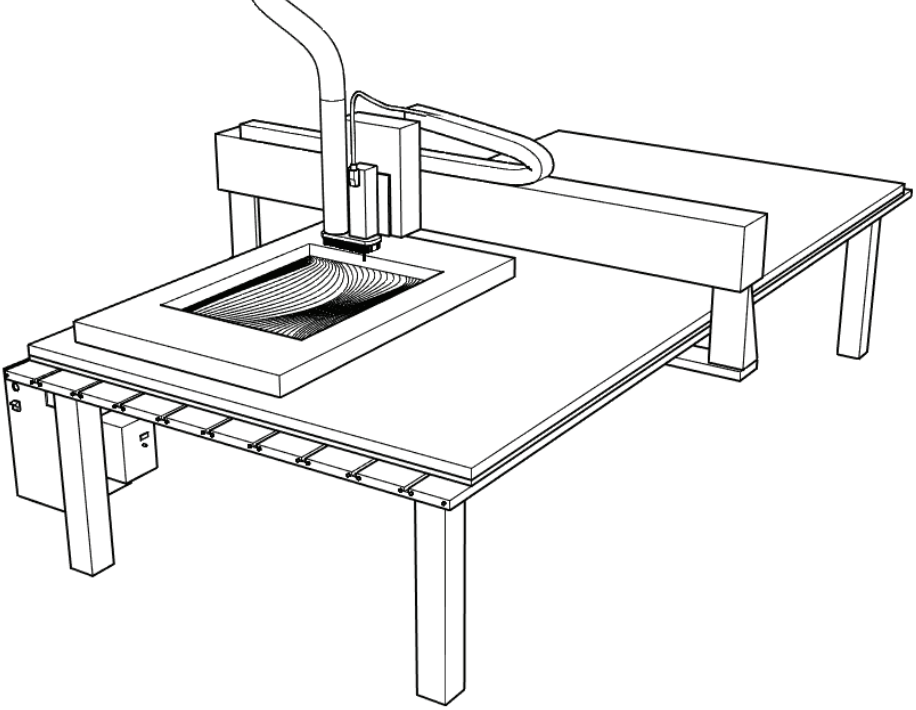


CNC INTRO WALKTHROUGH
NDSU WOODSHOP 2018

This is a program guide to utilizing the CNC router digital fabrication equipment in the Woodshop at NDSU. The guide contains instructions on understanding the basic setup of a file and its relation to the operation of a CNC router.

...upon completion of this walkthrough, one will have gone through essential concepts and features of the CNC equipment, responsibilities and expectations, and prepared a file ready for import into the Aspire9.015 program.

...for **clarification** of any content, or for extended study into the more advanced operation of the CNC, talk to the Graduate Research Assistant and/or NDSU Woodshop staff.

CNC GUIDELINES:
RESPONSIBILITIES & EXPECTATIONS

Use of CNC is limited to the following:
- Individual student use: Arch 3-5yr, LA 3-5yr, and Art 2-4yr
- Class projects will be the exception to the above rule at the discretion of woodshop tech/in consult w/ department chair
- Academic work only (no personal or professional work allowed)
- Shop hours: 8AM-8:30PM Mon-Th and 8AM-4:30PM Fri
- Operation by shop staff or CNC Graduate Research Assistant
- Materials: hard/soft wood, plywood, and (some) foam

User Steps for CNC Work-flow

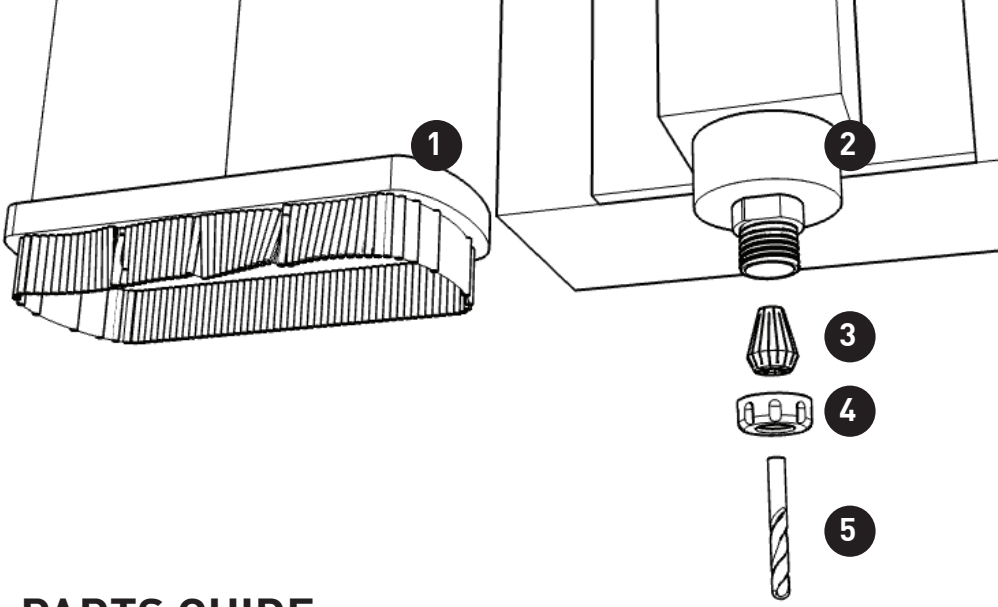
- User having academic project will sign-up for assistance with GRA
- User to create drawing file in Rhino, AutoCAD, Illustrator, SketchUp, SolidWorks, Aspire, or other compatible vector program
- User will transfer drawing file to GRA for review/approval
- Once drawing file is approved, user will create Aspire file
- User will transfer Aspire file to GRA for review/approval
- Once Aspire file is approved, user will schedule project runtime
- User will supply all materials required for project completion
- Shop staff will assist user with material selection, glue-ups, attachment to CNC bed methods, blank sizes, and tooling
- User must be present at all times during production of project
- User is required to clean router area at completion of project

Duties of CNC Graduate Research Assistant (GRA)

- Give orientations to class/user groups
- Advise on project viability
- Advise on drawing options and any necessary conversions required
- Approve drawing and Aspire files
- Post files to CNC computer
- Operate CNC

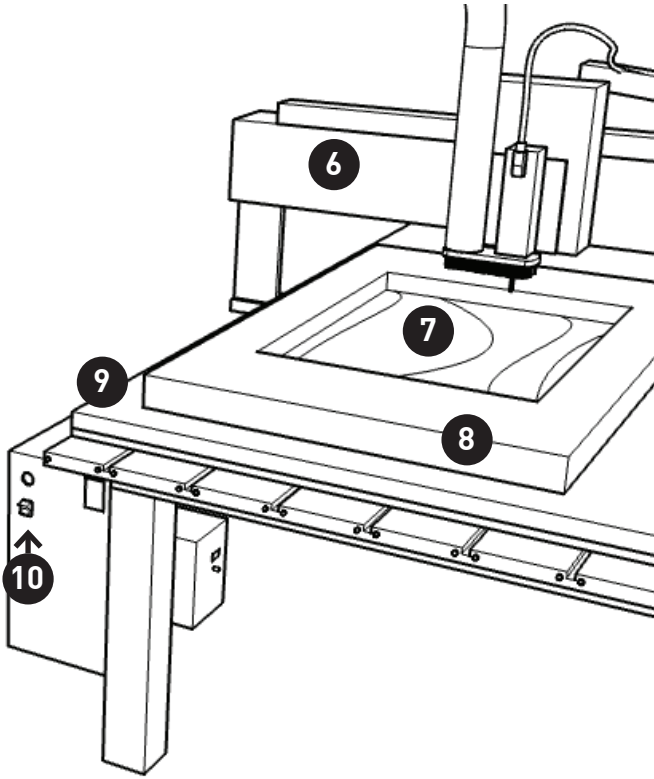
Duties of Shop Staff

- Advise on material selection and glue-ups
- Ensure required tooling is available
- Advise user on fastening material blank to bed
- Post files to CNC computer
- Operate CNC



PARTS GUIDE

1. dust foot
2. spindle
3. collet
4. collet nut
5. end mill (bit)
6. gantry
7. part (your model)
8. stock (material)
9. spoilboard (table)
10. power



STEP ONE :
UNDERSTAND WHAT YOU WANT TO CUT

like the laser cutter, the CNC allows you to cut incredibly complex models with a high precision. **unlike** the laser cutter, the CNC asks you much more about what you want to cut and how you want to cut it.

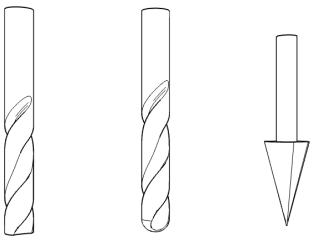
the **two** things you need to have in mind before you prepare a model to be fabricated on the CNC are the **type of tool** you are going to use, and the **type of operation** you're going to ask the tool to perform. the two factors give you a broad palette of techniques on the CNC.

most of the time, you'll use one of these:

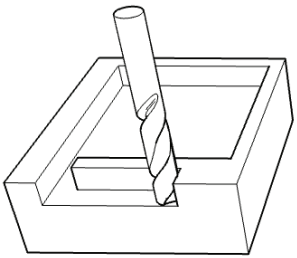
flat end mill

ball end mill

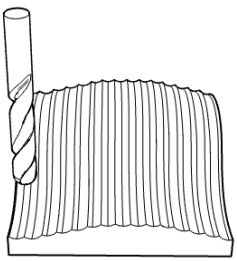
vee (V) mill



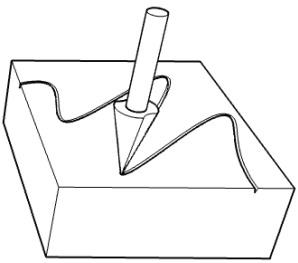
the different bits will produce different cuts, which you will use for different situations:



flat cuts

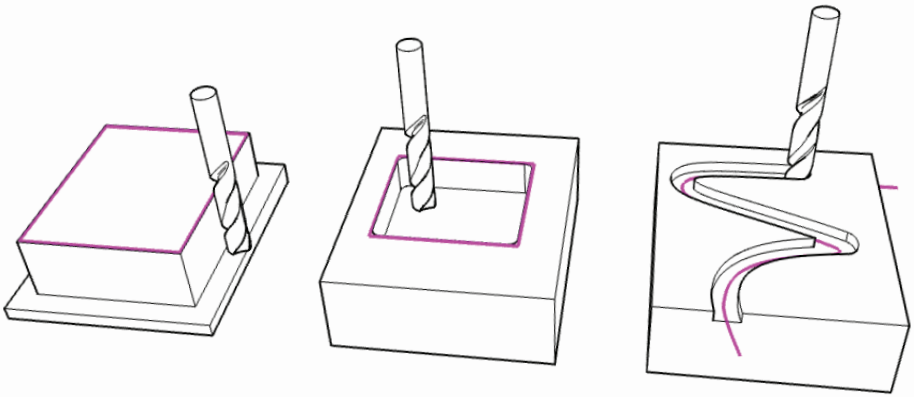


ball cuts



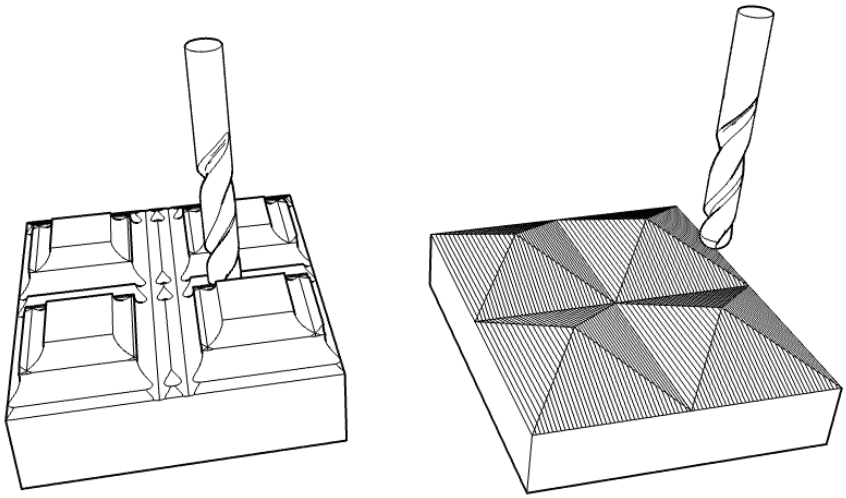
vee cuts

(COMMON OPERATIONS)



profiling pocketing engraving

these operations are considered **2D**. this is how to "cut out" pieces or how to carve simpler grooves, notches and pockets.



horizontal roughing parallel finishing

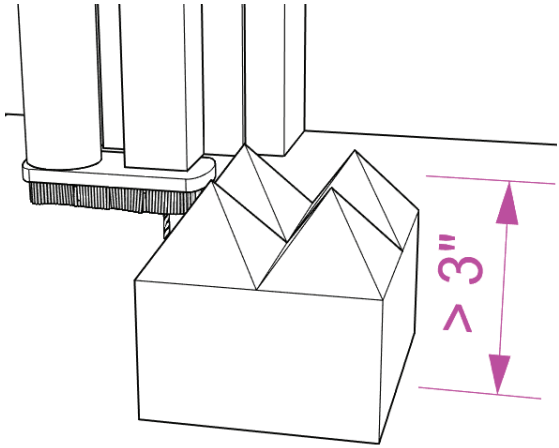
3D operations almost always come in pairs: a **roughing** pass to cut away large amounts of material in a faster, more imprecise way... and a **finishing** pass, to closely approximate your digital model shape. a parallel finish is the most common and universal, but you can determine almost any kind of finish pattern.

(LIMITATIONS!!)

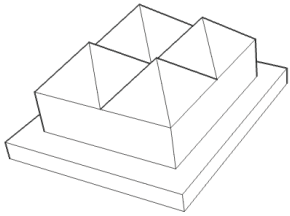
1: max depth

all CNC routers have a **working envelope**, or a maximum size object you can cut. the biggest limitation is usually the z-axis, that maximum is about **3 inches** depending on tool length.

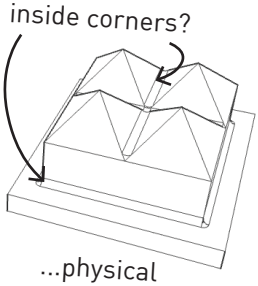
don't make your model taller than that. you can slice your model into multiple parts to achieve greater depth.



2: end mill shape



digital...



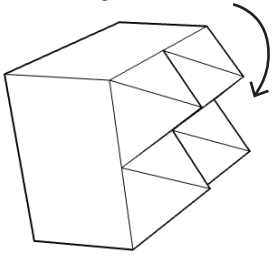
...physical

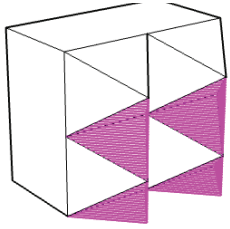
...remember that you can only cut into spaces **wider** than the bit you decide to use.

as a result, **inside corners** on your model may be left with a small radius of material.

3: no undercuts!

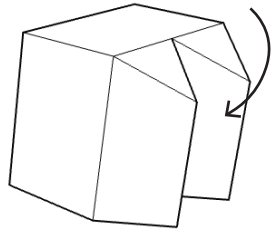
if your model has overhanging parts...



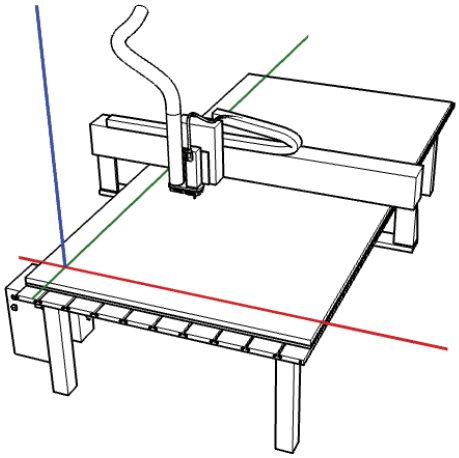


the machine won't reach those undercuts...

...you can still send the file, but you'll get this



STEP TWO :
UNDERSTAND WHERE YOU ARE



the CNC mill is a physical representation of the virtual space of your digital vector model. Some conventions always hold:

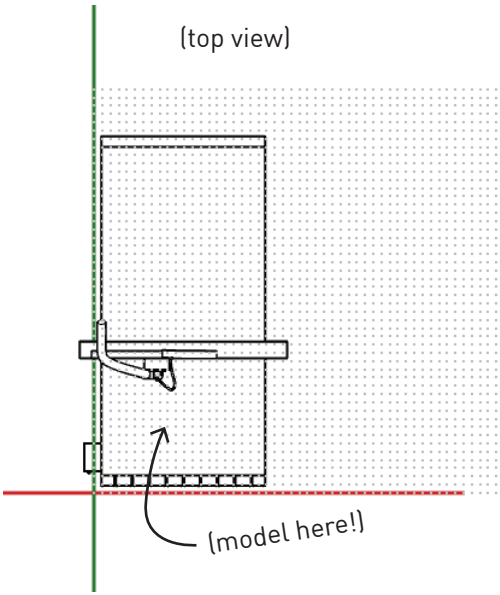
- the x-axis in the digital model runs along the edge parallel to gantry.

- the y-axis in the digital model runs along the edge perpendicular to gantry.

- the z-axis in the digital model is "vertical" in the real world.

- x increases to the "**right**" of the router, y increases toward the "**back**", and z increases "**up**"

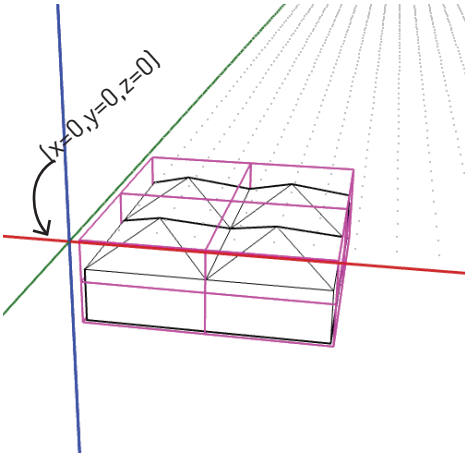
accordingly, it makes sense to locate your digital model in the quadrant where X and Y are both positive. in 'top view,' this is the upper-right quadrant.



the CNC depends on you to manually indicate where your model "starts," or where to set, as a reference point, the origin in your digital model.

YOU SET THE ZEROES MANUALLY ON THE MACHINE , LATER!

where you set the zeroes depends on how you want to cut something. often it works to set the X and Y zeroes at the physical **corner** of the CNC table. but you can just as well set those zeroes anywhere you like.



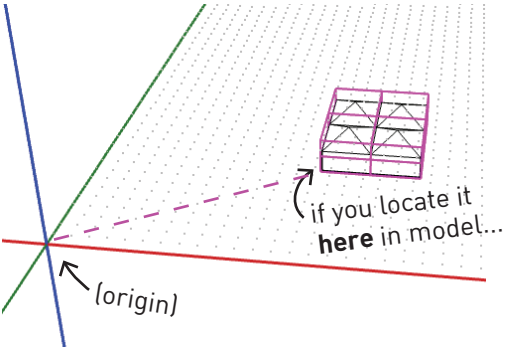
in **most** cases, you'll be starting the router at the top of your material and cutting **down** into it.

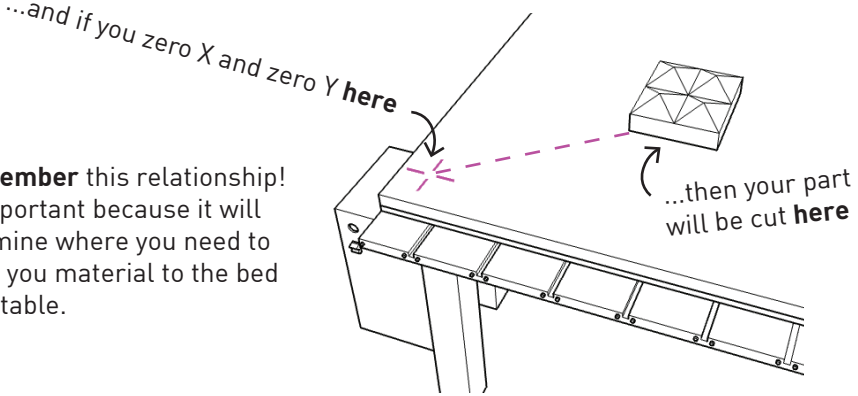
this means you'll **zero the z-axis** of the CNC mill to the TOP of your material.

in this case, z=ZERO needs to be at the **top** of your digital model.

in the digital model, this means moving your object **below the origin** in x-y plane.

as mentioned, the location of your digital model relative to the origin (0,0,0) determines where the part will be cut on the CNC, after you have **manually** set where x=0 and where y=0 on the machine.





...remember this relationship! it's important because it will determine where you need to fasten you material to the bed of the table.