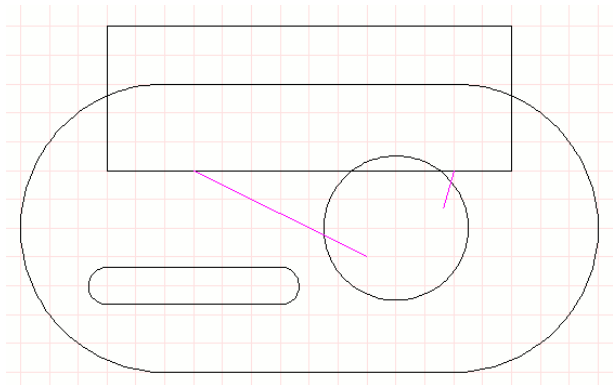


Back End

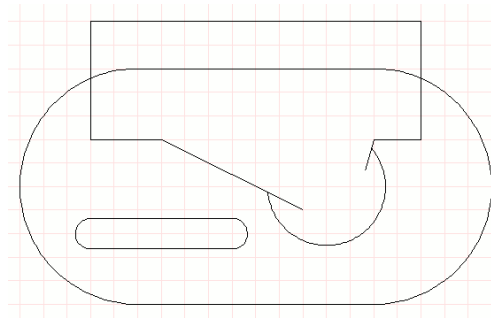
Now, to Trim the unnecessary lines, click the Trim button.



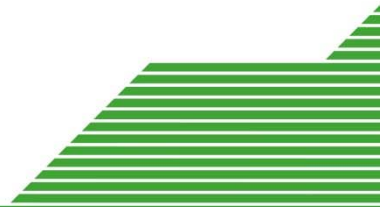
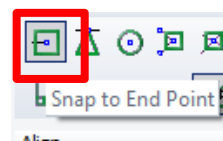
The first step of trimming is selecting the line which you DON'T want to trim, which in our case is the 2 lines. Then right click, and then select the lines which you wish to trim, mine being the top bit of the circle and the bottom line of the rectangle (the parts in the middle of the two selected lines).



Once that has been done, it should look something like this.



Now the next step is to join the 2 lines to the circle. To do this click the 'Snap to end point' tool.

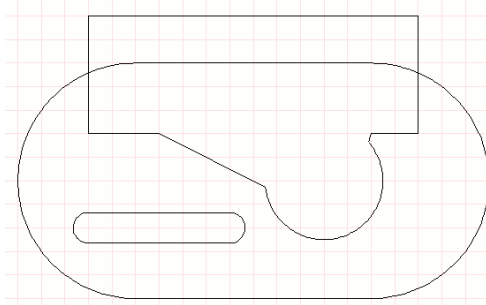




Back End

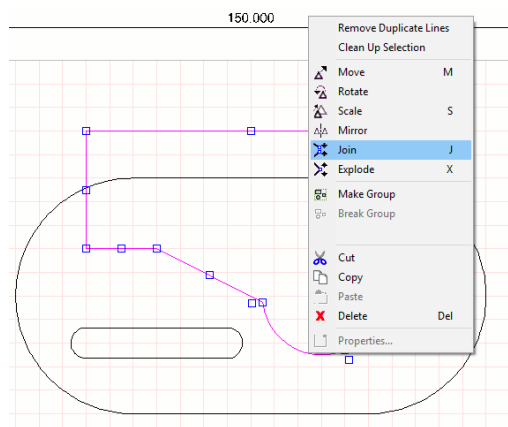
The line is then moved by selecting the line and dragging the end point to meet up with the end point of what was the circle. This should be repeated for both lines.

It should look something like this design.

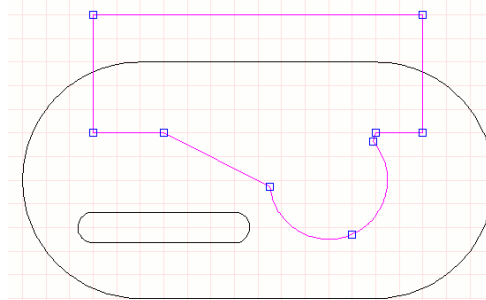


Now all the new shapes need to be joined so that the part can be machined all together. To do this click on the first line and then by using the 'Shift' button on the key pad select all the other lines required.

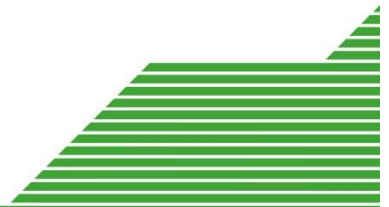
Then right click on the mouse and click join.



This is checked by then selecting the shape and the whole of the shape should be highlighted pink, just like the image on the right.



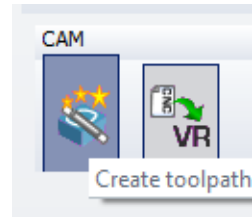
The design is now complete and needs to be saved before commencing with the CAM.



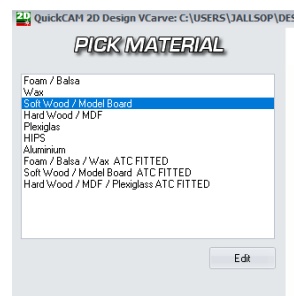


Back End CAM

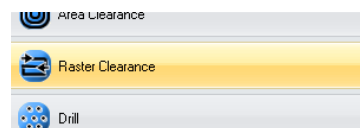
Once again, after your design has been saved, click the CAM Wizard at the bottom of the page, to create your CNC Machining Program.



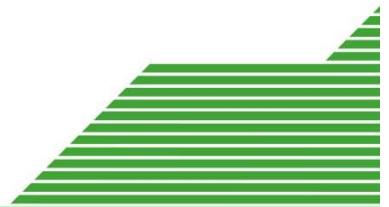
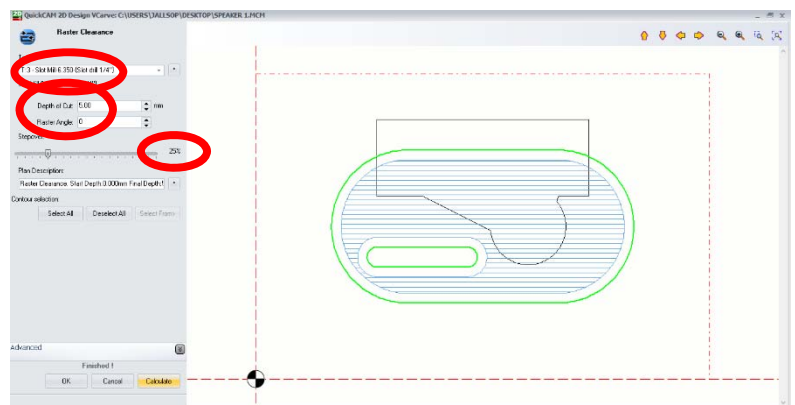
Once again, select soft wood. Click on edit and just double-check that the 30% step down is still in from machining the first end.



The first process of the Machining Plan would be a Raster Clearance.



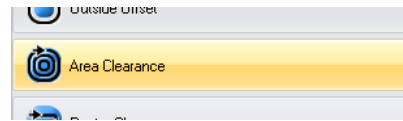
When programming the Raster Clearance, we once again use tool 3, with a depth of cut of 5mm and move the stepover up to 25%. Once these alterations have been made, click on the outer line and then the line of the slot. Click 'Calculate' and the blue cutter path should appear like the image on the right.





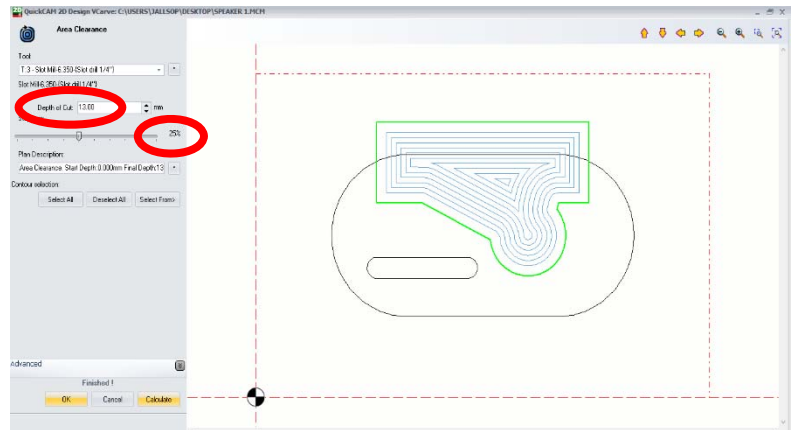
Back End CAM

The next step for our plan is to use the Area Clearance cutting path.

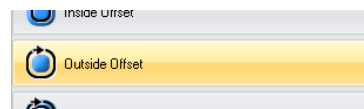


Once again, using tool 3, the depth of cut is 13.00mm. This will change depending on the thickness of the phone. We are basing ours around an iPhone, so this is 5mm to get down to the depth of the raster and then 8mm for the thickness of the phone. So, when working yours out go down 5 + whatever the thickness of your device is.

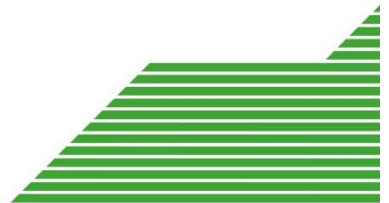
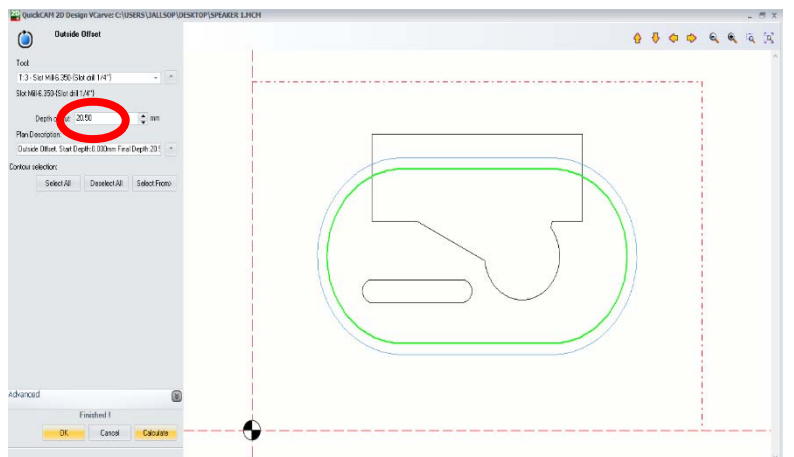
Then click 'Calculate' and you should get the blue tool path lines inside and then click 'OK'.



Next, we will be using the Outside Offset option on the Machining Paths.



Once you have selected Outside Offset, change the depth of cut the 20.50mm to cut all the way through. Then click 'Calculate' and then 'OK'.

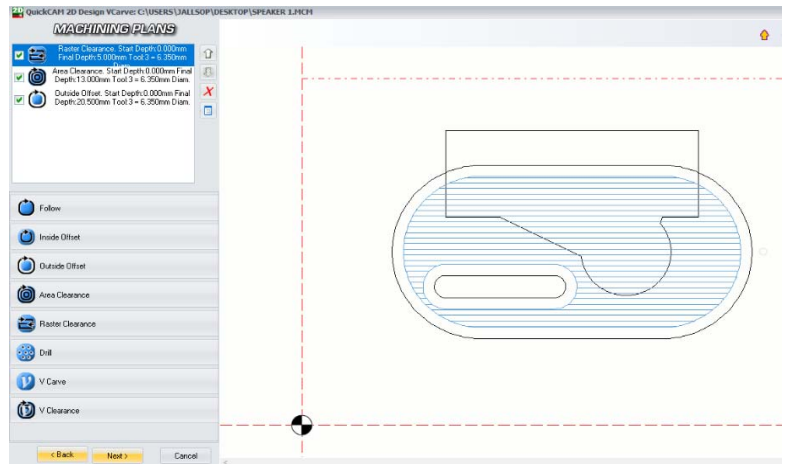




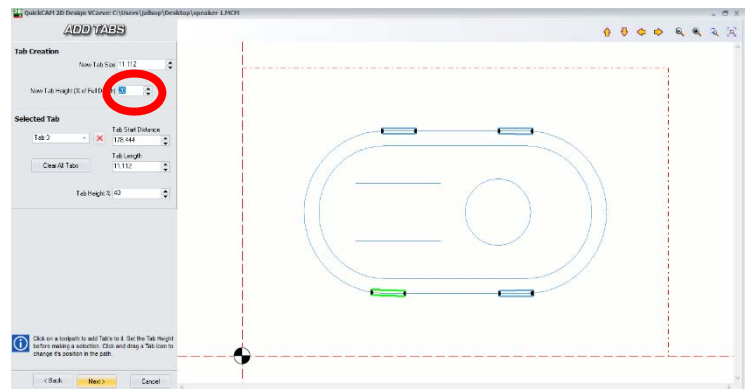
Back End CAM

Now that this has been done, we can look at the Machining Plans just to make sure we have got everything we need.

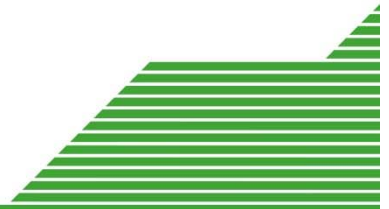
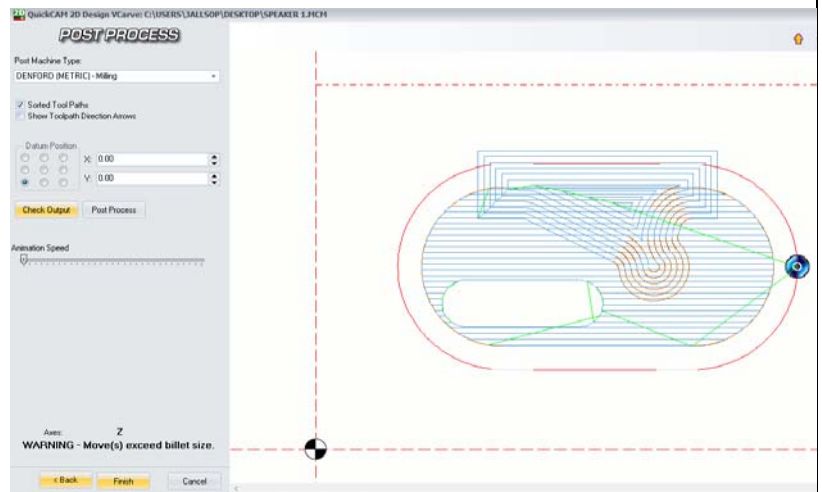
Then we can click 'Next'.



Now we can put some tabs on, just like we did for the first side. Change the 'Tab Height' to 20 and then pick the 4 places to put the tabs. Like the image on the right.



Once 'Next' has been clicked, this image should be the next screen, which allows for us to check the cutter paths. If you click 'Check Output', it will show the program from start to finish. Once you are happy with this, it is complete, and you can click 'Post Process'. It will ask you to save the program, so save it somewhere you will remember.





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CAD/CAM Projects

Passive Speaker Dock Project



TEACHER SUPPORT GUIDE



Denford: Passive Speaker Dock Project - Denford CNC Router

Teacher Support Guide

This Project takes the form of design and manufacture of a saleable product. Students are tasked with designing and making a passive speaker dock for a mobile phone or small MP3 player. Students have free reign on the shape and function of the design.

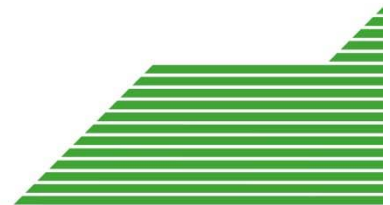
The only limits are that the dock must be manufactured using maple wood on a Denford CNC Router, and the design must be made in 2 halves and glued together when finished.

Project Timeline Summary

It is anticipated that learners will spend a total of approximately 8 hours in producing the work for this project (each session being around 1 hour). Learners will be expected to have had previous experience in using QuickCAM 2D design software.

Throughout this project, learners will need to apply problem-solving and designing skills, developed in earlier years, in order to achieve a successful outcome.

Session	Focus	General Content
1	Product Analysis & Design	Analysis of the design problem / understanding the context of their product / start to generate initial sketches.
2	Designing & Developing a Final Solution	Finish initial sketch ideas to satisfy the requirements of the problem / sketch final design in 3D form, both assembled and exploded.
3	CAD Design	Using QuickCAM 2D Design, draw the outlines of the two parts of your design. Save the design as front and back.
4	Create the Cutter Paths	Using the CAM Wizard, select the material and create the tool paths for machining both the front and back of the part.
5	Post Processing	Simulate and then post process the cutter paths to create the G&M Code CNC Program for both parts, ready for output to the Router.
6	Manufacture, Assembly & Finishing	Using VR Milling and the Denford CNC Router, machine out both halves of the part. Glue and assemble speaker dock, sand and wax to finish.
7		
8		



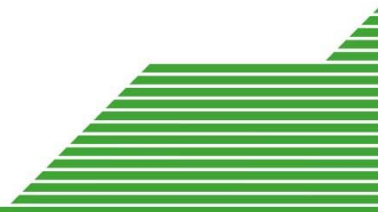


Project Delivery Session Detail

Session	Focus	Session Content
1	Product Analysis & Designing	<p>Start the session off with a discussion of how students can make the sound come out louder and clearer without the use of electronics.</p> <p>Demonstrate playing sound from a mobile phone, then putting the phone in an empty cup... what happens?</p> <p>Repeat with a rolled paper cone placed on the phone speaker... are there any differences?</p> <p>Ask students to read through the design problem, then - working individually - ask students to make a rough sketch of their device (or a neighbour's device). Ask them to measure and note critical dimensions such as the width and thickness of the device, as well as where the speaker is on the device - again, with dimensions.</p> <p>Now get students to look at examples of docks that have already been created and start to sketch up their own ideas. There is an area for each idea, with each having room for a front and back of their design. This is to allow understanding of how it will be made.</p> <p>There is space for students to create 4 initial ideas. They are not expected to finish these all by the end of this session.</p>
2	Designing & Developing a Final Solution	<p>Students will need to finish their sketched ideas, then decide on one design, or elements of some to take forward to their final idea.</p> <p>On the Design Realisation page, get students to sketch out their final idea in two ways: the first needs to be a complete assembled design and the second an exploded view.</p> <p>IMPORTANT: You can only machine the front face of each part, so students need to ensure that they create the cut-out on the front face of the back piece.</p>



Session	Focus	Session Content
3	CAD Design	<p>Using Quick CAM 2D, follow the CAD Support Booklet to draw the speaker dock ready for manufacture.</p> <p>Design both the front and rear halves of the speaker dock.</p> <p>Students can use the CAD Support Booklet to support them in self-guided learning.</p> <p>By the end of this session, it is expected the students will have their design finished.</p>
4	Create the Cutter Paths	<p>Using the CAD Support Booklet, Students will use QuickCAM 2D to set up machining programmes for the front and back part of the speaker dock.</p> <p>It will be necessary for students to select the material, set up the tool strategies, depths of cut and tools to be used.</p>
5	Post Processing	<p>Once the cutter paths are defined, they can be simulated and then both parts are post processed to produce the G&M Code CNC Program (.fnc file)</p>
6	Manufacture, Assembly & Finishing	<p>The next three sessions will be used to machine the parts on the Denford CNC Router.</p>
7		<p>The Teacher/Technician will need to set up the Router with a sacrificial bed, as the tool will have to machine deeper than the billet thickness to cut the part out.</p>
8		<p>Open the two programs in VR CNC Milling V5, and machine them.</p> <p>The tooling and work offsets for this project will need to be pre-set. This will be covered in training, but you can also check your Denford VR CNC Milling V5 Training Guide for guidance on how to do this.</p> <p>Once students have both halves of their dock machined, they will need to assemble the two halves together using PVA glue.</p> <p>Once glued, students can then sand with the glass paper (or use a power tool where available) and seal with wax.</p>





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CAD/CAM Projects

Passive Speaker Dock Project



Project Duration: 8 Hours

STUDENT WORKBOOK



Denford: Passive Speaker Dock Project - Denford CNC Router Student Workbook

DELIVERY PLAN (HOURS)

1. Product Analysis & Design
2. Designing & Developing a Final Solution
3. CAD Design
4. Create the Cutter Paths
5. Post Processing
- 6-8. Manufacture, Assembly & Finishing

DESIGN PROBLEM

Students are tasked with a project to design and manufacture a passive speaker phone/MP3 player dock.

The Design Emphasis will focus on designing to ensure good acoustics.

MACHINE

Denford CNC Router
Router Tooling Package –
BI00846

MATERIALS

2 x 160mm x 100mm x 20mm
Maple Wood Blocks –
BI03509G Class Pack of 50

ADHESIVE

PVA Glue

FINISHING MATERIALS

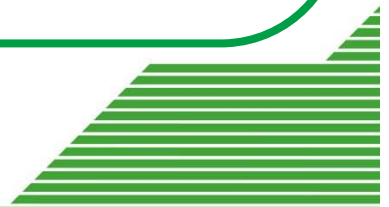
Glass Paper for finish
Wax to finish

EXTRA INFORMATION

The product is one complete unit and will be manufactured using the Denford CNC Router in two separate halves, then glued together to complete the dock.

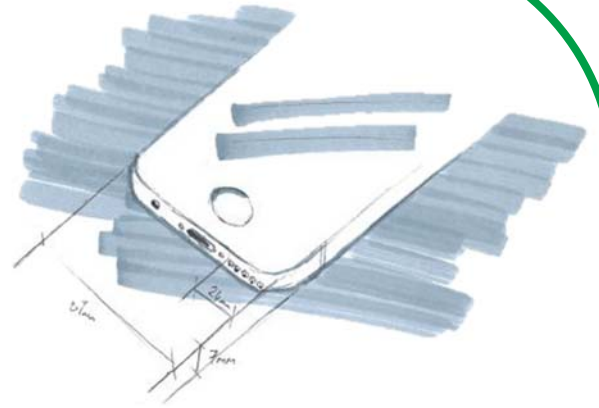
It is expected that the dock will be finished with wax. However, there are opportunities to embellish the design with accent colours.

IMPORTANT – *When machining you can only machine one face of each block. This MUST be considered in your designing.*



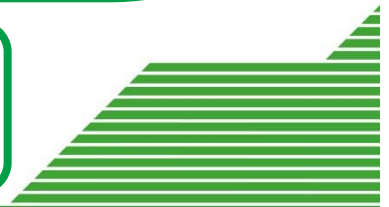


Where does your sound come from?



Take a look at your mobile phone and MP3 player. Do they have an inbuilt speaker? If so, where is it?

What are the critical dimensions of your device? Show your findings above.

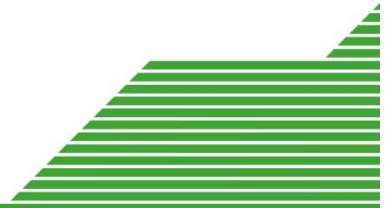




What's out there already?



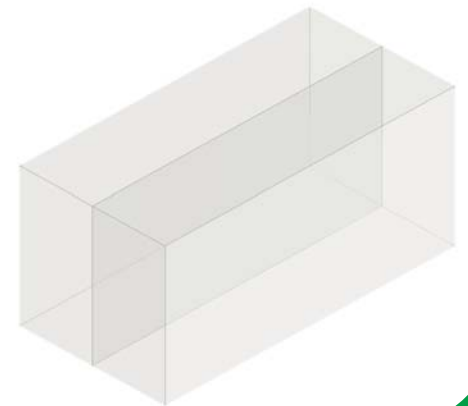
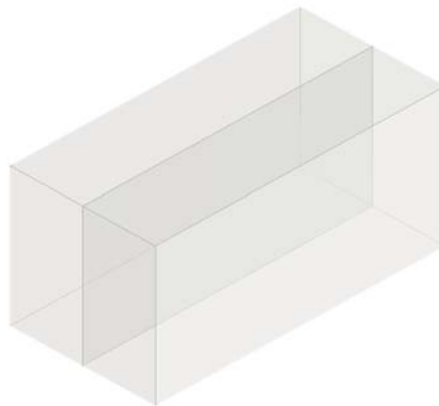
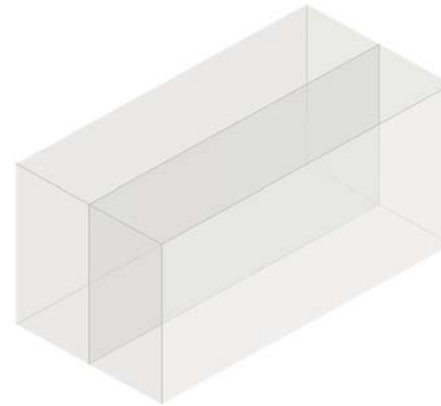
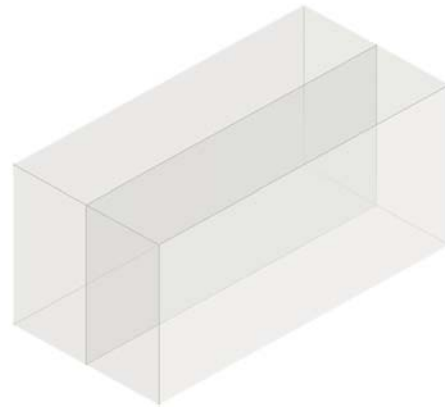
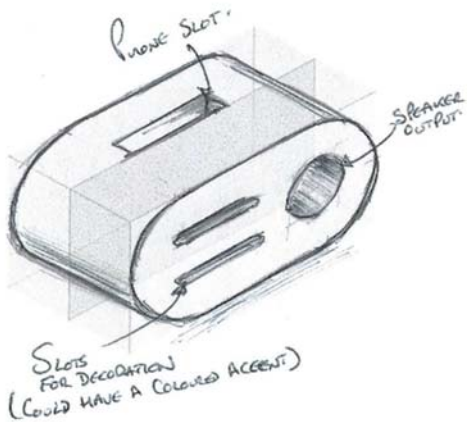
Above are research images that are associated with the function of this product. These are to help you in your designing.



Design

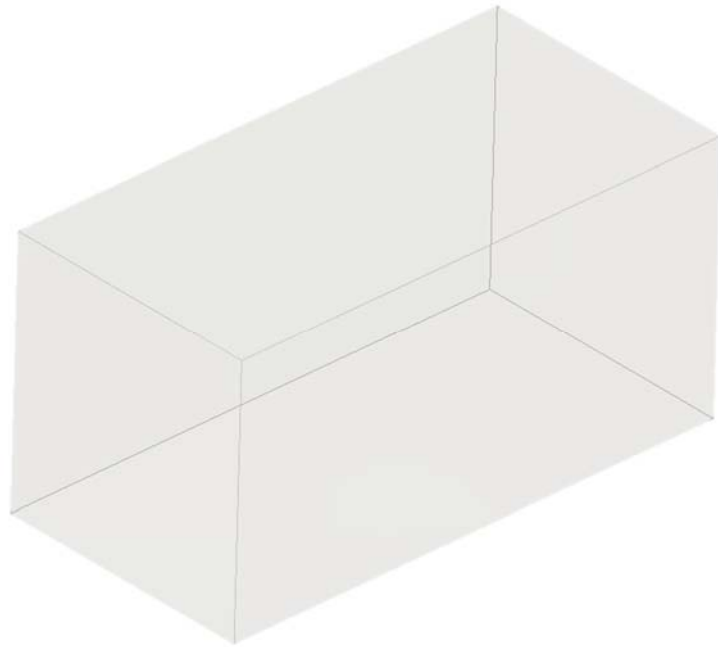
Using 3D Sketching generate some ideas to resolve the problem.

Sketch your ideas over the shaded blocks like the example below. Add annotation to help explain them!

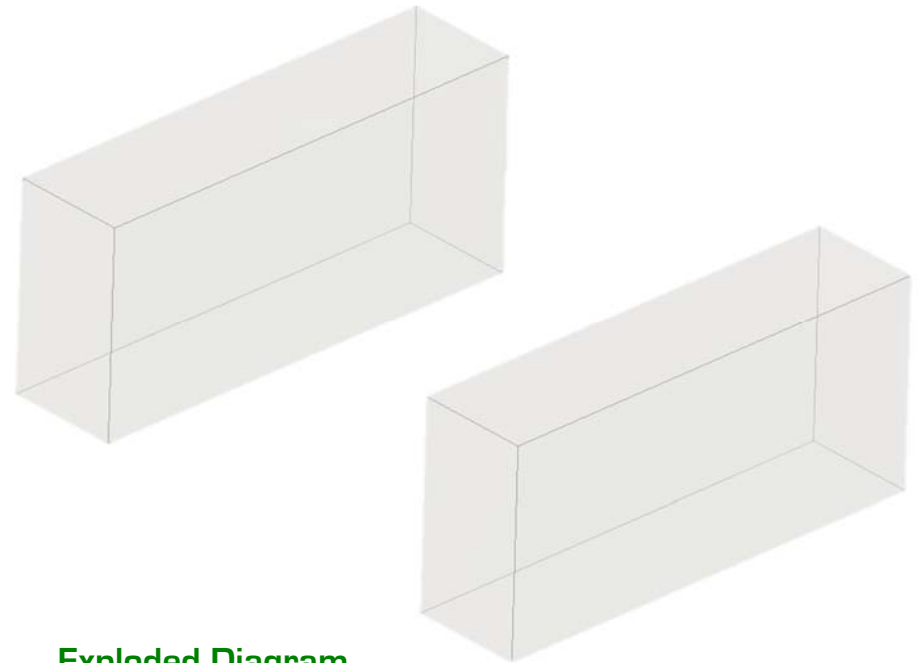


Design Realisation

Bring your favourite idea forward from the previous page and produce two separate sketches, one final 3D sketch, and one exploded sketch showing the two halves of the dock to be manufactured. Add dimensions to help with your CAD drawing



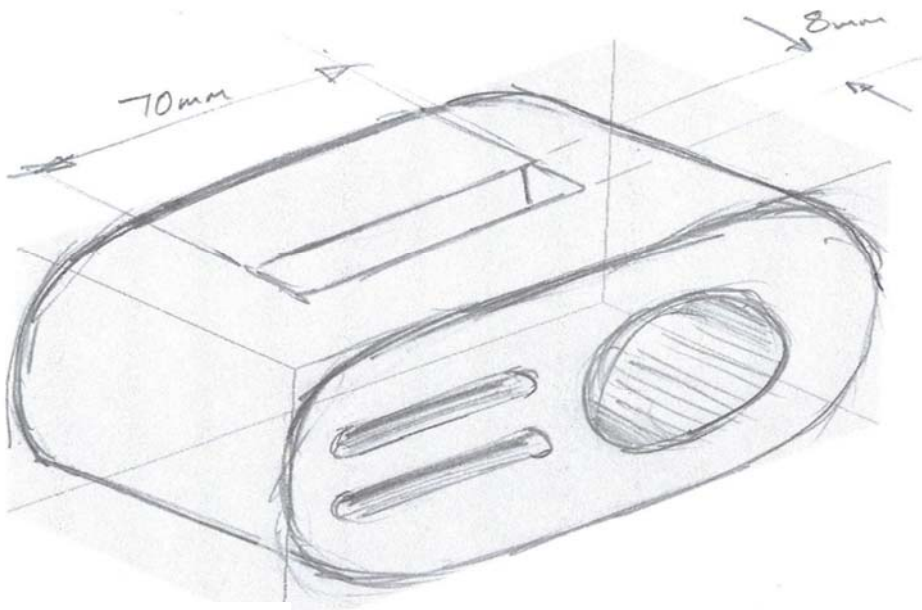
3D Sketch



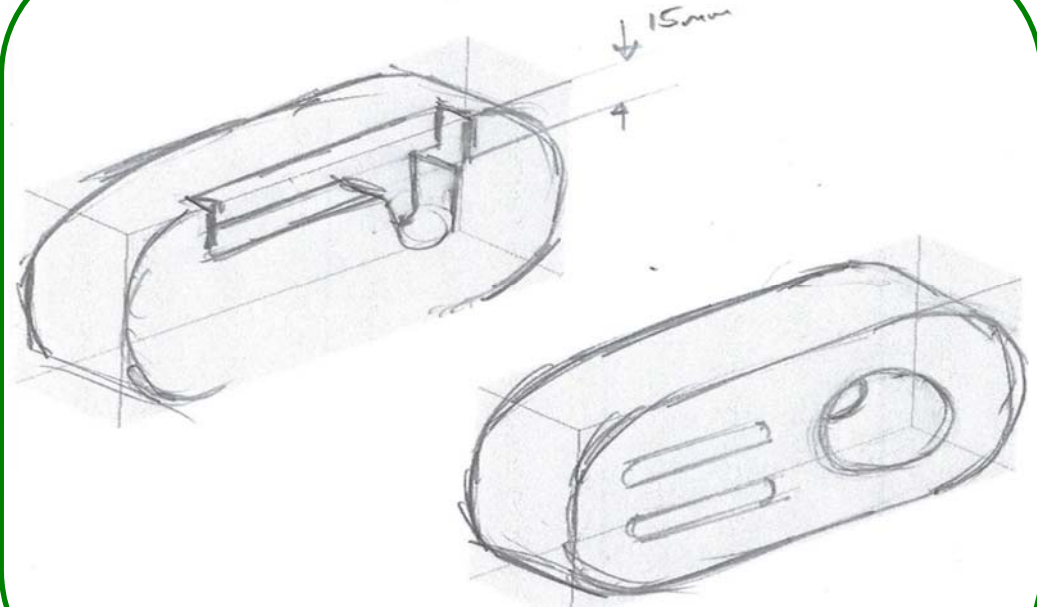
Exploded Diagram

Design Realisation - Worked Example

Bring your favourite idea forward from the previous page and produce two separate sketches, one final 3D sketch, and one exploded sketch showing the two halves of the dock to be manufactured. Add dimensions to help with your CAD drawing.



3D Sketch



Exploded Diagram



Your Final CAD Design

Export a final copy of your CAD Design and attach to this sheet.



CAD Design – Finished Product Example





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