

## The Zen of CNC

Being at one with the material, the tooling and the machine is the goal. But the machine is the most important, since the other two sit idle without it. Be the machine. Embrace the material. Sense the tooling.

Yes, it is almost like that. Improper programming, tool selection, work-holding or inattentiveness can make for a very bad day. There is a balance required between speed and results. High spindle speed with slow feed speed will have a detrimental effect on tooling and material. But too high a feed speed will have a detrimental effect on the machine. Finding the sweet spot of feeds and speeds will yield good part finish and tool life without being overly hard on the machine.

The spindle (cutting head) of the CNC router is moved by motors with belts and 'lead screws' – threaded rods that moved a 'nut' as the rod turns. All of these are subject to wear and damage. Wear is normal, and is a function of load, speed of movement and amount of movement. Amount of movement is determined by how many parts are cut, but load and speed can be varied.

It is not so much speed as change of direction that puts heavy loads on the motor, belt and lead screw. Built into the machine control are values for acceleration and deceleration of the cutting head between zero and cutting speed. If there is sufficient distance of travel of the cutting head, then it will accelerate smoothly to cutting speed and then decelerate smoothly as it approaches a change of direction. But if the distance between changes of direction is too small, then 'accel' and 'decel' must happen very quickly. This causes a noticeable 'bumping' of the cutting head as it changes direction. This indicates a very heavy load being placed on the machine. Minimizing the 'bumping' will maximize machine life. (And can noticeably affect the quality of the finished part.)

Just as in driving, 'speeding will get you there 30 seconds quicker' (if you are lucky). This is where we can practice Zen. Slow down (feed speed), take a breath (Zen) and wait that extra 30 seconds for your part to be cut. Your CNC router will love you for it.

The worst direction changes are 90 degrees or more. This is greatly magnified if the distance traveled is small (less than 1 inch). On longer cuts, the accel/decel will minimize 'bumping'. So what are the recommendations for speeds and feed (rates)?

General recommendations for wood are: spindle speed of 10,000 RPM; depth of cut equal to cutter diameter; feed speed of 50 inches per minute. For engraving, 20 inches per minute or slower is recommended. Small parts – less than 12x12 inches – somewhere between 50 and 20. Note that you may need to use the sliders on the machine control to slow down the feed rate if there is a lot of 'bumping'.