CNC Wood Worker

HANDBOOK

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Pocket Guide

Use this document as your quick reference practical guide for key points that you may need to know quickly. Of course you can refer back to the relevant course lesson anytime for a refresh as well.

Welcome

MESSAGE

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CNC routers can be a daunting thing to get started with, even for the wood worker, already experienced in using machines. Good results are delivered from a balance between practical, hands on and technical software skills. We'll cater for both along the way.

When I first had my machine delivered, I got one days rather under whelming training and from there on, I had to work the rest out myself. I wasted a lot of time and money on broken tooling and parts fit only for the bin. I was guessing at cutter types, tool paths, cut depths and had no idea what feed and speed even meant. If you are here looking for help, advice, tips or just to learn something new then I'm guessing you might have had a similar experience so far either in part or full?

My goal in creating this course was simple; to deliver a course and support network that would overcome the feeling of abandonment that CNC users experience. To create a lifetime reference guide that can be referred back to at any time. To deliver a complete training guide for those wanting to learn from scratch. Top tips and refinement for those wanting to expand their existing knowledge. And, to make the most comprehensive reference possible. Putting out there the support and guidance that I wish I had when I got started.

Upon reaching the end of this program, you'll be able to design and machine parts with ease, efficiency and assurance. You will be able to press that run button and know what comes out the other side will be well finished, accurate, efficient and repeatable. You'll be able to run your machine with confidence not hesitation.

Crashes will happen, tools will break and curse words will likely be aired! But, together we'll learn to recover from these things and improve. In this handbook you'll find some key points to remember along the way and in the course lessons you'll find the in depth video tutorials, demonstrations and file downloads to back it all up.

Overall, enjoy the journey, learn, have fun and I'll see you in the first lesson. Dan Lee

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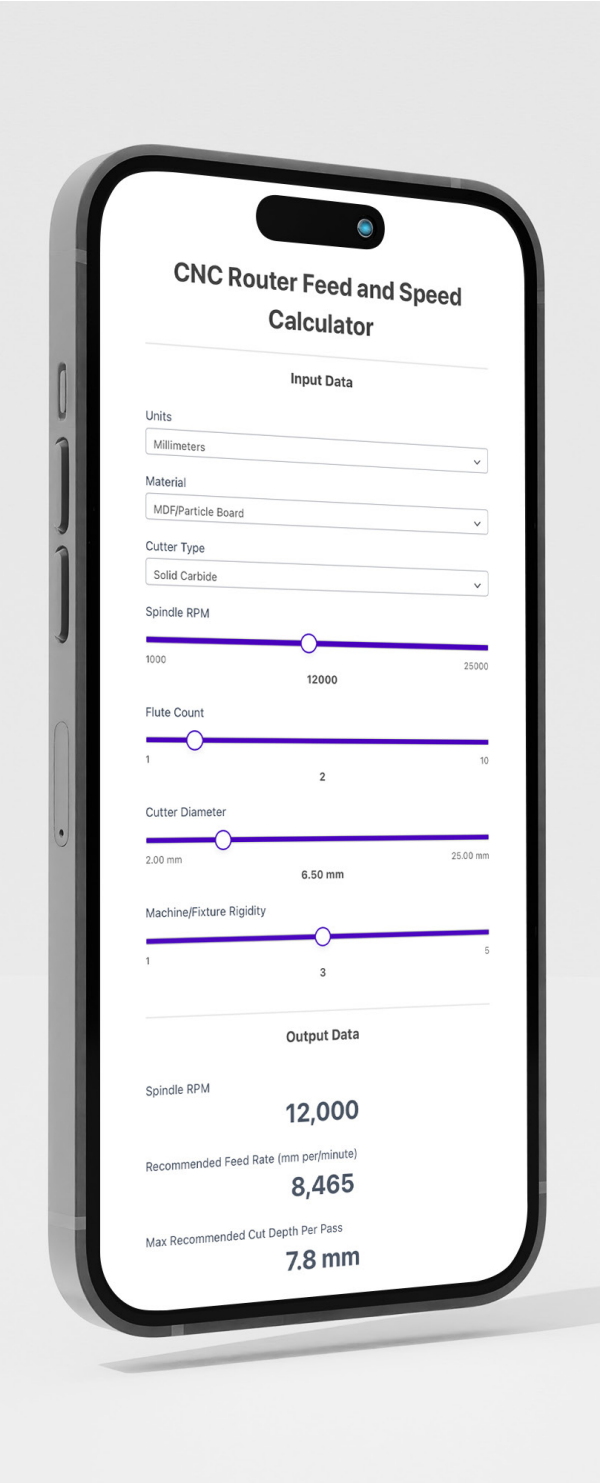
Feed and Speed

CALCULATOR



What Is This?

Feed and speed is the balance between spindle RPM and the rate that your machine travels at. As your machine flies blind you must tell it what do to here. The feed and speed calculator gives you real time outputs for these based on a combination of variable input sliders.

How The Calculator Works

Start by filling in the known quantities on the form. For example, the units that you prefer to work in and the material that you are cutting will usually be fixed here. Then adjust the more variable parameters to find a balance that works. Do this using the sliders, these allow for you to tweak the input values quickly, finding a solution that works best for your application.

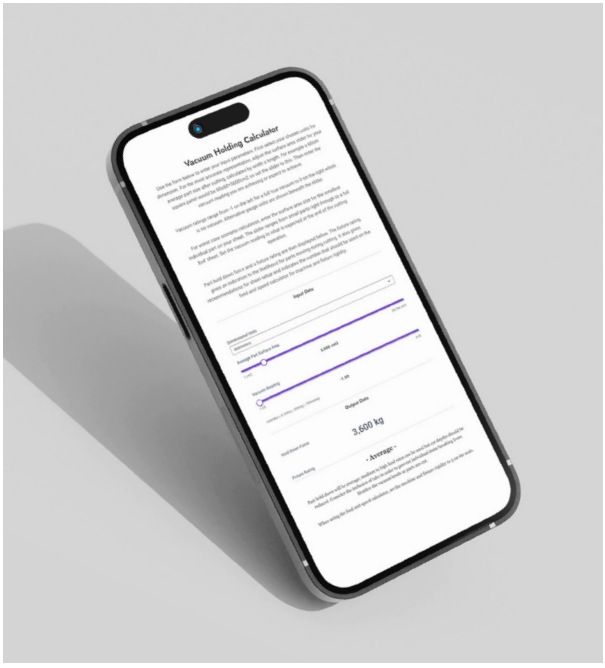
Machine/Fixture Rigidity

This is often overlooked. Use this slider to account for the rigidity of your machine and/or the quality of your hold down system. Set this to 1 for small, lightweight machines or low vacuum ratings. Move it up to 5 for rigid, full industrial machines and reliable hold down systems.

Find the calculator in your course dashboard under the Module 1 resources and under the feeds and speeds lesson.

Additional

CALCULATORS



Vacuum Calculator

Vacuum holds can break away suddenly without notice and when they do it can often result in ruining a part or at least requiring you to re locate it and start again.

The vacuum hold calculator indicates the quality of your hold down based on the gauge reading that you enter and your average part surface area post cutting.

Tips for improving the hold are displayed in cases where you are getting lower result readings. An overall rating figure also indicates the fixture rigidity setting that should be used on the feed and speed calculator.

V Carving Calculator

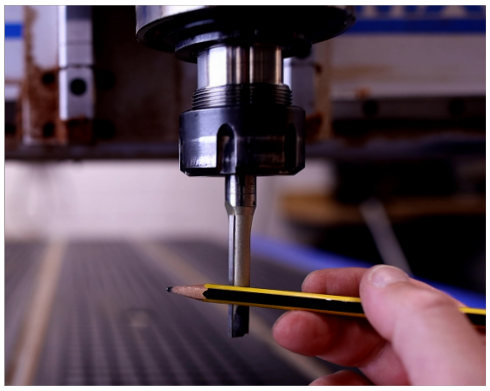
Within your course tool kit you will also find the V carving cut depth calculator. This will help you to decide upon which angle of V carving bit might be best for your operation. It gives you a cut depth for a specified bit angle and line weight.

Finer angled bits are great for sharp details, small line weights and fine fonts but they can cut deeply into your part. Wider angled bits are great for large text and heavier font weights.

Cutter

TYPES

Take a look through some of the common cutter geometries to understand what they are best suited for and where their limitations lie.

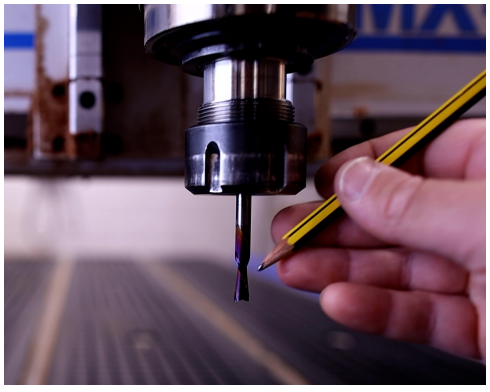


Straight Flute

- Shears at 90º to the material face
- Does very little to prevent breakout
- Doesn't actively extract chips
- May see increased vibration
- Versatile for most cutting operations
- Produces an average finish
- Can usually do a plunge entry
- Good general all rounder

Upward Spiral

- Flutes run helically up the cutter
- Shears material upwards to the top face
- Likely to cause breakout on the top face
- Gives a clean bottom face if through cutting
- Effectively extracts chips upwards
- Applies a continuous cutting load
- Can do a plunge entry
- Can lift parts upwards under high feed rates

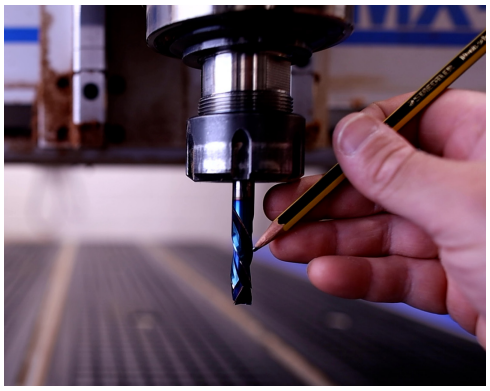


Downward Spiral

- Flutes run helically down the cutter
- Shears material away from the top face
- Gives a clean cut to the top face
- Can cause breakout on the bottom face
- Pushes chips downwards into the part
- Cannot plunge without a ramped entry
- Good for pockets with a clean top face
- Can push parts downwards into the bed

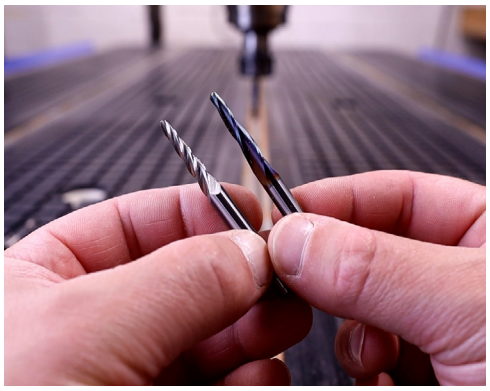
Cutter

TYPES



Compression Spiral

- Flutes run helically up and down the cutter
- Shears material away from both faces
- Gives a clean cut to the top and bottom faces
- Pushes chips inwards within the part
- Cannot plunge far without a ramped entry
- Usually requires a deep first pass
- Mostly pushes parts downwards
- Clean through cuts in veneered material

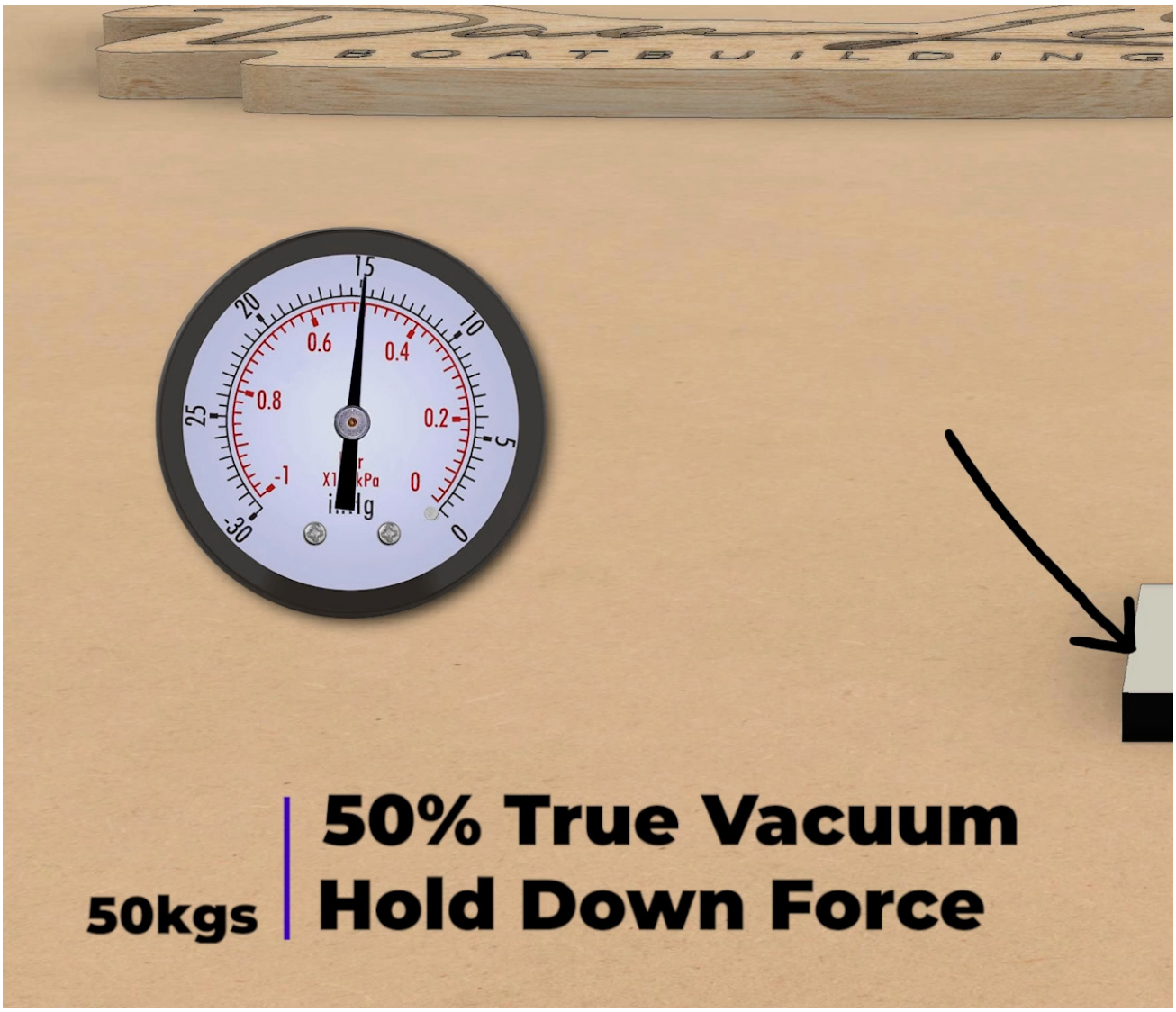


Special Geometry

All of the above flute types are available for standard flat end mills. Some of them are also utilized in tools with non straight geometry. Particularly upward and downward spirals. Tapered and ball end mills are common for 3D carving and shaping operations that give a smoother, step free finish on steep side walls.

Vacuum

PRINCIPLE



Contrary to what you might think, a vacuum hold down system doesn't suck parts down to the table. It works by creating a pressure differential to secure materials during the cutting process. The vacuum pump reduces the atmospheric pressure on one side of the table, which creates a difference between that and the surrounding atmosphere. This difference results in an inward pressure that effectively holds down the material to be cut. It's important to note that while a true vacuum state is rarely achieved, the system can still exert significant force, making it an effective, obstruction free method for holding parts, particularly when cutting thin materials or large parts.

Maximizing

VACUUM HOLD

Pump Types

There are two primary types of vacuum pump available. Flow and pressure rates are the primary ratings that should be considered. A blower pump achieves less vacuum pressure but offers a higher flow rate to cope with leaks. This is more likely to maintain its hold as parts are cut and leaks increase. A rotary vane pump achieves greater vacuum pressure when sealed and therefore a stronger hold. However, with a lower flow rate it may not be able to maintain this as effectively when system leaks begin to increase.

Improvement Tips

Face off your spoil board on both sides to improve air transfer through it. Without doing this, consider that some of the vacuum gauge reading may refer to spoil board hold and not that of your parts on top of it. Be proactive in minimizing leaks within the setup to enhance the performance of the vacuum system. Closing off edges and regularly facing the spoil board will help with this. If possible, shut off unused bed zones. Ensure that your system has a vacuum gauge installed so you are able to monitor the quality of vacuum levels.

Estimating The Hold

Quality of the hold is based on the achieved vacuum reading and the size of parts to be cut. In order to estimate the quality of the hold down you have, use the vacuum holding calculator to work this out based on your average part surface area and achieved vacuum reading.

Tool Path

ANATOMY

Key Phrases

Learn to understand some key functions that can be applied to any tool path. A range of entry, exit and ramp processes can be utilized as part of any tool path. The biggest killer of tooling is heat build up, understanding and managing the anatomy of the tool path is just as important as your feed and speed settings. Get this right and you'll dramatically increase the life of your tool and reduce marking on the finished parts.

Ramps

Ramps are the section of the tool path in which the tool comes down and first enters into the material. This is probably the most common time in which tools sustain heat build up and therefore damage if this it not set up correctly. A straight forward plunge is the most common operation here but some tools cannot sustain this and, even if they can you might still mark your part.

In the tooling lessons and on the cutter type sheets above, we learnt about the different geometry of cutters and how they offer varying properties for finishing. Some shear material in an upwards motion, some downwards and some do both at the same time. The caveat to these can often be found in their ability to ramp and enter the material so we need to make allowances for this.

Ramps can allow you to get the tool down to the full desired cutting depth so that the flute geometry is doing it's job correctly. For example; a compression spiral will initially produce an up cut to the top face of the material until it is at sufficient depth for the downward flutes to engage. You may wish to combine ramps with leads to further assist with this. We will look at leads shortly.

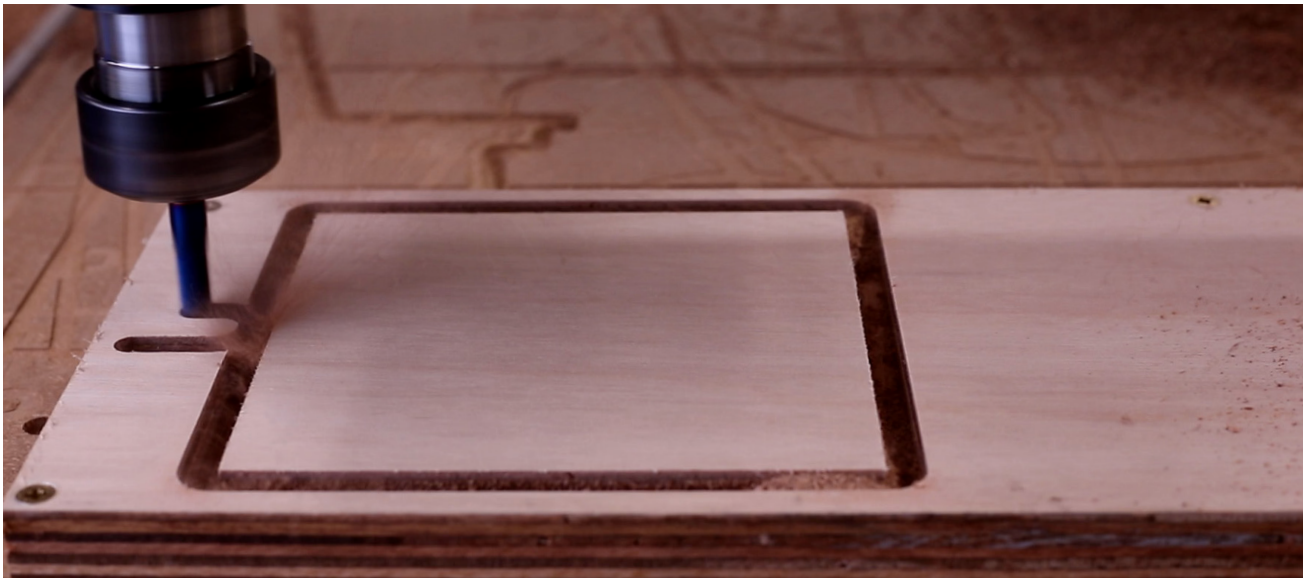
Ramp

TYPES

- **Plunge** is where the cutter or Z axis travels straight down into the part with no lateral movement, in just the same way as how you would use a drill bit. Any cutter that has downward facing flute geometry should not be used in a plunge ramp type. Chips will be forced down into the part and this will create rapid heat build up.
- **Zig-zag** (above)is where the cutter rocks back and forth on the X and/or Y axes as the Z axis travels down. This allows chips to clear out from the side of the cutter as it goes down. This entry can be used for all bit types but is essential when using any bits that have downward facing flutes.
- **Helix/Spiral** is where the cutter will circle around as the Z axis travels downwards. This allows chips to clear out from the side of the cutter as it goes down. This puts a constant, even load on the bit and is great for efficient cutting of holes or starting tight pockets.

Lead

IN AND OUT



Leads

Leads are a small section outside of the parts profile that run into the waste material. The idea is that in this section, the cutter can ease into contact with the part. This means any marking due to ramping or speeding up/down of the bit is contained within scrap material and not along the parts profile.

In

The lead in is positioned at the start of the cutting operation and so can work in combination with the ramp. For example; if using a compression spiral, the up cut flutes at the tip of the bit will initially begin lifting the top face upwards until sufficient cut depth has been reached. If this is done within the length of the lead then any marking to the top face will be within the scrap and not on the finished part.

Out

The lead out is positioned at the end of the cutting operation. Sometimes the bit can slow down here and create a burn line. If the bit stops to do a vertical retract then this can create a lift line. Using a lead out ensures that these operations are undertaken within scrap material or even in free space.

Finishing PASS

The Single Best Way To Get Great Finishes

The finishing pass is the ultimate way to get incredible finishes on profile and pocket cuts. It involves running a final small stepped over pass, usually taken only on the last cut at final depth. The step over is typically 10% of the cutters diameter (0.6mm for a 6mm bit). This greatly reduces load on the bit as cutting is only undertaken on one side rather than loading all edges. Any steps left from cutting passes, created by deflection of the machine, part or bit can be eradicated at this stage. That makes this process an especially good save for those using smaller, lightweight machines that want to achieve professional results.

Work Piece

INTEGRITY

An Important Consideration

As you cut parts from a sheet of material it will essentially begin to break down and if you aren't careful, fall to pieces. Certain methods of planning can allow you to maintain the integrity of your work piece. This will ensure solid holding of even the smallest parts giving versatility to your tool path options and giving great finishes. Remember, the minute any part on your sheet starts to move, all your design, planning and accuracy goes out the window!

Maintaining INTEGRITY

Tabs

Tabs are the small bridges that remain in place to keep your cut parts tied to the surrounding waste stock. These are great for keeping full sheets in place if you are sending parts out to a third party, like a giant Air Fix kit. Consider that large numbers of tabs may be needed to maintain full work piece integrity. They have little effect in long grain solid timber and should span at least 2x veneer layers when used in plywood to ensure variation in grain direction. They do require an amount of clean up post cutting.

Vacuum

If you can achieve a good vacuum hold then this is the ideal solution. It ensures full, uninterrupted part holding and therefore maintains the integrity of the work piece entirely whilst cutting. This method means that very little or no rework is needed on parts post cutting. This often isn't viable for smaller sized parts though and cannot be achieved with rough sawn or cupped timber.

Onion Skin

The onion skin method is my preference for solid wood cutting. It involves leaving a small layer of material in the bottom of the cut profile. This maintains a fully reliable work piece integrity and uninterrupted part holding which allows finishing passes to be taken effectively. Repeat finishing passes can also be utilized where a final pass is run again without cutting the part. These may seem counter intuitive as more machining time is used, however, this will clean out cut channels and reduce the need for post machining, manual cleanup.

As the base layer of material remains intact, vacuum holds will not reduce by such a large factor as parts are cut. New leak points are not created and so part sizes can be viewed as that of the whole sheet, reducing the risk of individual breakout.

Onion skins can be anything from fractions of a millimeter (an onion skin) to several millimeters thick. Even more if desired and sometimes enough to hold the stock in a machine vice. There is always after work to do though in order to release parts. This can be done with a flush trim router bit entered into the profiles from behind. Boards can also be machined down to thickness at a later date, releasing the parts at that stage.

Getting HELP

Ongoing Support

I want to continue to evolve the course and the support that it offers to students. You have lifetime enrolment and referring back later on down the line saves trawling through YouTube to find a decent tutorial on the subject. Below are some of the ways in which you can get additional support outside that of just the standard lesson material.

Under Lessons

The best way to get help on a specific topic is to post a comment underneath the relevant lesson. I will then be able to respond to this which is helpful for all other students to see in the future.

On The Forum

Topics can be posted on the forum which allows for the sharing of images. This may be necessary for showing a particular problem in more detail. Other students may be able to give some insight as well as course instructors. This is also a great place to share projects and connect with other students.

1 to 1 Training

Should you need more specific advice or want to learn certain subjects in more detail. 1 to 1 training lessons are available and they can be booked through the student dashboard at a discounted rate. On site training can also be arranged if necessary.

Summary

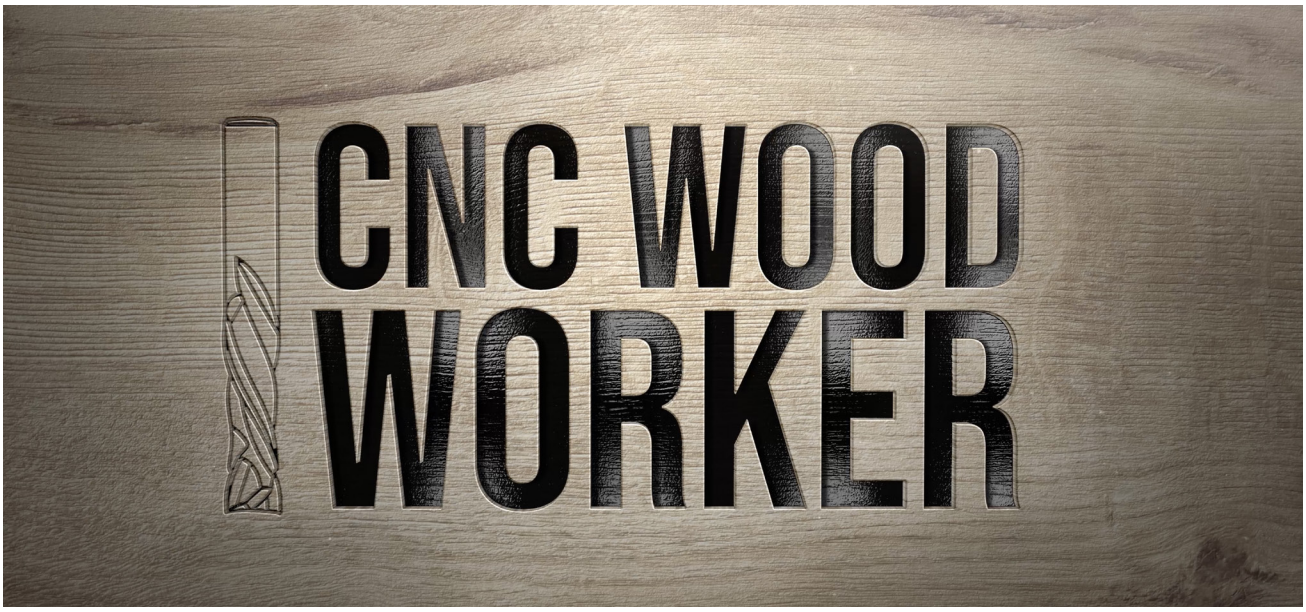
Current Students

If there is anything further that you feel should be covered in the CNC Wood Worker course then feel free to let me know. I will continue to expand and develop the course material over time in order to build it into the ultimate resource for CNC router users.

Handbook Visitors

If you are reading this handbook as a visitor or prospective student of the CNC Wood Worker course then please take a look at the program and consider coming on board today. Lifetime access to the comprehensive training videos that accompany all of the information above will dramatically increase the quality of what you are able to produce on your machine.

You'll get lifetime access to all this training along with the full set of calculation tools and project downloads. Come on board today and join our growing community of CNC users.



Thank YOU

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