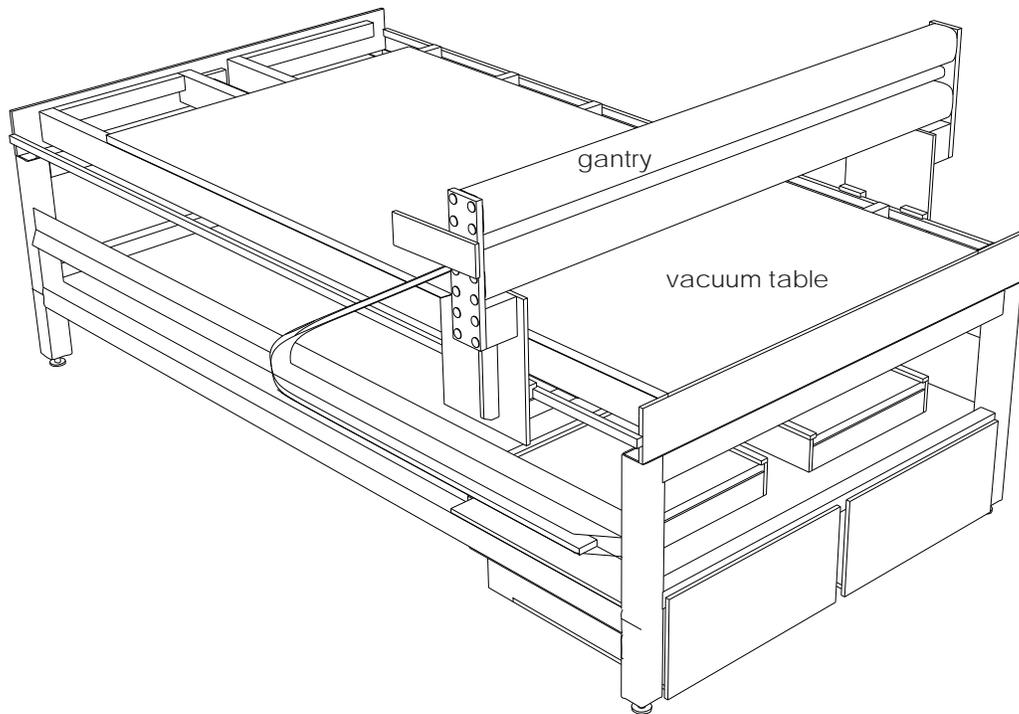


# GUIDE TO CNC ROUTING



NEWSCHOOL OF ARCHITECTURE + DESIGN  
MATERIALS LAB

APRIL, 2014

# THEORY

The CNC router is a Computer Numeric Controlled cutting tool which allows a user to create analog objects directly from a digital file. Most digital modeling programs can be used to generate either a 3d or 2d model that can then be cut using the router.

The router uses a rotary cutter to remove material from the base stock guided by a digital file. To accomplish this the digital file is read by milling software which generates the cut paths, which are then converted to a Gcode file by the post processor, which is read by the CNC controller via a software interface, which then manipulates the cutter head to create the final piece.

# PROCESS

The process for cutting a file is as follows in brief:

- Begin with a 3D file type you can read into Rhino as a surface
- Bring this file to the lab to have a tech setup the cut file in RhinoCAM
- They will generate the cut paths and Post-Process them for export to a TAP file
- You can then make an appointment FOR THE FOLLOWING DAY to route your material
- The next day you will bring your material and TAP file to the lab for your appointment
- A tech will help you setup the material on the deck and vacuum it down
- They will set the X, Y and Z zero settings, check the limits of travel and run the file
- You must stay in the lab while the file is running to monitor the CNC router
- Once the file is complete you must cleanup the equipment and the area around it

# BENEFITS

There are a number of advantages to using the 3D router. The router removes material so it is very useful when creating accurate 3D surfaces, such as with a topography. It can also be used to create 2D parts by following lines, useful for cutting plywood and other flat material into complex shapes and patterns

The router itself is a very complex tool and it takes significant experience with it to utilize all the benefits of 3D routing but with some time and practice, combined with an experienced operator, even those new to the tool can yield impressive results. Make sure to plan additional time when preparing projects for the CNC.

# MODEL

Most digital modeling programs can generate a model that can be cut using the CNC router. If the file is created using a program other than Rhino it must have the ability to export as an 'OBJ' or 'STL' file type. For all software, if it is a 3d model it must be a mesh or polysurface, if it is a 2d model all curves must be closed and for all types units must be inches.

As a note, files generated in Sketchup seem to have the most issues importing into Rhino. This usually stems from the mesh or polysurfaces being incomplete. Please make certain Sketchup files consist of only complete surfaces. Finally, delete any unused layers from the model. If there are multiple layers with information, it is best to select the layers or items that will be cut and export them to a new file. Try to have all information contained in one layer on one file

# MATERIALS

The router can cut many different materials ranging from expanded polystyrene to acrylic as well as wood products such as plywood, MDF, hardwood and softwood. You can cut multiple layers of plywood or MDF but the lamination process must be completed 24 hours BEFORE cutting. Lastly, the router CANNOT cut metal as we do not have bits or cooling capabilities for this purpose.

The router cuts by removing layers of material. With foam it is possible to begin with a finish pass as the upper surfaces are removed during this process, with other harder materials such as MDF it is necessary to make several roughing passes in order to remove upper layers before running the finishing passes. This can result in tremendous increases in time requirements for a single topography file. Additionally, surface texture, overall weight, size and scale should be considered BEFORE purchasing material for routing, speak to a routing technician for more information.

# SIZE

As with any 3D process, doubling the scale of an object can increase process times by a factor of four. For this reason it is important to consider the overall size of the piece before you purchase material. The router deck itself is 48" x 96". This is useful when cutting a 4 x 8 piece of plywood but may be far to large to reasonably cut for an MDF topography.

The other important factor when considering size is the size of the objects in the file. If the model contains an extensive number of small objects with fine detail this can greatly slow the cut process by so focus on larger geometries and surfaces and avoid excessive routing times. Finally, the maximum depth for cutting is 4" so avoid creating models thicker than 4 inches. There are methods to create deeper models but discuss this BEFORE buying material.

# CUTTERS

The Materials Lab keeps a large inventory of cutter bits available for the router. From large 0.75” bits to fine .063” bits for small detail work, there are multiple bits and multiple choices to be made when creating a file. As with overall model size, the size of the bit greatly effects the cut time. When using a larger bit there is an increase in the amount of surface area of the bit as well as an increase in the forward speed of the cutter. This means larger bits can remove more material per a pass which achieves greater speed. Creating larger geometries that utilize larger bits can greatly speed your cutting process.

There are other factors related to edge conditions, material hardness, finish quality, resolution, forward speed as well as many machine-related factors. Please ask questions about your particular file BEFORE buying material or setting up the final cutting model.

## CHARACTERISTICS

The CNC router uses a rotary cutter which removes material from the stock piece. No matter how small a bit you choose the inside corners of any piece will always have a radius equal to the radius of the bit. This is an inherent part of using a rotating cutter so there is no way to make square cornered holes on the CNC router. There are techniques to help you around this limitation but you need to plan them into your file BEFORE preparing the file for cutting.

Also, the bit travels in a path across the surface when it is cutting. This will leave tool marks no matter how small the step-over. Rather than fight this with extensive post-sanding or minute step-overs, plan for this as a natural remnant of the machine process and incorporate it into your design.

## CONSTRAINTS

Size:	The cutting area is 48” x 96” x 4”
Time:	Plan for at least 24 - 48 hours
Bit Sizes:	From 0.75” to 0.063”
Bit Types:	Downcutters, Roughers, Ball Nose and V-Carve bits are available
Cost:	There is no cost other than students purchasing their own material
Units:	Use Inch units in your model
File Type:	A Rhino ‘3DM’ file or an ‘STL’ or ‘OBJ’ from other software