Inventables – Carvey CNC Router

Standard Operating Procedures (SOP)

Training:	Required
Reservation:	Required

Please check with makerspace staff to confirm minimum age certification requirements to use this machine with supervision and without supervision

Updated September 2022

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Certification Training

To become certified on this piece of equipment you will need to attend a training class. By the end of the class, you will be able to:

-Know how to safely operate the Inventables – Carvey CNC Router.
-Understand basic design options in Easel software.
-Know how to tidy up the CNC Router workstation after use.

To sign up for a training session please inquire at the front desk.

Reservation

To reserve this piece of equipment you will need to first be certified on this equipment. After you have attended a training for the equipment, you may sign up for a time slot to use the equipment. Inquire at the front desk for more information.

Key Concepts

Router

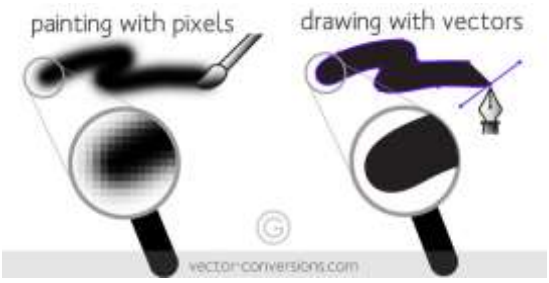
A router is a piece of equipment used to hollow out, carve, and/or cut through material. Traditional router materials include woods, plastics, and in some cases metals. A router by itself is a motor with an attachment for holding onto various bits. The style, shape, and size of the bit are highly dependent on the task and material at hand. (See the Bit Chart and Bit Description on pages 22 - 23 for more information on when to use which bits.)

CNC (Computer Numerically Controlled)

CNC is the abbreviated term for “Computer Numerically Controlled” or something that is operated with the control of a computer. A computer turns the tool on, sets the speed, and moves it in space to generate a carve path and control the machine as it carves out a design.

Raster vs. Vector

Two-dimensional images can be created using two different methods, either a raster or a vector. Raster images are composed of pixels and are capable of capturing a lot of detail—photographs are an example of raster images. Vector images are composed of perfect mathematical curves and can be infinitely scaled without a loss of quality—text in a text editor is an example of a vector image. Many makerspace machines requires vectors to operate. The CNC router specifically will only cut vector lines. However, you can convert an image from a raster to a vector. See page 19 for more information.



Reference Sheet

Approved Materials:

ABS	Delrin	FR1 Circuit Boards
Acrylic	Machinable Foam	Expanded PVC
Aluminum*	Natural Hard/Soft woods	Machinable Wax
Corian	HDPE	

** Safe limits for Aluminum are as follows: 5"/min feed rate, 2.5"/min plunge rate, 0.003"/pass with minimum 0.0625" milling bit.*

NOTE: The Carvey can mill a number of different materials including woods, plastics, and some non-ferrous metals if the proper procedures are observed. Every material cuts a bit differently and will require a different feed rate and depth per pass to be cut successfully. Easel (the software used with the Carvey) has presets for commonly used materials that are an excellent place to start. Note that these presets are mainly designed for 1/8" and 1/16" bits. If you are using larger or smaller bits, you may have to slow the feed rates a bit to ensure proper carving performance.

Maximum Material Dimensions:

X-axis: 12 inches width (30 cm)
Y-axis: 8 inches depth (20 cm)
Z-axis: 2.75 inches thick (7cm)

Machine Accessories:

Digital Calipers
Spindle Wrench (13 mm) (use in left hand)
Collet Nut Wrench (17mm) (use in right hand)
Super Short, Short, Medium & Long Plastic Clamps/Hold-down Pieces
Short, Medium, Long, & Extra Long Hold-down Bolts
Short & Tall Aluminum Stepped Blocks (Standoff Boosters)
Assorted Cutting/Milling Bits with plastic color-coded collars

Workflow:

Design (http://easel.inventables.com/)
    Enter Material, Material Dimensions, and Bit to be used in software
Clamp material, install bit (with machine off)
Power Machine on, Carve
Power off machine, Remove Bit and hold-downs and return to kit
Vacuum sawdust and debris (before and after removing material)
Remove work product and finish vacuuming

Software:

Beginner: Easel http://easel.inventables.com/
Available: CorelDraw
Advanced: Fusion 360, CAD, Adobe Illustrator and others

Equipment, Accessories & Materials Used in Training

Carvey Desktop CNC Router	Vacuum with hose
Computer with Internet access	Router Bit
8” x 12” x 1/2” Plywood	Digital Calipers

Training Overview

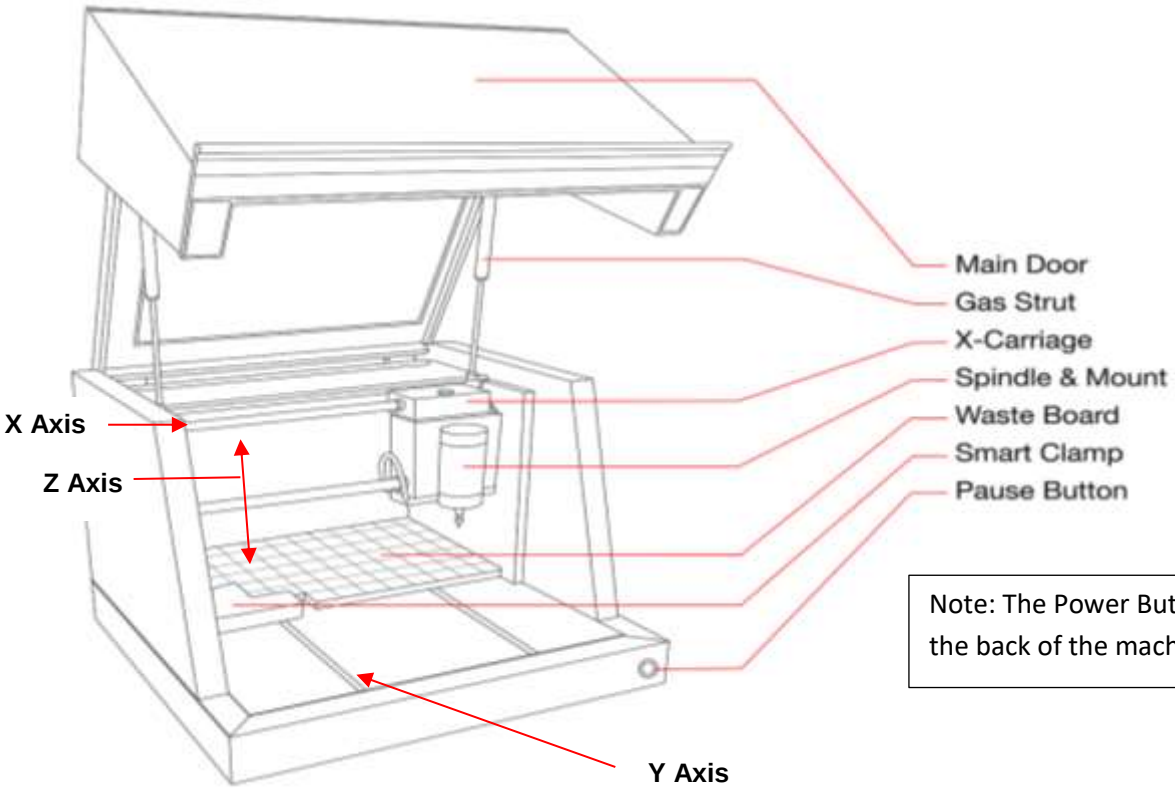
Makers will learn how to operate the Carvey Desktop CNC Router to carve plywood. Lessons learned may be applied to other materials and projects.

Safety

- Ensure the machine is turned off before securing material or changing bits. The button on the front is only the “Pause” button; the on/off toggle switch is on the back of the machine. The manual also recommends that the machine be unplugged when changing the bit.
- Improperly secured material may come loose and damage the machine.
- If the machine is not set up correctly, router bits may break.
- Securing the material before inserting the bit will help to ensure you do not cut yourself on the overhead bit while you are working to secure the materials.
- Removing the bit before removing your finished project and vacuuming will also help to ensure you are not cut or scratched on the overhead bit.
- Keep hands clear of pinch points when opening and closing the front cover.
- Keep hands clear of pinch points on the panel behind the spindle.

Note, although the machine is designed not to carve when the lid is open, making sure the machine is powered off when there is a bit in the machine is the only way to ensure your safety.

Machine Layout & Part Identification



Note: The Power Button is on the back of the machine

X-axis: 12 inches width (30 cm)	The X-Carriage moves from side to side on the X Axis
Y-axis: 8 inches depth (20 cm)	The floor moves forward and back on the Y Axis
Z-axis: 2.75 inches thick (7cm)	The mount moves up and down on the Z Axis

Although there is a “Pause” button on the front of the machine, the actual power toggle switch in on the back just under the lid/door hinge (you can access it with your right hand).

When the top of the button is pushed in, the machine is turned on. When the bottom of the button is pushed in, the machine is turned off. The **"I"** represents **Power ON** and the **"O"** represents **Power OFF** (Figure 1).

Figure 1 – Power Toggle Shown “Off”

Aluminum Stepped Blocks or Standoffs

Bolts

Plastic Clamps or Hold-Downs

Design, Easel Software, Import Options

1. On the computer use a browser to go to easel.inventables.com
   Create a “free” account if you do not have one. Create a new document. The Easel Design Interface uses a left-hand screen for editing designs and a right-hand screen for showing a preview of your job (Figure 2)

Figure 2 – Easel Interface

2. The Easel software is used for several routers to include the Carvey. In order for Easel to know what machine you are using, Click on “Machine” in the upper left hand corner and select “Carvey” from the drop-down menu.

3. In the “File” drop-down menu, we can choose between New, Open, Rename, Make a Copy, Import SVG, Import g-code, etc. For our training, we will select “New” or click on the green “New Project” button in the top right-hand corner.

4. Set up your piece by editing the “Material and Material Dimensions” in the upper right-hand corner by clicking on the box labeled “Birch Plywood” (assuming that is the material you are using). By default, Easel assumes you have a full size piece of birch plywood.

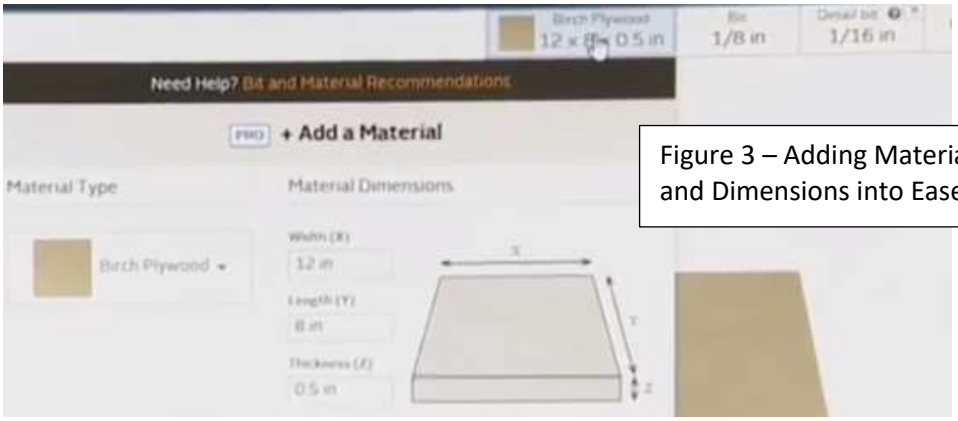


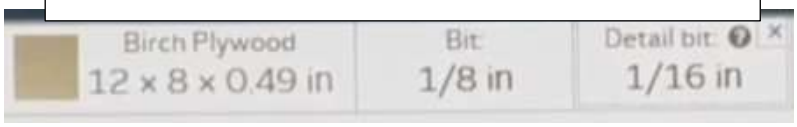
Figure 3 – Adding Material and Dimensions into Easel

   Update your material type to what you are machining as well as the material dimensions of your piece (Figure 3). Entering accurate measurements are important. See page 13 for “Measuring your Material.”

Note: You must use the digital calipers to measure the thickness of the material, if you are unsure of how to use the calipers please consult makerspace staff. Inaccurate thickness measurements could ruin the waste board underneath.

5. Set up your bit by clicking on the box labeled “Bit” in the upper right hand corner. Select the bit you will be using from the drop down list with pictures. If you are unsure which bit to use, consult the bit chart and descriptions on pages 22 – 23.

Figure 4– Selecting your Bit or Bits in Easel Software.



You will notice two bit-related boxes on the screen. One is marked “Bit” and the other is marked “Detail bit” (Figure 4). There are various sizes of bits. A 1/8” bit cannot do detailed carvings but it cuts quickly. A 1/16” bit does more detailed work, but takes much longer to do so. To both save time and get the best-detailed results, you can enter two bits. One to make the first pass and do a rough cut with a larger bit, and then changing the bits to do the finer more detailed work with the finer bit. In our training, we will just use a single bit—the blue collared bit.

6. The left-hand side of the screen features several menu options (Figure 5).

The top one is the **“shapes tool”** for you to grab and insert a shape. For training, we will be grabbing the “Star.”

The next one features a **“line tool”** represented by a fountain pen. You can draw lines with this tool.

The third one is a **“drill tool.”** This will come in handy if you would like to drill a hole into a board to hang it on the wall.

“T” represents the **“text tool.”** Use this to add text with font and style options.

A smiley face represents the **“design library.”** Scroll through the list of designs or use the search box to find what you are looking for.

The picture of a building represents the **“Inventables library”** of pre-produced projects that you can grab and use.

The bottom **“Import tool”** allows you to import designs created in other programs you might have access to.

Figure 5 – Menu Tools at Left

Additional design tool information is covered on page 11.

Note: The computer attached to the Carvey features Corel Draw software. For designing using CorelDraw, refer to pages 19 – 20.

7. For our training lesson, start by placing a star in the middle of your work piece. To do this click on the box in the upper left hand corner that has a square, circle, triangle, and star, and then click on the star to automatically place a star in the workspace. In Figure 6, you will notice on the design half (left side) of your screen a star appeared. It will have the points around the perimeter along with an extended handle. You can use the perimeter points to stretch or resize your shape. You can pull the extended handle to rotate the star.

8. You will notice to the right are options under two tab headings—Cut and Shape. We will first look at the "Cut" tab. For our training project, adjust the depth of the carving by moving the slider to 1/16" or typing .0625 in the depth field (Figure 6). However when doing your own projects, you can use other depths to include cutting all the way through the board (accomplished by moving the slider all the way down). More information about cutting through can be found on page 12.

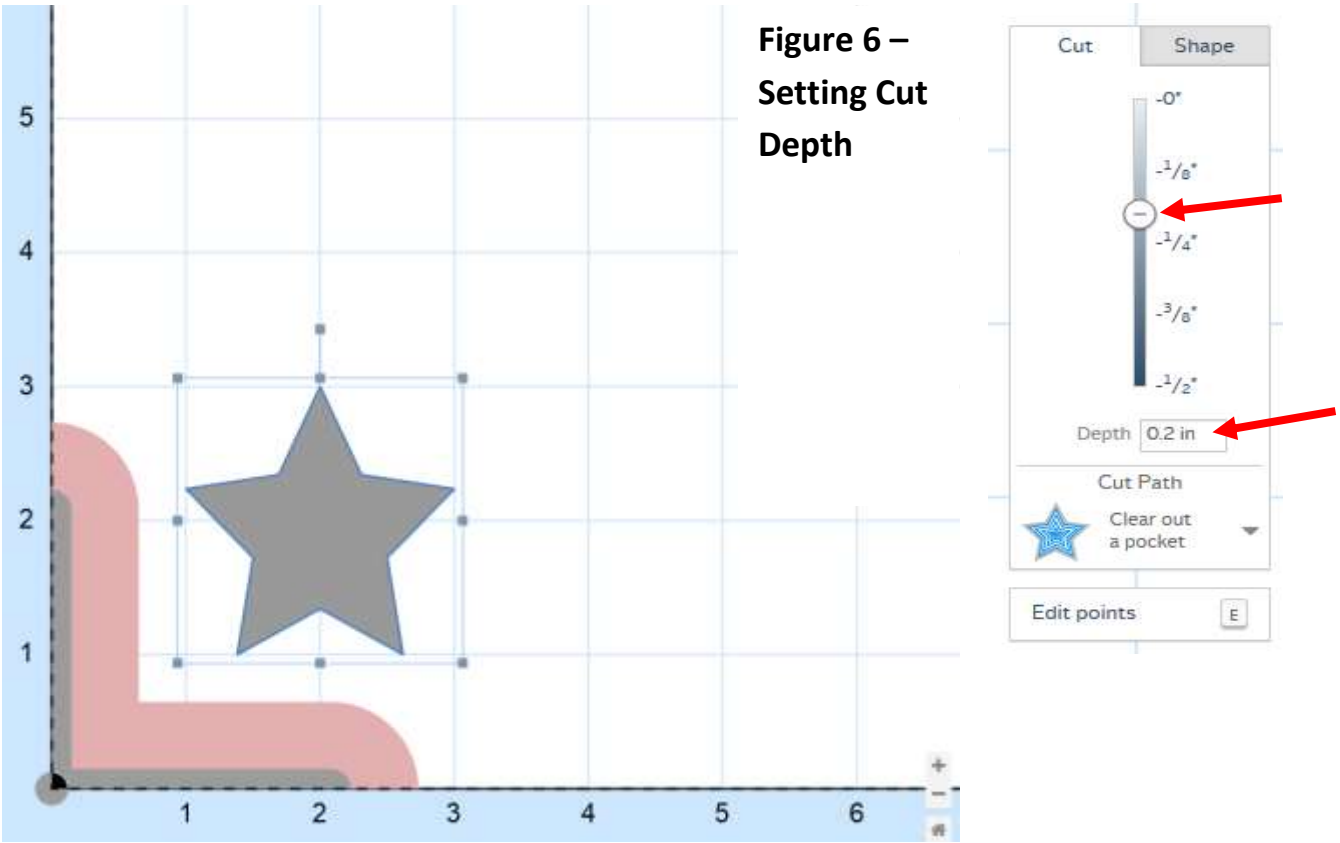


Figure 6 – Setting Cut Depth

9. Under the depth selector is the Cut Path drop-down box (Figure 7). From there you can choose between Clear out a pocket; cut on shape path; cut outside shape path, cut inside shape path. “Clear out a pocket” indicates that you want the router to grind out everything in the middle of your shape. The other options “cut on, cut outside of, or cut inside the shape path,” are self-explanatory.

Figure 7 – Cut Path Options

10. There is also a “Shape” Tab that you can toggle from “Cut” to “Shape.” As you can see from the “Shape” menu (Figure 8), you can enter your preferred width, height, rotation angle, and you can even round the corners of your shapes. Although you can drag your shape to anywhere on your design area, you can also indicate an exact position on the Y and X-axis if you need to hit a precise location for your project.

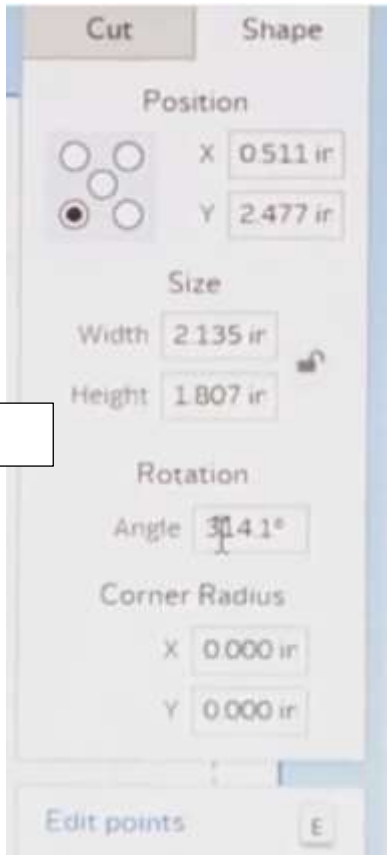
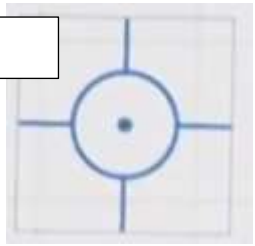


Figure 8 – Shape Options

11. Simulate the cut by clicking “Simulate” in the lower right hand corner of the preview screen. Note the time estimate in the lower right hand corner. As you view the simulation on the screen, the blue lines are the toolpath when it is carving the material and the red lines are the toolpath when it is not carving the material.

More About Easel's Menu Selections (Left side of Design Screen)

Figure 9 – Drill Tool



Drill a Hole—The drill tool (Figure 9) on the left hand side of the design screen will come in handy if you would like to drill a hole into a board to hang a project on the wall.

Adding Text to you Project—The "T" or Text tool (Figure 10) on the left hand side of the design screen can be used to add text to your project. You can make adjustments with text from this screen just as you can with shapes.

Figure 10 – Text Tool

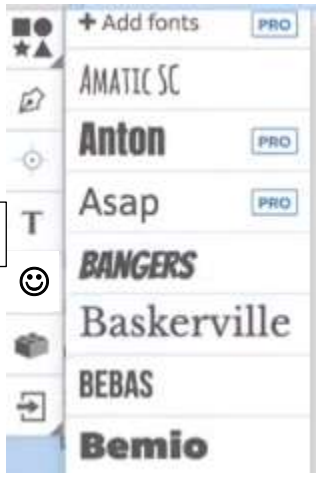


Figure 11 – Design Library

Adding Quick Pictures/Icons to your Project—The Design Library tool (Figure 11) represented by a Smiley Face on the left hand side of the design screen can be used to add pictures and designs to your project. There is also a search feature so you can search for images you might be interested in such as Dog, Balls, Traffic Signs, etc.

Pre-Produced Projects from the "Inventables" Library—You will notice the "Inventables Library" tool (Figure 12) that is represented with a building in the left-hand menu. Here you will find a variety of pre-produced projects that you can grab and use. The "inlayed" projects that are made of two difference pieces of wood are particularly eye-catching.

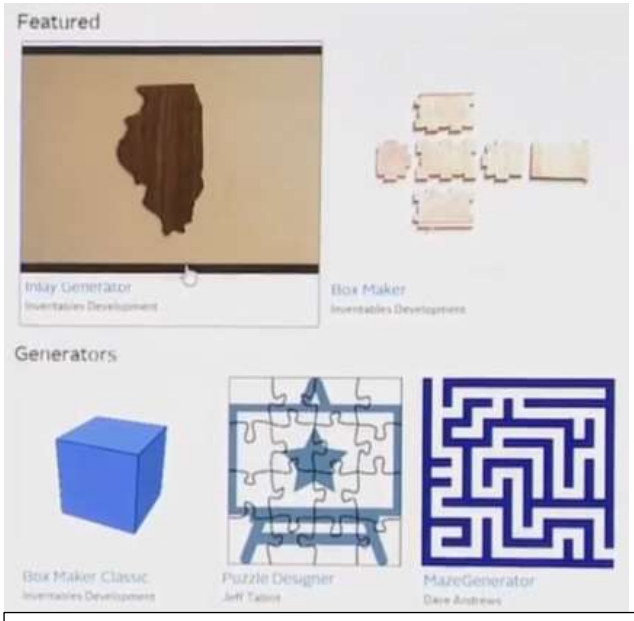


Figure 12 – Inventables Library

Importing Images and Files—SVG, DXF and gcode files are supported by Easel. You can upload JPG and PNG files through the Image Trace app. The Importing Tool icon is an arrow entering a box.

More Tips Using Easel

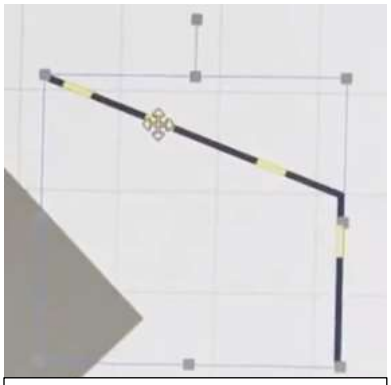


Figure 13 – Yellow Tabs

Cutting through your Material—If you elect the deepest cut—to cut through the entire depth of your material, you will notice on the design screen that it shows yellow tabs where it will "not" be cutting through the entire material (Figure 13). This is because if it cut a solid connected line through the material (square, circle of other shape), the material will start to shift because the hold-downs would no longer be effective if there is a "floating piece of material."

If you select a depth that cuts through your material, a tabs checkmark will be below the depth menu. When you click on tabs, you see menu options so you can edit the tab length, height and number of tabs. You will also be able to click and drag the yellow tabs on your design screen. Although you can eliminate the tabs, your bit will likely jam, break, and you could ruin your project. After your project is complete, you will need to use a hand tool to remove the tabs that continue to hold the work piece together. After popping out the tabs, sand the edges smooth using sand paper.

More about Cut Settings and using more than one Bit—As mentioned on page 8, you can save time while still getting the best end product by using two bits to complete your project. You will notice that there are actually two bit-related boxes. One is marked "Bit" and the other is marked "Detail bit." There are various sizes of bits. A 1/8" bit does not do detail carvings but it cuts quickly. A 1/16" bit does more detailed work, but takes much longer to process. To both save time and get the best, detailed results, you can enter two bits. One to make the first pass and do a rough cut with a larger bit, and then changing the bits to do the finer more detailed work with the finer bit.

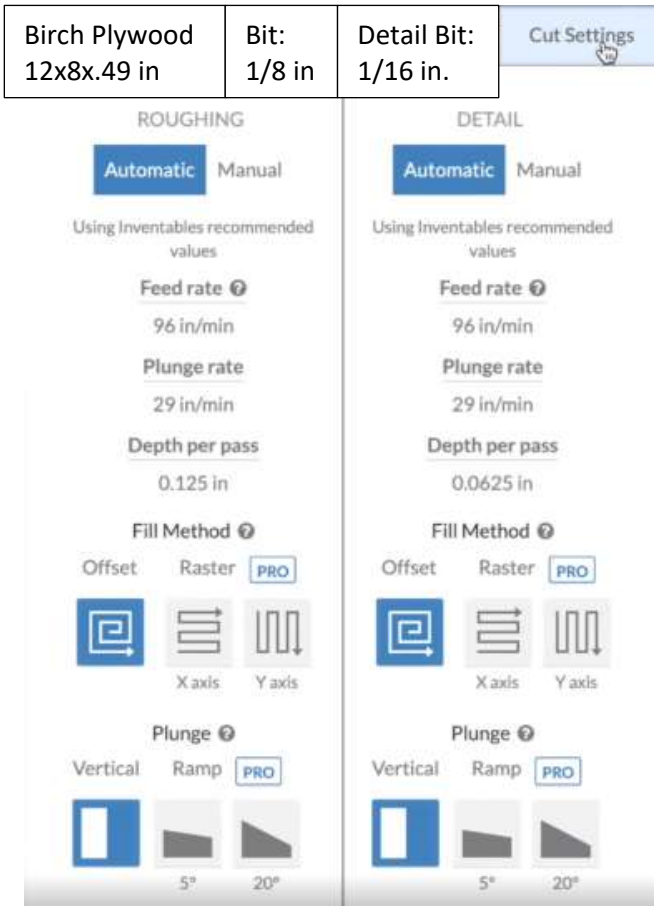


Figure 14 – Cut Settings Menu Featuring Two Bits

You will notice that Easel will default to using Inventables' recommended values for Feed Rate, Plunge Rate, and Depth per Pass for both the Roughing pass with the larger bit, and the Detail pass with the finer bit. If you need to make manual adjustments, you can make them on this screen (Figure 14).

Online Easel Guide--Although we could include an entire guide on how to use Easel, Inventables has an online guide at: https://inventables.zendesk.com/hc/en-us/sections/360002670833-Easel-Guides

Measure Your Material

1. Before securing material, measure the thickness using the digital calipers (Figure 15). Write this number down on a piece of scratch paper. Note that the thickness of your material may vary from the example; use the measurement from your caliper reading. Note a ½-inch thick board is NOT actually that thick—so use the calipers to measure the actual thickness.

Figure 15 – Measuring Material Thickness

   Important Note: Measuring the thickness of your material with digital calipers is important because inaccurate measurements may cause the router to cut too far into the waste board—potentially making that waste board or some of the mounting holes unusable. Because Carveys are no longer being made, acquiring additional pre-made waste boards will also be impossible at some point in time.

2. Using a tape measure, you should measure the length and width of your material. Write down the length (longest dimension) and width (next longest dimension).

Clamping/Securing Your Material

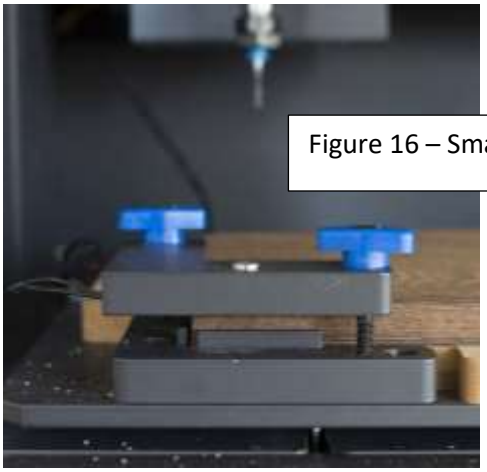
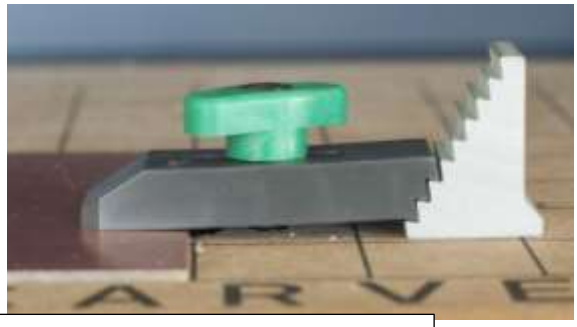


Figure 16 – Smart Clamp

Your Carvey comes with clamping hardware to secure materials to the waste board for cutting. The Smart Clamp is the main L-shaped clamp located at the lower-left corner of the carving table. It is secured by two hand-tightened bolts of the same length (Figure 16). This clamp has a sensor that allows your Carvey to automatically zero your Z-axis to the top of whatever material you are using. It is vital you use the Smart Clamp to secure your material on every carving job. If you do not use the Smart Clamp, you risk damage to the machine.

In addition to the Smart Clamp, the Carvey comes with clamps that are secured to the threaded inserts of the waste board by hand-tightened bolts and are supported on the other side by stepped blocks or standoffs (Figures 17).



Figures 17 – Clamps used with Stepped Blocks/Standoffs

The clamps and bolts come in several lengths that are used in conjunction with several heights of support stepped blocks to clamp materials to clamp materials of various thicknesses.

Figure 18 -- Power Switch Shown "OFF"

1. To begin make sure the machine is powered off. The on/off toggle is on the back of the machine, under the right door hinge, push in the bottom of the toggle marked "O" to turn the machine Off (Figure 18).

2. Now open the machine's door by lifting up on the handle. Clear your cutting table (the waste board) of any obstruction and debris, then remove the Smart Clamp (Figure 19). Take care not to stress the wires attached to the Smart Clamp.

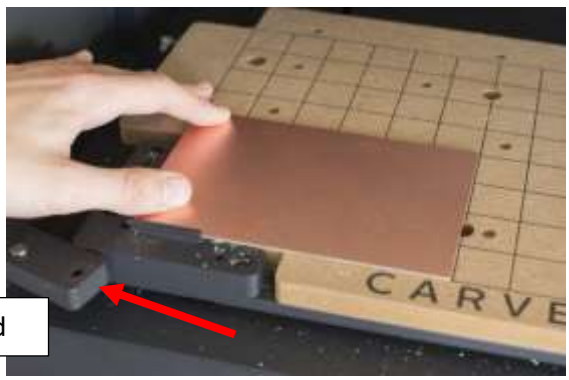


Figure 19 – Smart Clamp Removed

3. Position your material against the metal locating bracket in the front left-hand corner of the board, then reposition the Smart Clamp and reposition the green-headed bolts to loosely secure the Smart Clamp on top of the material (Figure 20).

Figure 20 – Replace Smart Clamp

The Smart Clamp has an L-shaped groove on its underside that must be mated with the similarly shaped protrusion on the base plate. When the material is thicker than the protrusion, take care to ensure that the clamp is properly aligned (flush) with the base plate.

4. Secure the other sides of your material not held by the Smart Clamp. Locate the best mounting holes to secure your material.

Figure 21 – Securing Plastic Clamp on the Stepped Block

For our ½-inch thick plywood used in our training, we will use three short aluminum standoffs, three medium gray plastic clamps/hold-downs, and the blue-headed bolts to secure the plywood.

Set a stepped block/standoff in the upright position, then mate it with the tooth end of the gray hold-down clamp just above the top of the material so the clamp presses onto the material at a slight downward angle (Figure 21). Use the bolt to loosely secure the clamp. Repeat this process for the rest of the clamps. Now tighten ALL of the bolts to include the ones on the Smart Clamp, alternating sides to ensure the material is tightly and evenly secured to the bed.

To maximize clamping strength, always choose the shortest pieces of clamping hardware that will still allow for proper tool clearance. The plywood should be secure, if you can move it without loosening the standoffs it is not secure enough. (See Figure 22 for our newly secured material.)

Note: The aluminum standoffs and hold-downs cannot extend past the back of the cutting bed or the machine will not operate. Be aware that the bed will move forward and backwards during carving.

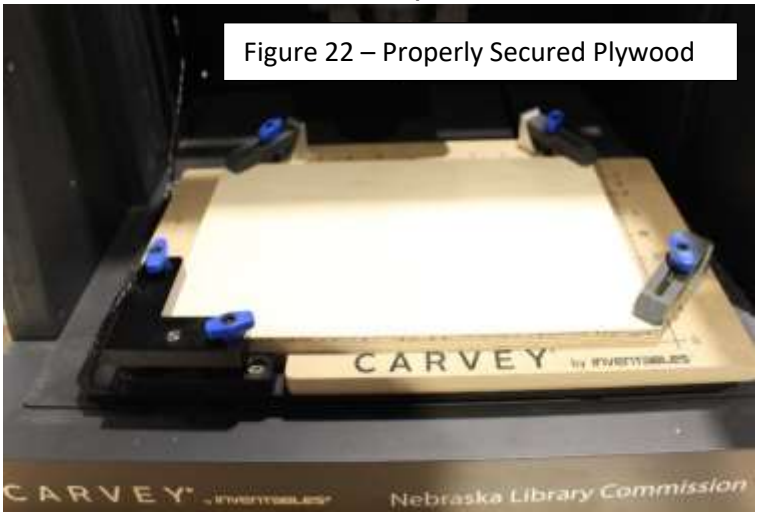


Figure 22 – Properly Secured Plywood

Check that the plastic hold-downs are not where the CNC will be cutting, as the machine will cut through, damage the hold-downs, and may break the bit. Once the material is secured and unable to move, proceed to installing the bit.

Install the Bit **(after you secure your material)**

Note: Generally, when you begin to use the Carvey, it will not have a bit in the collet. However, if there is a bit installed and it is the wrong bit for your project, you will find the “Remove the Bit” instructions on page 18.

Figure 23 – 1/16” Spiral Bit

1. After you have secured and clamped your material, you can install the bit. Begin by making sure that the Carvey is turned off. For training, we will use a 1/16” spiral upcut bit with a blue collar (Figure 23). (Note: outside of training you will want to select a bit that fits your material and task. See bit selection information on pages 22-23.)

   Before we insert the bit, we will first loosen the collet nut. ALWAYS hold the smaller of the two wrenches (the spindle wrench) in your left hand and the larger of the two (the collet nut wrench) in your right hand. (If you switch hands then the push and pull instructions are mixed up.)

Figure 24 – Loosen the Collet Nut by pulling the wrench handles towards you

   Using the smaller wrench in your left hand, slide it onto the router shaft or spindle to prevent the shaft from spinning. Using the larger wrench in your right hand slide it onto the bottom part of the collet nut (Figure 24). Loosen the collet nut by pulling your hands toward you in preparation for inserting the bit.

2. Always make sure the collet nut is free of debris and obstruction before inserting a new bit. Insert the router bit until the plastic collar hits the collet nut. Then tighten the collet by holding the wrenches as described in Step 1 (Figure 25) but this time pushing your hands away from you to tighten (Figure 26). Check that the router bit is properly installed and snug in the collet (Figure 3). If the collet is not tight enough, the router bit may slip out of the collet during the job. 4

Figure 25 – Installed Bit

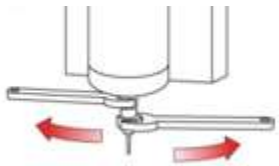


Figure 26 – Push back on the wrench ends to tighten and secure the bit

Carve

1. Power on the Carvey and close the door. Back at the computer, in the upper right hand corner of the Easel interface select “Carve” (Figure 27).

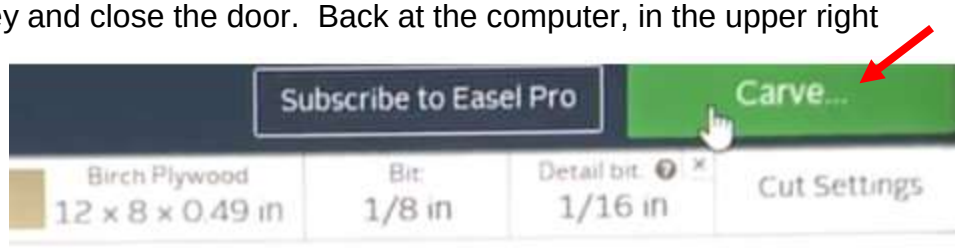


Figure 27 – Carve Button

2. The software will prompt you to verify the material and dimensions of your work piece. Refer to your measurement notes.

Figure 28 – Steps Easel Incorporates to Verify you are Ready to Carve

It will go through each step to confirm that you have fed in your selections and have completed all the steps (Figure 28). It will go through:

Measure Material	Choose Pass Type (Rough or Detail)
Position Material	Confirm Bit
Secure Smart Clamp	Start Carving
Secure Side Clamps	

3. Once that checklist has been confirmed, standby when the CNC begins to cut the material. You may pause the job from the Easel interface by pressing the pause button at the computer, or by pressing the “Pause Button” on the front of the machine. Stay near the machine while it is operating in case of an error.

4. When the Carvey machine is done cutting, the spindle will turn off and the head will return to its home position. Turn the Carvey off with the switch on the back of the machine. Clicking the bottom of the toggle in is the “Off” position. You may now lift up to open the door.

5. Go directly to the steps that follow on the next page.

Remove the Bit, Shutdown Procedure & Cleanup

1. **Remove the Bit**—Make sure the Carvey of powered off. Remove the bit before removing material to prevent accidental cuts and scratches. Remove the bit by loosening the collet nut on the spindle. Always put the smaller spindle wrench in your left hand and the larger collet nut wrench in your right hand. Slide your left hand's wrench onto the router shaft or spindle. Slide the right hand's wrench onto the bottom part of the collet nut below. Loosen the collet nut by pulling the ends of the wrenches towards you to loosen the nut (continue to loosen it by hand if necessary). You should now be able to pull the milling bit straight out of the collet. Store the bit with the rest of the Carvey bits.

2. **Remove the Hold-downs**—Remove the hardware (bolts, gray hold-downs and standoffs) that was securing the work piece to the waste board and store those accessories in the hardware box (Figure 29). Keep the Smart Clamp and the bolts that hold the Smart Clamp secured in the machine.

Figure 29 – Accessories Box

3. **Vacuum**—Carvey lacks a dust collection system so makers should clean out the build area after each job with a vacuum. You can first vacuum your newly carved piece. Once your material is removed, you can use a brush to move dust and debris away from hard to reach corners before vacuuming out the machine. Do not use liquid cleaning agents or solvents to clean the Carvey. This can damage the machine.

4. **Finishing Touches**—You may want to use sand paper to smooth out any imperfections on your project. Do this at a location that does not create a mess. Makerspaces may prefer you did this step outside or at your home.

5. **Log out of your "Easel" Account**—Don't forget to log out of your personal "Easle" Account. Check with makerspace staff to see if you should turn off the computer or leave it on.

CorelDraw Trace Guide

Many makerspace machines requires vectors to operate. The CNC router specifically will only cut vector lines. (See Key Concepts for more on Raster vs. Vector on Page 3.) There are two options to convert an image from a raster to a vector. First is to manually recreate the design using CorelDraw's drawing tools. This option can be more accurate to the actual design but it takes a lot of time and expertise. Tracing is a function in CorelDraw that will automatically convert raster images to vector images based on a few parameters.

Begin by pasting or importing an image into an artboard.

Copy/Paste

Right click on an image and select "Copy" to place the picture on the computer's virtual clipboard. Right click on the artboard in CorelDraw and select "Paste" will add the image to the artboard. Not all images can be put onto the artboard in this way. If this fails move on to the "Import" option.

Import

Save the file to the computer (either the desktop or a flash drive) and then go to your CorelDraw file. Select "File" and then "Import." Navigate to your file and select "Import." A single left click will place the image on the artboard, or by left clicking and dragging you can specify the size of the object.

With the object now on the artboard and the object selected, click "Trace Bitmap" in the upper toolbar (Figure 30). There are different preset Traces depending on what sort of image you are tracing, try experimenting with them to find the one that works best for your image.

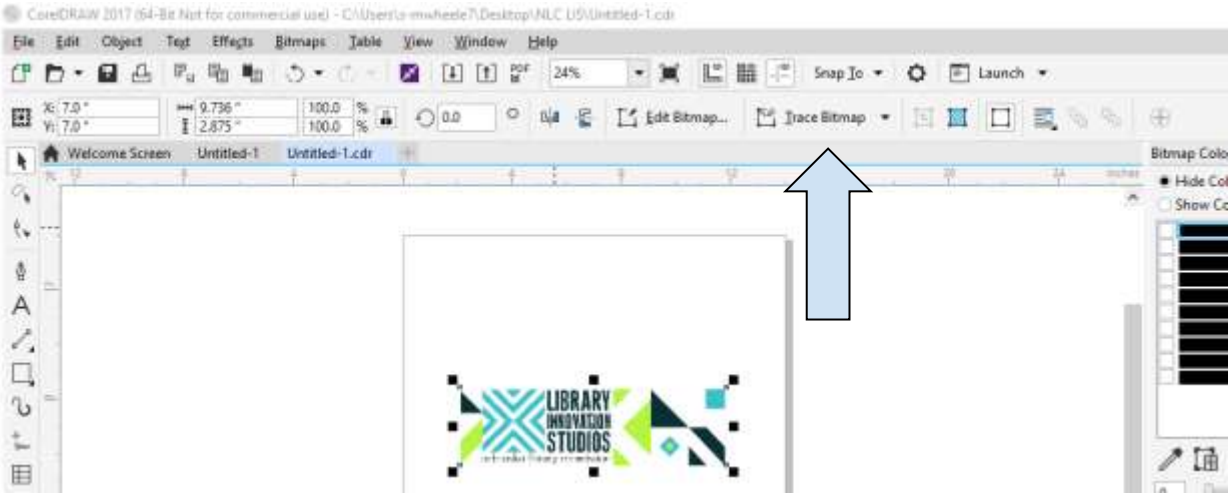


Figure 30 – Trace Bitmap in CorelDraw's Toolbar

Each trace will show the original image and a preview of the Traced image. By adjusting the Detail, Smoothing, and Corner Smoothness sliders you may find more or less accurate results (see Figure 31). You will find there are some details that do not trace well. Overly complicated designs or small text will often be ignored by the Trace function.

For best results with the CNC Router, do not use overly detailed designs. The CNC router has limitations on the smallest piece that it can make and if Easel detects that a design is too small to machine it will just leave that part off the design.

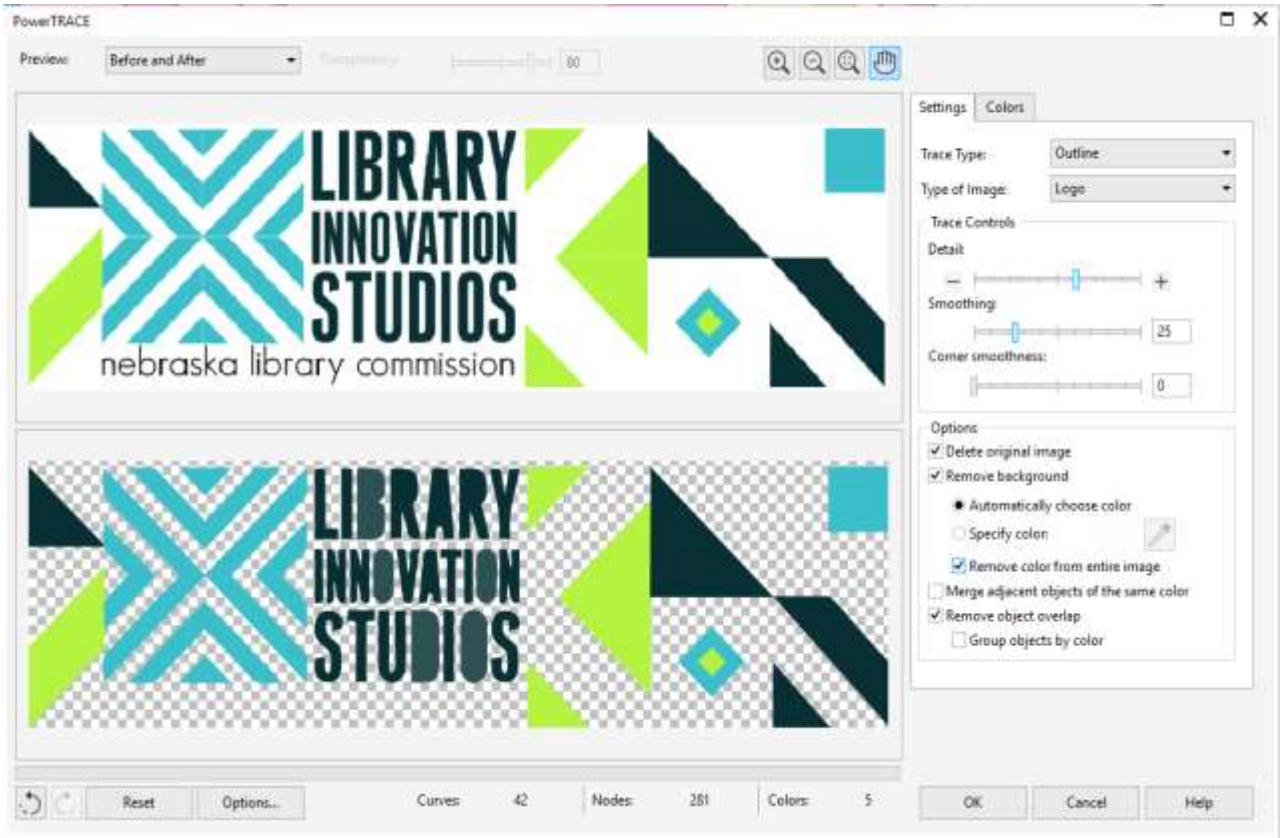


Figure 31 – PowerTRACE Screen Showing Sliders and Options

After clicking “OK,” the design has now been converted to a vector design and it may be saved as a .svg file and imported into Easel.

Additional Resources

Advanced Design and Toolpath Creation - Fusion 360
https://www.autodesk.com/products/fusion-360/

Inventables Easel Guide https://inventables.zendesk.com/hc/en-us/sections/360002670833-Easel-Guides

Carvey Manufacturer's Manual -- http://carvey-instructions.inventables.com/

This Carvey Standard Operating Procedure manual can be downloaded from:
https://nlc.nebraska.gov/grants/InnovationStudios/Components/Equip_Instructions.aspx

Troubleshooting

Problem: The machine will not proceed past initialization during Carve.

Solution: Aluminum standoff or plastic hold-down may be extending past the end of the bed. Rearrange the hold-downs so that they do not hit the back of the housing.

Problem: Easel cannot connect to the Carvey CNC Router

Solution: Unplug Carvey's USB cord from the computer, wait a moment and retry the connection.

Replaceable Parts

Parts available through Inventables.com include the bits, clamps, bolts, stepped blocks, waste board, the acrylic window on the door, the Smart Clamp, the spindle, and the belts. For those parts that need to be installed, the Inventables website walks makerspace staff how to change out these replacement parts.

Changing out the Waste Board is included on pages 27-18 of this document. This task should be left to makerspace staff and not to makers.

BIT CHART

Upcut Bits

	Single Flute	Three Flute	Four Flute	Fishtail		
	 1/8 in	 1/8 in	 1/8 in	 1/32 in	 1/16 in	 1/8 in
Wood Hardwood Softwood Plywood MDF	—	—	—	—	—	—
Plastic Acrylic HDPE ABW	✓	✓	✓	✓	✓	✓
Expanded PVC	✓	✓	✓	✓	✓	✓
Linoleum	✓	✓	✓	✓	✓	✓
Corian	✓	✓	✓	✓	✓	✓
Aluminum	✓	—	✗	✗	—	✓

Straight Bits

Downcut Bits

	Straight Cut		Fishtail	
	 1/8 in	 1/32 in	 1/16 in	 1/8 in
Wood Hardwood Softwood Plywood MDF	✓	✓	✓	✓
Plastic Acrylic HDPE ABW	✓	—	—	—
Expanded PVC	✓	—	—	—
Linoleum	✓	—	—	—
Corian	✓	✓	✓	✓
Aluminum	✗	✗	✗	✗

✓ Best, requires minimal sanding/finishing

— Ok, but rough finish. Requires significant sanding/finishing

✗ Bad, not recommended

See Next Page for Additional Information about the Bits on this Chart

BIT CHART (Continued)

Note: All bits are color-coded and have their name and size of the bit written on the colored collar.

Straight Bits
This end mill has two straight flutes. It works well for materials where the lifting effect of a spiral flute might cause unwanted results, like wood or things with thin laminates or veneers.

Single Flute Bits
The spiral upcut bits pull chips from the cutting surface upwards, leaving a flat-bottomed pocket. This provides accurate cuts without chatter in the plastic because the chips are being evacuated away from the cutting edges. This bit is not recommended for wood because it pulls the wood fibers causing tear out.

Three - Four Flute Bits
Great for applications with high feed rate or slow spindle speed. Slow feed rates or high-speed spindles will cause excess heating in bits with high flute counts. Excess heating can cause chips to weld to the bit when cutting plastics and metals, premature tool wear, and poor cut quality.

Fishtail - Upcut Bits
These fishtail bits are great for fine detail and inlays. The upcut tip design creates a cleaner edge on the backside of the sheet when cutting through materials. The flute design works well with high-speed spindles and high feed rates.

Fishtail - Downcut Bits
These fishtail bits are great for fine detail and inlays. The downcut tip design creates a cleaner edge on the topside of the sheet when cutting through materials. The flute design works well with high-speed spindles and high feed rates. They are also good for cutting thin materials since the downward force tends to keep the material flat.

FOR MAKERSPACE STAFF: Cleaning and Maintenance

Cleaning your Carvey (this step to be completed after each use by the maker)

Carvey lacks a dust collection system so we recommend cleaning out the build area after each job with a vacuum. You can also use a brush to push dust and debris away from hard to reach corners before vacuuming. Do not use liquid cleaning agents or solvents to clean your Carvey. This can damage the machine.

How to Remove Floor for Periodic Cleaning (perhaps once a year)

Tools required: 2mm (or 5/64") Hex Key

The metal floor of the Carvey conceals the electronics and the X-axis motion control systems of the machine. The slots in the floor allow the X-axis carriage to move freely, however they also allow debris and small parts to fall through. Whether it is for regular maintenance or to retrieve a lost item, this floor can easily be removed.

Step 1: Prepare

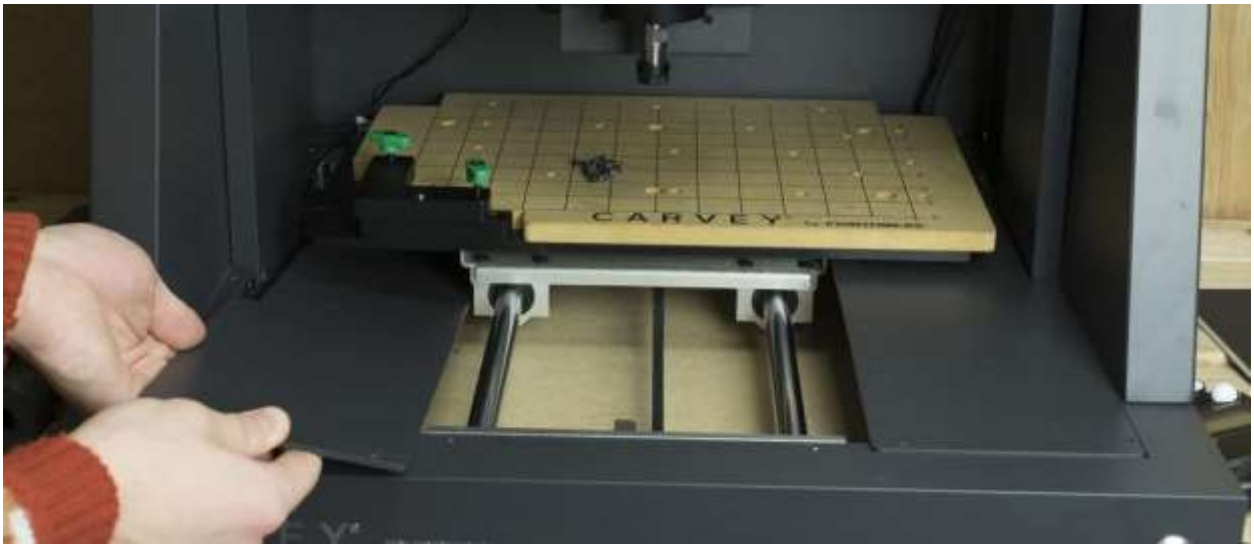
Shut down Easel and disconnect your Carvey from your computer. Power down and unplug your machine. Remove any milling bit that may be present in the spindle. Remove any materials and/or clamps (excluding the Smart Clamp) from your Carvey. Use a vacuum and soft brush to clear out any excess sawdust or debris from the waste board and the floor. It is a good idea to have a small bowl handy to put the small M3 screws in.

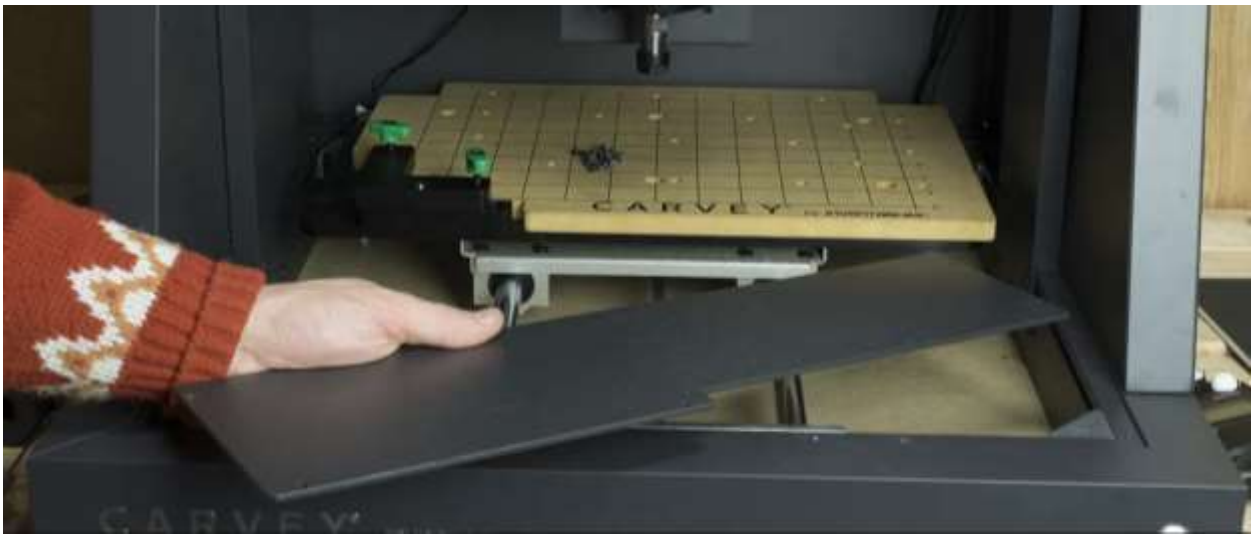
Step 2: Remove the Floor Mounting Bolts

The three plates of the floor are held down by 14 M3x8 button head cap screws. Five on the left and right plates and four on the central plate. These accept 2mm hex keys, though a 5/64" (~1.98mm) key is generally fine to use if it is the only thing you have on hand. Avoid using any hex key with a ball head with these small screws as they have a greater chance of stripping the head. If you do strip the heads of any of the screws, you can generally use a small pair of pliers to loosen the screw head until it can be backed out by hand. Replace any stripped screws with an exact equivalent.

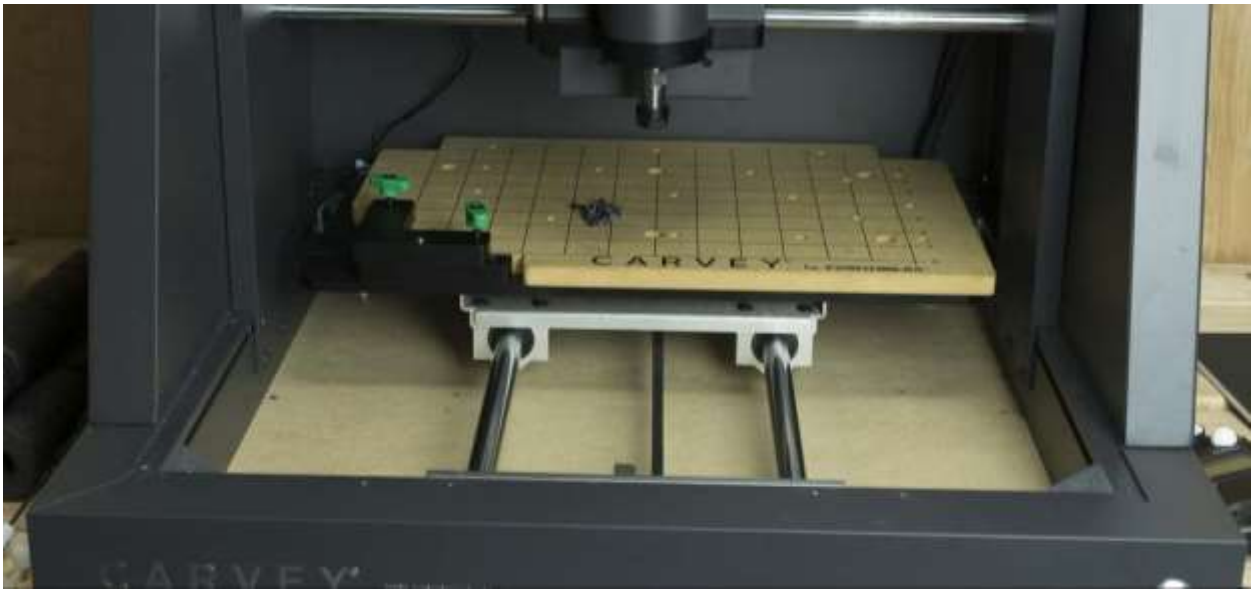
Step 3: Remove Floor Plates

Gently slide the center plate forward over the front lip of the machine. Set the plate to the side. Repeat this process with the two side plates, taking care not to damage any of the carriage parts.





You can now carefully vacuum the inside of the machine. **Do *not*** use any liquid or aerosol cleaners or solvents on the inside of the Carvey.



Step 4: Replace Plates

Reposition the plates in their proper places and thread in the M3 screws by hand. Do not tighten them as you thread them in. Once all of the screws have been replaced, use a hex key to tighten them just until they are snug. You can put a small bit of thread locker on them if you wish.

Clearing the Air Intake on the Back of the Carvey

A couple times a year makerspace staff should check the air intake on the back of the Carvey. If it looks clogged like the one in the picture, you can remove the dust by using a can of air to blow out the accumulated deposits. Again, do NOT use any solvents or liquid cleaners.

FOR MAKERSPACE STAFF: Waste Board Replacement

The waste board or spoil board is the main cutting surface of your Carvey. The relatively soft MDF provides a sacrificial surface that allows for easy through-cutting operations without having to worry about damaging tooling or your machine. After extended use, the waste board will degrade to the point that it is no longer possible to properly clamp material for carving. This guide will show you how to properly change your Carvey's waste board. You may or may not be able to find replacement parts for your Carvey on the Inventables.com website.

Tools Required:

- 3mm Hex Key
- Drill driver with a 5mm hex bit

Note: You may wish to keep the old waste board in the event you cannot replace the waste board in the future and you determine it is still useable.

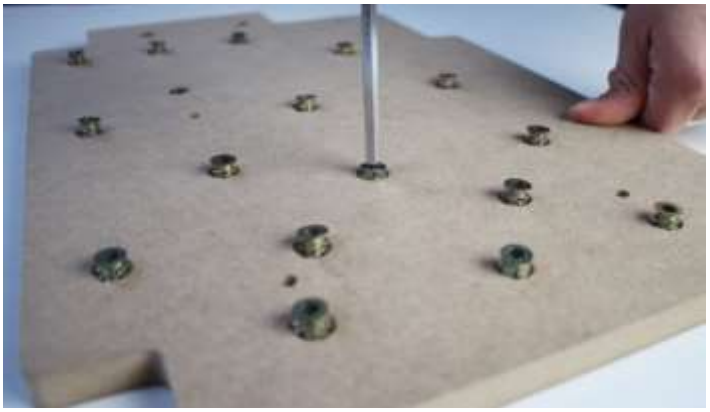
Step 1: Prepare

Shut down any active connection with Easel and unplug the USB cable from your computer and the Carvey. Power down the Carvey and unplug the AC power cable from the wall. Open the door and remove any material and clamps present. Remove any milling bit that may be present. Clean any excess dust from the inside of the Carvey with a vacuum and soft brush if necessary. Since you will be working with small parts that are easily lost, it is a good idea to have a small bowl or other container for bolts at your workstation.

Step 2: Install Threaded Inserts

The photos below show the top and bottom of the new waste board. Note that there are 19 holes for clamping, 6 countersunk slots on the inside of the board.

Top of New Waste Board



Bottom of New Waste Board

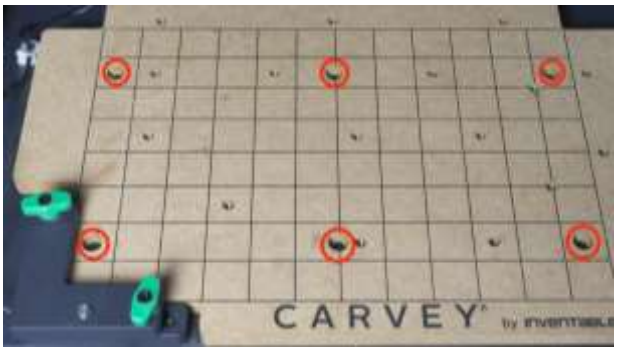
Flip over the waste board. The holes are countersunk at a bevel from the back to accept the threaded inserts. Use a drill driver with a 5mm hex bit to speed this process up. (These tools are not included in the tool kit.) If you do not have access to a drill driver, you can use an Allen wrench with 5mm hex head to manually install each threaded insert. Make sure that you install the inserts neatly and as straight as possible as this will make clamping material much easier.

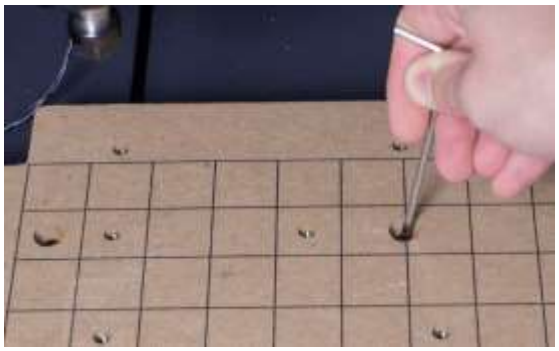
Step 3: Remove Smart Clamp and Waste Board

Remove any clamp bolts that are present on the Smart Clamp and move the Smart Clamp bracket to the side. (See below)

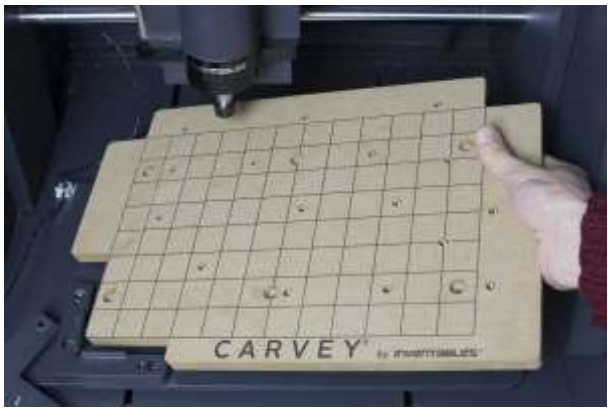
Shown below, locate the six cap-head bolts that secure the waste board to the base plate.

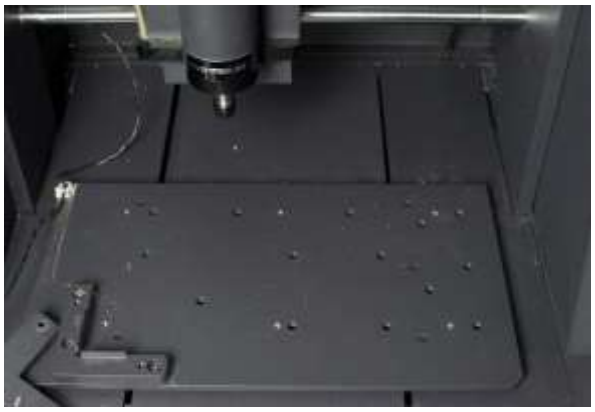
Use a 3mm hex key to loosen and remove all six bolts and set them aside. Lift the waste board off the base plate.





Remove waste board.





Step 4: Install New Waste Board

Clean off the base plate so that there will not be any debris stuck between the base plate and waste board once the latter is installed. Seat the waste board on the base plate and align the mounting holes with the threaded holes on the base plate. Thread in the cap head screws and tighten opposite bolts in sequence similar to tightening lug nuts to ensure that there is even pressure on the waste board. You can now replace the Smart Clamp and get back to carving!