



# CNC Router Operations

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~~REVEAL~~

## CNC Router Operations

The Edge has developed a CNC Router Operations e-manual in order to safely and efficiently promote public engagement with this piece of equipment.

The Edge's operation e-manual will be made available to CNC router users via the Edge's wiki served Raspberry Pi [digital signage system](#).

This e-manual can be broken down into the following sections.

### Contents

- [Machine Safety](#)
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## Machine Safety

- When machine is running, keep clear of any rotating or moving parts eg. the cutting bit, spindle moving gantry and head parts.
- Do not lean on machine whilst in operation.
- Parts of the machine , particularly cutting bits, will get hot so you may need gloves when handling/ or changing tooling.
- Maintain a clean workspace-check that the gantry and rails for tooling/materials left behind.
- Clean up as you work. The machine does the messy work for you to clean up!
- Use the right tool for the job. Different tooling pieces have a specific purpose and material.

### Safety - Emergency Stop

The CNC is fitted with an emergency stop.



This can be activated to bring the machine to an immediate stop in an emergency.

**Note -if the machine is turned OFF mid operation, wait 1 minute to turn ON. After activating emergency stop, needs to be homed.**

## Safety - Operator Hazards

The CNC router is capable of **directly** causing death or serious injuries, including amputations, fractures, de-gloving, lacerations, contusions and crush injuries. The hazardous parts of the machine are:

### The spindle

- The spindle spins at up to 18,000 rpm - capable of cutting at over 10 metres/minute (m/m)
  - through metal
  - (or flesh)
- The bit takes at least 30 seconds to come to a complete stop.
  - Every time.
  - Even if you touch it.
- The bit can fracture, break or shatter.
  - A bit rotating 18,000 RPM will fly out about 50 km/hr
    - at your eyeball

### The Gantry and Machine Head

The gantry can move at over 10 meters/min and weighs over 100 KG.

It can hit with enough force to knock a person over, or trap and mangle a limb.

## Safety - Damage to Machine

- The vacuum bed is soft aluminium. If it is damaged the machine is unusable.
- Drill bits are brittle, and will shatter or crack if dropped on concrete.
- The router will cut through metal clamps and screws

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## CNC Materials

The Edge currently holds a stock and sells 1200x1200mm (half sheets) 15mm Plywood. Participants

are also welcome to have a look in the offcuts for suitable material (this is for prototyping only- no commercial/professional jobs)

We also have a small reserve of 15mm ply and 18mm Formply in full sheets (2400×1200)

These are stored offsite and require extra handling. Prearrange if you want to organise a full sheet for your next booking

The Edge has also started experimenting with Expanded PVC Board and Expanded Polystyrene Foam.

Talk to your Fab Lab Supervisor if you have a specific material you would like to trial on the machine.

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# Router Tooling, Feed Rates and Cutting Speeds

## Tool Geometry

*You always want to use the right tool for the job.*

Different tool geometries produce different effects and results with the range of materials that can be cut on this machine.

Tool Geometry	
Straight Flute	Will not lift material out of cut.
Spiral Flute	Spiral Flute lifts swarf or pushes it towards cut. depending on geometry
Flute Geometry	
Single Flute	Single Flute cutters only have one cutting edge. These are good for faster feed rates in softer materials.
Double Flute	Double Flute cutter have cutting surfaces and are good for cutting harder materials at slower feed rates.
Upcut Spiral	The geometry of an upcut spiral draws swarf up and out the top surface providing the best finish on the down side of the material
Downcut Spiral	The geometry of an downcut spiral draws swarf down and out the bottom surface providing the best finish on the upper side of the material.
Compression Cutters	Compression Cutter have both upward and downward spiral geometry that forces swarf both upward and down and produces a clean finish on both upper and under sides of the materials and is particularly useful in applications with laminated materials.

<b>Tool Geometry</b>	
O Flute	Identified by the Half moon shape, OFlute cutters have a single flute that ejects swarf effeciently. As such they are suited to cutting timbers and plastics (softer materials ) at high speeds.

### Suggested Feed Rates - Soft woods/Plywood

<b>Tool Type</b>	<b>Tool Diameter</b>	<b>Spindle Speed</b>	<b>Feed Rate</b>	<b>Plunge Rate</b>	<b>Direction</b>	<b>Attribution</b>
Single Spiral	3.175mm	16,000rpm	2,000mm/min	1,000mm/min	Conventional	
Single Spiral	6.35mm	16,000rpm	4,800mm/min	3,000mm/min	Conventional	
Double Compound Spiral	9.5mm	12,000rpm	11,280mm/min	9,000mm/min	Conventional	
Double Compound Spiral	10mm	12,000rpm	11,280mm/min	7,000mm/min	Conventional	
Triple Compound Spiral	10mm	12,000rpm	16,920/min	12,000mm/min	Conventional	
Triple Compound Spiral	12mm	8,000rpm	13,320/min	11,000mm/min	Conventional	

### Suggested Feed Rates - MDF, Particle Board

<b>Tool Type</b>	<b>Tool Diameter</b>	<b>Spindle Speed</b>	<b>Feed Rate</b>	<b>Plunge Rate</b>	<b>Direction</b>	<b>Attribution</b>
Single Spiral	3.175mm	16,000rpm	2,240mm/min	1,200mm/min	Conventional	
Single Spiral	6.35mm	16,000rpm	5,280mm/min	3,500mm/min	Conventional	
Double Compound Spiral	9.5mm	12,000rpm	13,080mm/min	9,500mm/min	Conventional	
Double Compound Spiral	10mm	12,000rpm	13,080mm/min	9,500mm/min	Conventional	
Triple Compound Spiral	10mm	12,000rpm	16,920/min	12,000mm/min	Conventional	
Triple Compound Spiral	12mm	8,000rpm	15,360/min	11,000mm/min	Conventional	

### Suggested Feed Rates - Hardwood

Material Size	Tool Diameter	Spindle Speed	Feed Rate	Plunge Rate	Direction	Attribution
Single Spiral	3.175mm	16,000rpm	1,680mm/min	1,000mm/min	Conventional	
Single Spiral	6.35mm	16,000rpm	4,800mm/min	3,000mm/min	Conventional	
Double Compound Spiral	9.5mm	12,000rpm	10,080mm/min	8,500mm/min	Conventional	
Double Compound Spiral	10mm	12,000rpm	10,080mm/min	7,000mm/min	Conventional	
Triple Compound Spiral	10mm	12,000rpm	15,120/min	12,000mm/min	Conventional	
Triple Compound Spiral	12mm	8,000rpm	12,120/min	11,000mm/min	Conventional	

### Suggested Feed Rates - Acrylic

Material Size	Tool Diameter	Spindle Speed	Feed Rate	Plunge Rate	Direction	Attribution
Single Spiral	3.175mm	16,000rpm	6,000mm/min	2,000mm/min	Climb	
Single Spiral	6.35mm	16,000rpm	3,200mm/min	1,500mm/min	Climb	
Double Compound Spiral	9.5mm	12,000rpm	6,000mm/min	2,000mm/min	Climb	

### NOTES

The above setting are as suggested on page 194 of the Multicam A2MC Machine Installation and Training Manual unless noted in the *ATTRIBUTION* Column in ach Settings Table.

## Feeds and Speeds for the Tangential Knife

### Suggested Feed Rates - Corrugated Cardboards

Material Size	Tool Length	Feed Rate	Plunge Rate	Direction	Attribution
4mm Single Corrugated	15mm	5000mm/min	2000/min	Conventional	
7mm Single Corrugated	15mm	5000mm/min	2000/min	conventional	

### Suggested Feed Rates - Expanded Foam

These feed rates should be adjusted to suit design. Small radius curves should be cut slowly to

minimize knife flex.

Material Size	Tool Length	Feed Rate	Plunge Rate	Direction	Attribution
50mm	70mm	2500mm/min	1500mm/min	NA	TheEdge
50mm(radius $\leq$ 10mm)	70mm	1500mm/min	1500mm/min	NA	TheEdge
		5000mm/min	2000/min	NA	TheEdge

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## Preflight checks - Vcarve

Before Exporting the NC file for your cutting program from VCarve check the following:

- Have you checked the dimensions of the *plate* with the material you will be cutting? Especially the thickness - underestimating the thickness (z axis) can result in **punching the bed**
- Are you Parts nested far enough apart?

## Preflight checks before exporting NC Files - Continued

- Have you selected the right cutting tool for the job - cut diameter, cut depth, correct tool for required finish on the material, and for the features of the design (eg dogbone corners etc)
- Does the actual tool match the tool selected in the library for the toolpaths?
- Is the cut depth of each of the toolpaths consistent with the required depth? Are you sure your toolpath will not **punch the bed**?
- Have you selected the feeds and speeds recommended for the tool and material you are cutting?

## Preflight checks before exporting NC Files - Continued2

- Have you set your toolpath to cut in the right number of passes? - *Max pass  $Z \leq$  tool diameter.*
- Have you have selected correct cut direction (conventional or climb/ raster or offset) and vector offset (inside outside or on the line)?
- have you inserted the required depth, width, number of tabs and that the position of these is optimised?

## Preflight checks before exporting NC Files - Continued3

\* have you run an estimate cut duration and any tool changes to ensure you have enough time



complete the job within your booking time.

**Before exporting NC file have the Fabrication Lab Supervisor check your settings.**

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## Preflight checks - getting the Machine ready to cut

- Is there a hot work permit in place?
- Is there room in the extraction bag for your saw dust?
- Check the required tool is in the machine and is secure?
- Has the tool been qualified?
- Has the machine been homed?
- Are the required Vacuum bed zones turned on?
- Is the material secure on the bed?
- Have you loaded the right cutting file ( Preview File on the A2MC console)?

**Check with the Fabrication Lab Supervisor before cutting**

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## When you are cutting your job

- Are you and (everybody in the room) wearing your PPE?
- Are you and (everybody in the room) standing behind the yellow safety line?
- Are you alert and ready to hit the emergency stop if required?
- Are you ready to hit the pause button to clear debris?

**DO NOT GO NEAR THE SPINDLE UNTIL YOU CAN CONFIRM IT HAS STOPPED SPINNING**

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# Commonly Used Tabs and Functions

## A2MC Tabs

FUNCTION	NOTES
Tab 1 - Jobs Mode	
Tab 2 - Position & Jog Mode	
Tab 3 - Speed Mode	
Tab 4 - Spindle RPM	
Tab 5 - Origin Mode	
Tab 6 - Tooling Mode	
Tab 7 - Function Mode	

## Spindle Functions

FUNCTION	NOTES
Function 01 - Machine Properties	
Function 02 - Verify Job	
Function 09 - Abort Job	
Function 16 - Set Parking Position	
Function 20 - Set Material Thickness	
Function 25 - Set Tool Height	
Function 27 - Set User Z Origin	
Function 28 - Set and Plane Waste Board	
Function 30 - Edit Tools	
Function 31 - Change Active Tool	
Function 40 - Current Job Properties	
Function 41 - Feed Speed	
Function 42 - Spindle Control	
Function 43 - Job Repeat	
Function 44 - Job Array	
Function 45 - Plunge Speed	
Function 46 - Measured Move	
Function 47 - Cut Rectangle	

## Tangential Knife Functions

Function 24 - Set Knife Length	
Function 42 - Rotate Knife	
Function 58 - Swap from Spindle to Knife Control	
Function 67 - Knife Overcut/Undercut Compensation	
Function 822- Set up Tangential Knives	

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## Multicam CNC Bookings

The Edge's Multicam CNC Router is available for bookings by inducted members of the community on Tuesday Afternoons from 12 - 4pm.

Hit the [booking page](#) to make your 2 hour booking.

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