WATERJET

VERSION 3.1

WATERJET

THE WATERJET CAN CUT A WIDE VARIETY OF MATERIALS.
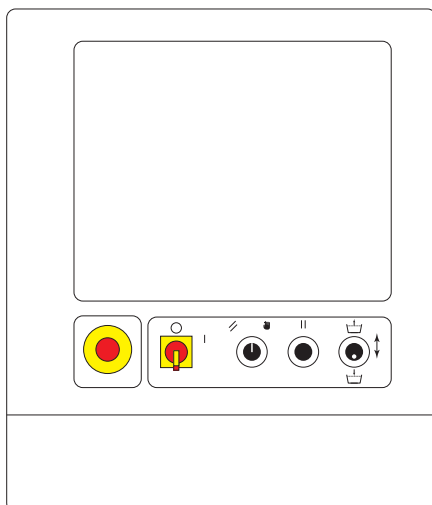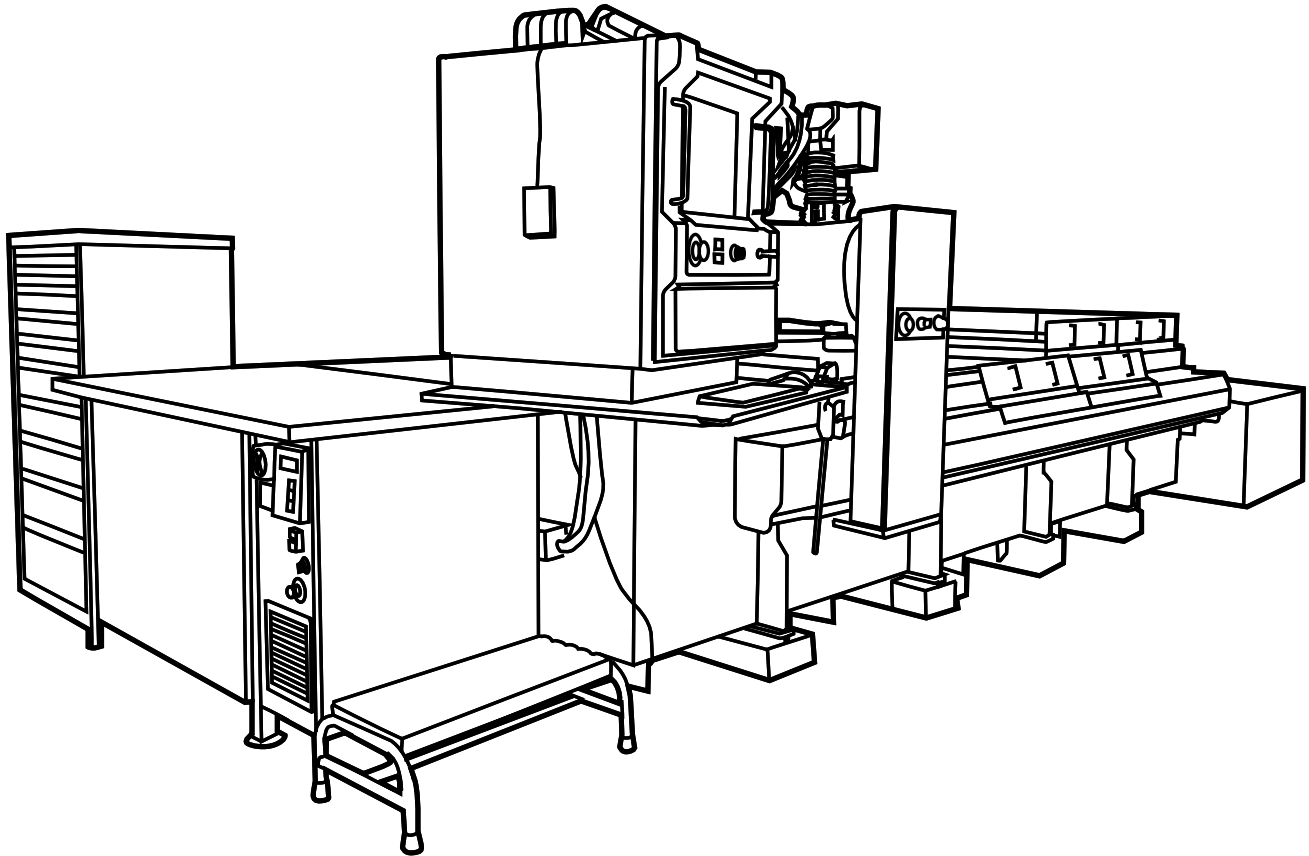
CONTROLLER

PUMP SWITCH

CHARGE   OFF   ON   PUMP
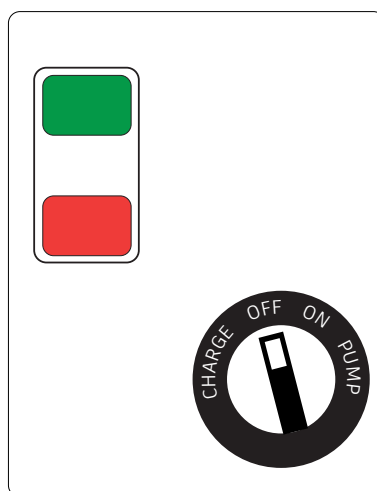
MATERIALS

ALLOWED MATERIALS

+ Wood
+ Most metal
+ Plastic

BANNED MATERIALS

+ Copper
+ Brass
+ Tempered glass

SEE SHOP STAFF FIRST

+ Other materials

PROTECT YOUR EYES FROM FLYING DEBRIS.
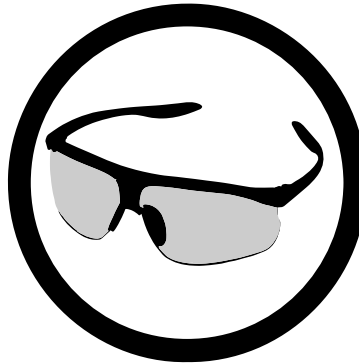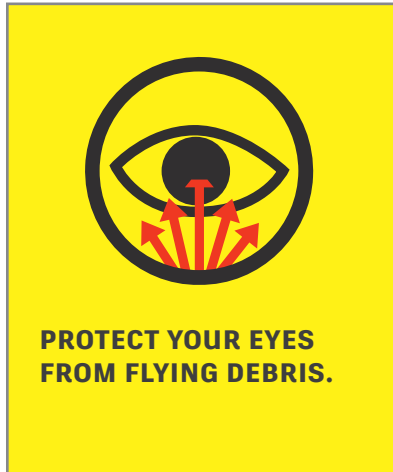
Always wear safety glasses.

WEAR GLOVES, AND TAKE CARE WHEN LOADING & UNLOADING MATERIAL.

The metal support slats are sharp. Wear cut resistant gloves to protect your hands.

KEEP YOUR BODY AWAY FROM THE JET AT ALL TIMES.
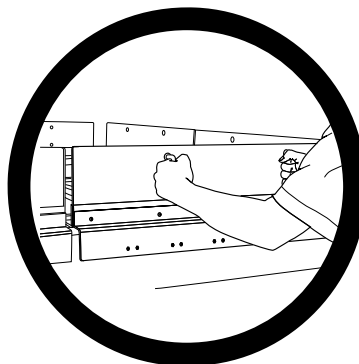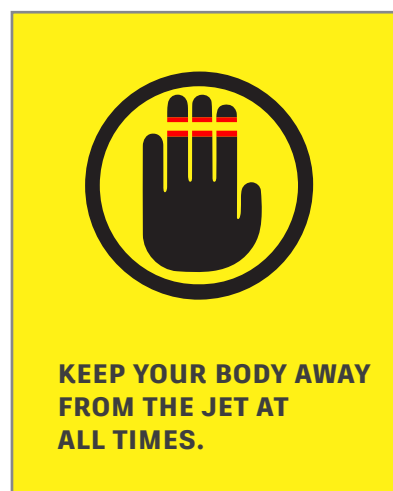
The clear plastic shields are required for all work.

Always install the shields before turning on the water pump.

WATERJET

SAFETY & OVERVIEW

VERSION 3.1

THE JET USES UP TO 60,000 PSI OF WATER PRESSURE TO MAKE THE CUT.

P. 4

OVERVIEW

A waterjet uses a stream of extremely high pressure water, mixed with particles of garnet, to cut almost any material up to about 8" thick.

The machine is capable of cutting complex shapes in 5 axis, but this Quick Start Guide will focus on 2D shapes, like cuts on the laser.

High pressure water enters the nozzle assembly. Garnet is added to the water, and mixed in the *mixing tube*.

The jet of water and garnet exits from the bottom of the nozzle.

The size of the mixing tube determines the diameter of the jet and the cutting width (called the *kerf*). The standard size mixing tubes at the P9 Workshop are 0.035" or 0.042" (0.89mm or 1.07mm).

Over time, the diameter of the mixing tube will enlarge because of erosion. To make parts to an exact size, you may need to edit the *tool offset* later in the cutting process.

WATER

GARNET FEED

MIXING TUBE

ABRASIVE JET
(Water & garnet mix)
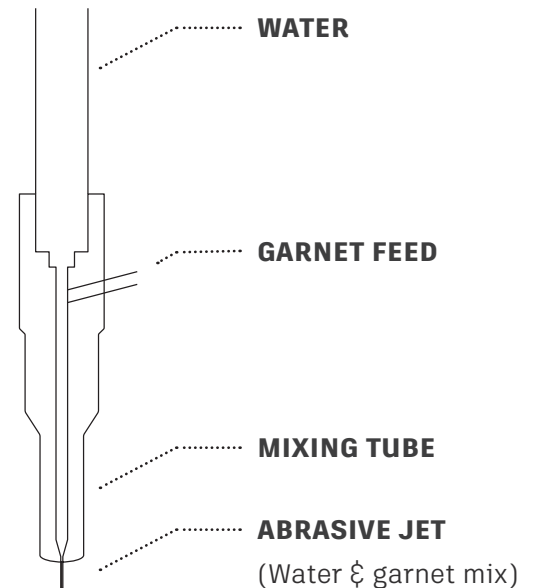
Cutaway view of the
nozzle assembly

SPECIAL SAFETY PRECAUTION

Because garnet is mixed into the water, getting hit by the jet of water requires **immediate** specialized medical attention.

ALWAYS INSTALL THE SHIELDS BEFORE STARTING THE PUMP.

NEVER PUT YOUR HANDS PAST THE SHIELDS WHEN THE PUMP IS ON.

SOFTWARE

You will need two pieces of software to use the waterjet. One will prepare the file for cutting, and the other will control the machine.

To prepare the file, you can use the **2D Pathing Tool** in Fusion 360 or **Omax Layout** to prepare a DXF or Illustrator file.

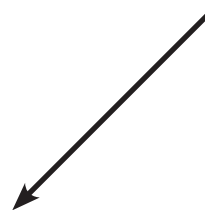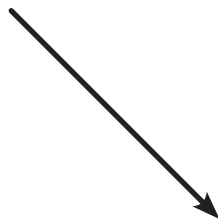**Omax Make** is always used to operate the machine.

Fusion 360 file

Illustrator or DXF file

2D Pathing Tool

(page 6)

OMAX Layout
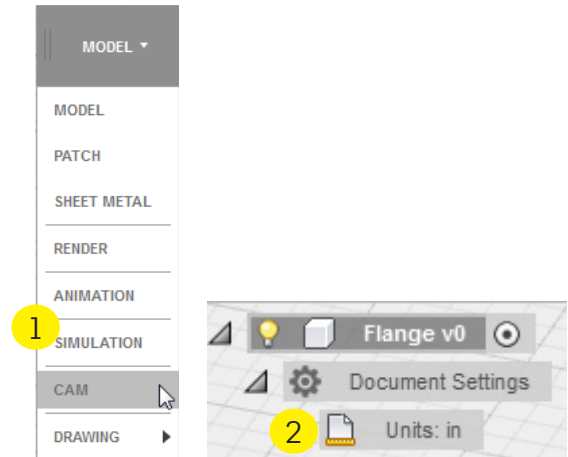
(page 12)

OMAX Make

(page 17)

CAM MODE IN FUSION 360

If you are creating flat parts in Fusion 360, you can prepare them for the waterjet without leaving Fusion 360.

*For using Omax Layout, skip to page 12.*

Get ready

1. Go into CAM mode.
2. Check your units in the tree.
   ▸ Make sure you are working in the correct units.

Create a new setup

1. Click the **New Setup** button.
2. Select **Cutting** from the Operations Type menu in the Setup tab.
3. Select **Select Z axis/plane & X axis** from the Orientation menu.
4. You need to select the Z Axis.
   ▸ Click on the top plane of your part and ensure that the blue Z arrow is pointed up.
5. The X axis arrow should be pointing to the right.
   ▸ Click the red x to flip the X axis if needed.
   ▸ Or you can select the **Flip X Axis** checkbox.
6. Select **Selected Point** from the Origin menu.
7. Click on the lower left point of your model.
   ▸ Double check that the Z arrow is up.
   ▸ The X arrow should be to the right.
8. Click the top plane of the model.
   ▸ The Model menu should change to **Body** and the top of the model should be blue to show that it has been selected.
   ▸ Double check that the model looks like it will cut correctly.
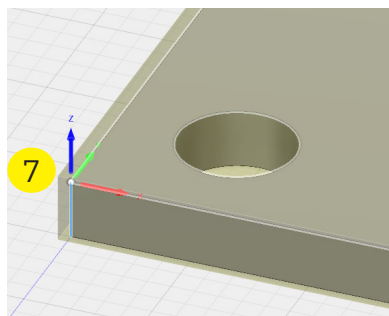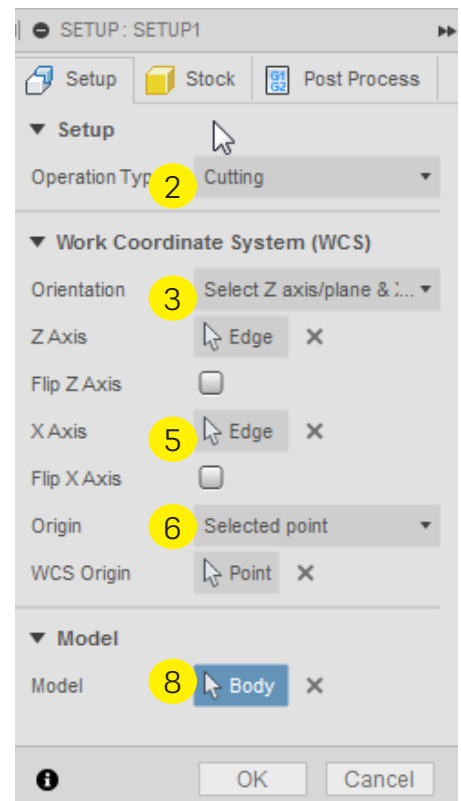
Input the stock size

1. Click the **Stock** tab.
2. In the **Mode** menu, select **Fixed size box**.

In the next steps, you'll enter the size of the stock, and how far from the edge your part is.

Be sure to set Z (material thickness).

3. Set the stock dimensions and the position.
+ In this example, the stock is 5" wide and the part starts .25" from the left edge.
+ The stock is 5" high and the part is offset .25" from the bottom.
+ The stock thickness is .25" and there is no offset; the part completely fills the height of the stock.

4. Check that the stock thickness is correctly displayed at the bottom of the dialog box and click OK.
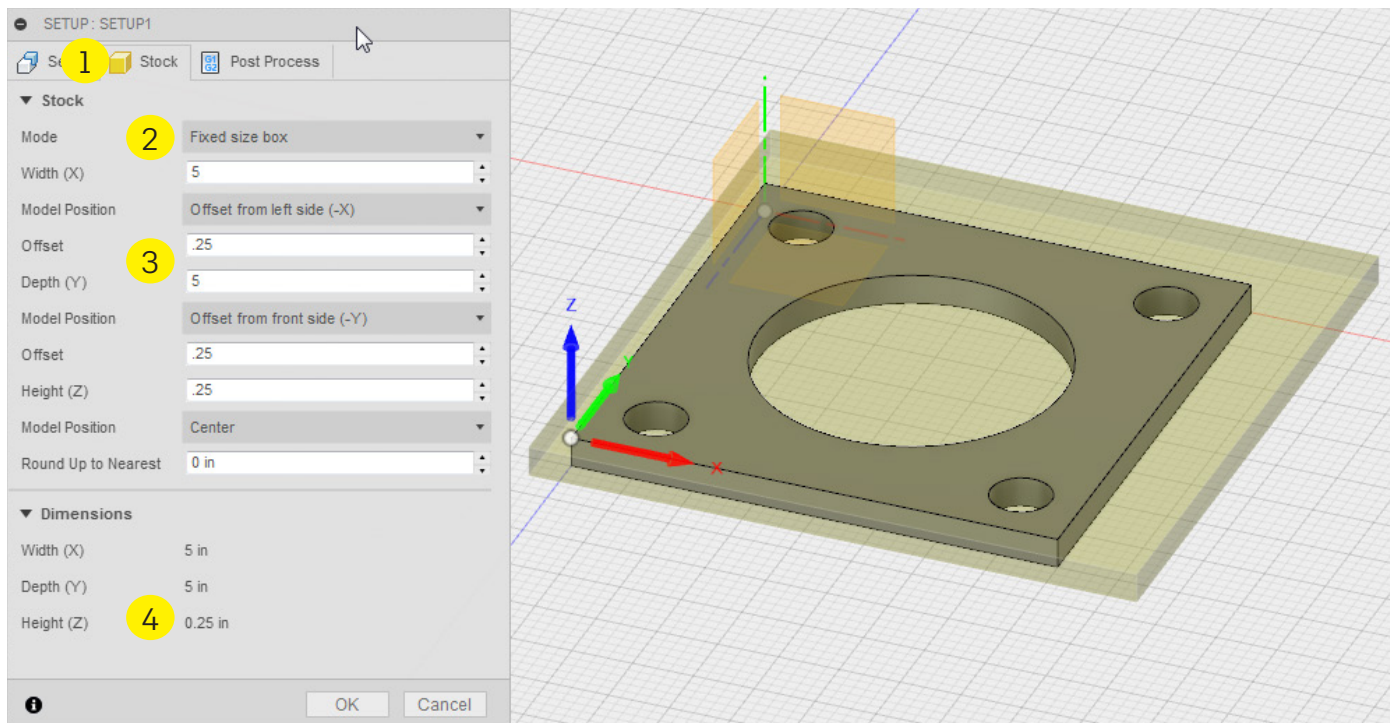
ADD THE WATERJET TO THE TOOL LIBRARY

In order to select the waterjet as a cutting tool, you'll need to add it to your tool library in Fusion 360.

1. Click the **Manage Tool Library** button.
2. Click the **Waterjet/Laser cutter** icon in the upper right.
3. Click the **Cutter** tab.
4. Select **Waterjet** in the **Type** field on the left.
5. Enter the **Kerf Width** on the right.
   ▸ The Kerf Width is equal to the diameter of the nozzle.
   ▸ It is noted on a sticker on the control computer.
6. Click the **Feed & Speed** tab
7. Select **Machine uses quality** in the **Feedrates** menu.
8. Click **OK**.
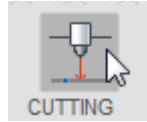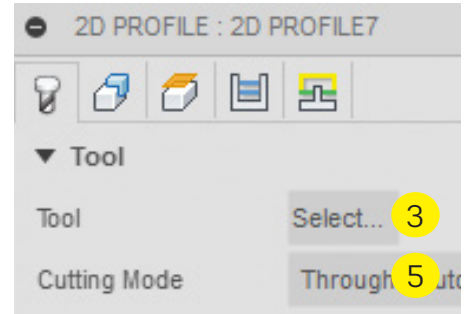9. Close the **Tool Library** window.
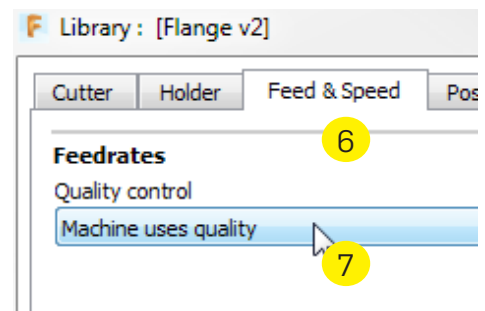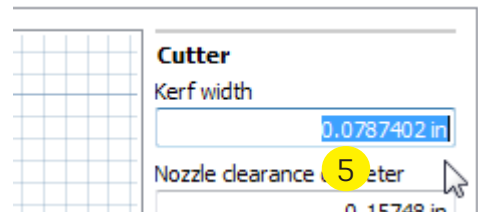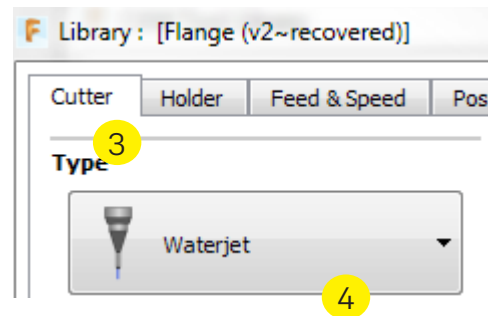
CREATE THE TOOLPATHS

The next step is to tell the waterjet where to cut.

Click the **CUTTING** button

Select the tool

1. Click the **Tool** tab.
2. Click the **Tool** button to select a tool.
3. Select Waterjet In the dialog that opens and click OK.
4. Select the desired quality in the **Cutting Mode** box.

Select the features to cut

1. Click the **Geometry** tab.
2. Click each feature you want to cut.
   ▸ Another option is to click **Select same plane faces** and click the face of the part.
   ▸ This will select all the features on that plane.
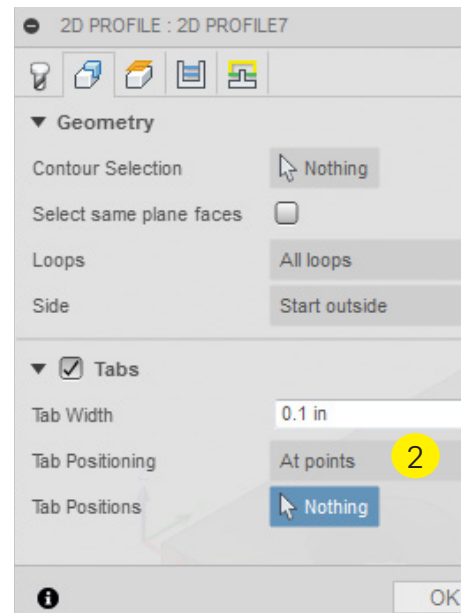
Tabs

Tabs are short gaps that don't get cut, in order to keep small parts attached to the workpiece. The tabs prevent the piece from moving during the cut or falling into the tank.

1. Click the **Tabs** checkbox.
2. Select **At points** in the **Tab Positioning** box.
3. Click to place tabs.
   ▸ Usually two or three tabs will keep a piece from moving.
   ▸ Place the tab in an area that will make it easy to remove, such as on a straight section. A tab in a tight corner may be difficult to remove.
   ▸ Be sure to place the tab on the **waste** side of the part.
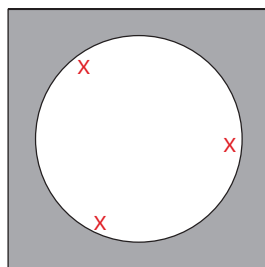
For a perfect hole, place the tabs inside the circle.

For a perfect disc, place the tabs inside the square.
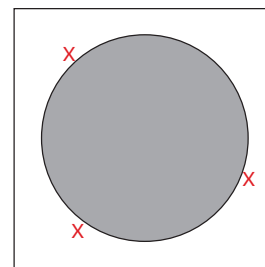
Heights

Setting the height of the nozzle helps to keep from breaking it on clamps and other objects. Make sure you set the nozzle high enough to protect it.

You will need to set the height for two different things

+ **Clearance Height**
    ‣ The distance above the workpiece at the start of a new toolpath.
    ‣ Make sure this is high enough to avoid clamps.
+ **Retract Height**
    ‣ The distance above the workpiece when the nozzle is moving between cuts (also known as a *traverse*).
    ‣ Make sure this is high enough to avoid clamps.

1. Click the **Heights** tab.
2. Set the **Clearance Height**.
    ‣ By default, this is added to the Retract Height.
    ‣ For example, if your Retract Height is 0.5" a 1" Clearance Height will give 1.5" of clearance.
3. Set the **Retract Height**.
    ‣ By default, this will be measured from the top of the workpiece.

CLEARANCE HEIGHT

RETRACT HEIGHT

WORKPIECE
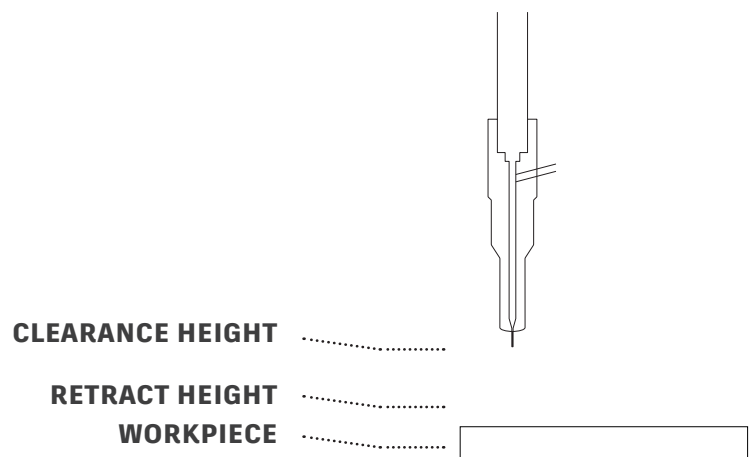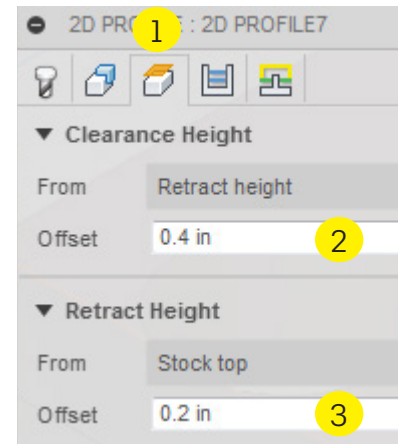
SIMULATE THE CUT

Simulating the toolpath will allow you to check for errors and collisions.

1. Select the part by clicking the **2D Profile** in the tree.
2. Click the **Simulate** button.
3. Use the controls at the bottom to run the simulation.
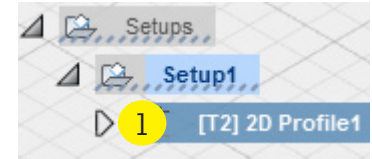
Tip: Use the view cube to watch the simulation from the front to check that your heights are correct.
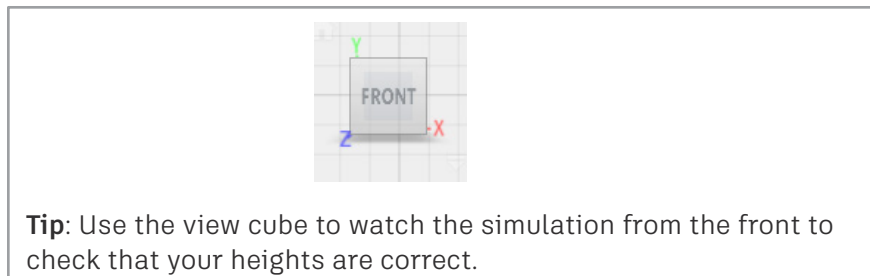
POST PROCESS

The post processor will write the machine instructions for the Omax, and save the file.

1. Click the **Post Process** button.
2. Select **Omax** from the **Post Configuration** menu.
3. Click **Post**.
4. Name and save the file to a thumb drive.

NEXT STEPS

Take your thumb drive to the waterjet, and skip to page 17.

USING OMAX LAYOUT

For instructions on using Fusion 360 CAM for the Omax, go back to page 6.

OMAX SOFTWARE TIPS - RIGHT CLICKING

Any icon that has a small red triangle in the upper right will allow you to right-click to choose an optional command.

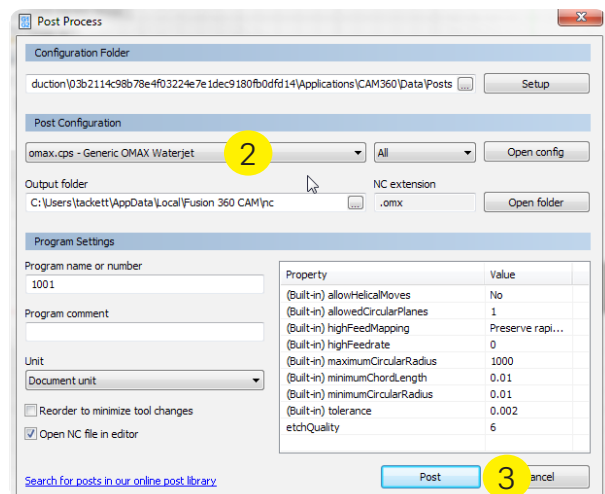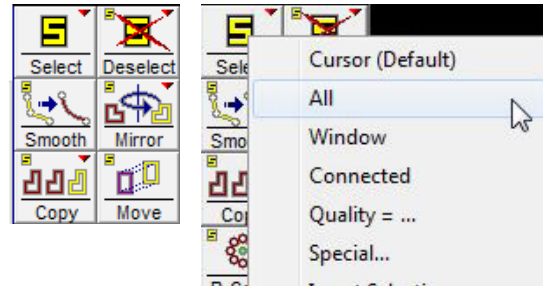+ For example, the **Select** button will default to **Cursor** when clicked. When *right-clicked*, it will show you a menu of selection options.

+ One of the menu commands will be **Help**, which opens a detailed help screen for that command.

MENUS

There are menus at the left, right and bottom of the screen, in addition to the standard menus at the top.

+ **Edit**
  ▸ The Edit menu is on the left side of the screen, and has options for selecting, moving, copying, etc.

+ **Draw**
  ▸ The Draw menu is directly below the Edit menu. It can be used to draw primitive shapes. However, it's much more simple to draw in CAD, Illustrator or other vector software.

+ **Special**
  ▸ The Special menu is on the right side of the screen, and is used for toolpaths and cleaning the vector file.

+ **View**
  ▸ The view menu is at the bottom of the screen, and has options for cut quality, undo and measuring.
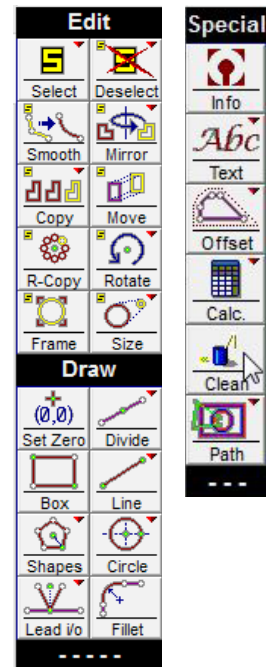
OMAX LAYOUT

Open the file

1. Open your file with **Import from other CAD...** from the **File** menu.
2. Leave the default boxes checked.
3. Click **OK**.

Clean the geometry

Some vector files are imported with errors, such as gaps or duplicates. This step will solve most of the problems.

1. Click the **Clean** button in the **Special** menu on the right side.
2. Select all the boxes in the dialog box.
    ▸ The **Remove unclosed paths** checkbox can be left unchecked if you have geometry with open ends (a line instead of a loop).
3. Click **Start**.
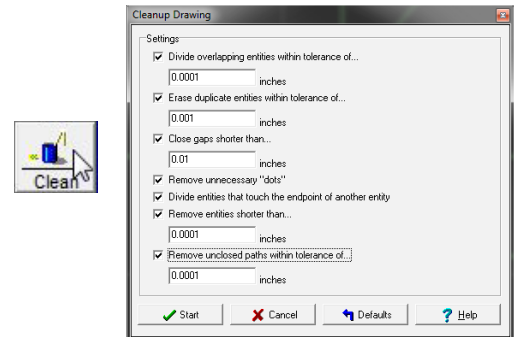
Check the size

Sometimes drawing are imported with incorrect units. Since each square in the grid represents an inch, it's simple to check if your vector file was imported with the correct units.

Change the size if needed

1. Right-click the **Select** button, and choose **All**.
2. Right-click the **Size** button for sizing options.
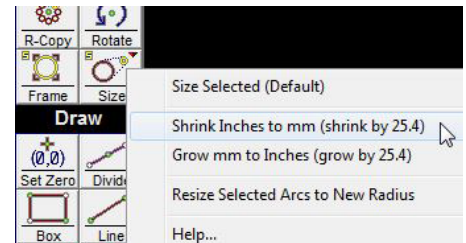
Move the geometry

You may need to move your geometry onto the grid.

1. Click the **Move** button in the **Edit** menu.
2. Click the geometry to select a start point.
3. Move the geometry until it is inside the grid, and close to the lower left corner (home).
4. Right click **Deselect** in the **Edit** menu, and select **All**.
    ▸ If the geometry is yellow, it is still selected.
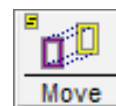
Quality & line types

You will need to assign a type or value to every line in your geometry. The quality of the cut can be assigned a value from 1 (lowest quality) to 5 (highest quality). Lower quality cuts will take less time and use less garnet, but produce a rougher cut. Each quality is represented by a different color on-screen. Other colors represent different types of lines.

Each line in your drawing will need to be assigned one of the values from below.

+ Quality (1-5)
    ▸ Quality 3 is a good compromise of speed vs. quality for most cuts.
    ▸ Thicker material shows the effects of a low quality cut more than thin material.
+ Traverse - **Do not use**
    ▸ The head will move from the end of one cut to the next.
+ Heads Up Traverse - **Use this move**
    ▸ This is like a regular traverse move, but the head will raise up several inches.
+ Etch
    ▸ This is a mix of water and garnet that will etch the surface, but not cut.
+ Scribe
    ▸ Scribing is like etching, but without using garnet.
+ Water Only
    ▸ This is a cut, but without the garnet.
+ Lead In/Out
    ▸ These are short lines that start (and stop) the cut away from the cut line.
    ▸ The initial pierce of the jet can distort the material; starting and stopping the cut in a waste area hides the damage.
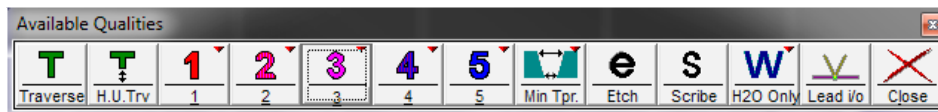
Set line quality

The menu on the bottom of the screen allows you to assign quality to each line.

1. Right click **Quality** to bring up the submenu.
2. Choose your selection method.
    ▸ This works like the **Select** button.
3. Choose the quality level for the selected lines.
    ▸ For the 5 levels of cutting, you can right click and select **slit**, which is a cut directly on the line, rather than offset to one side.
4. Right click **Deselect** in the **Edit** menu, and select **All**.
    ▸ This will show the line quality color.
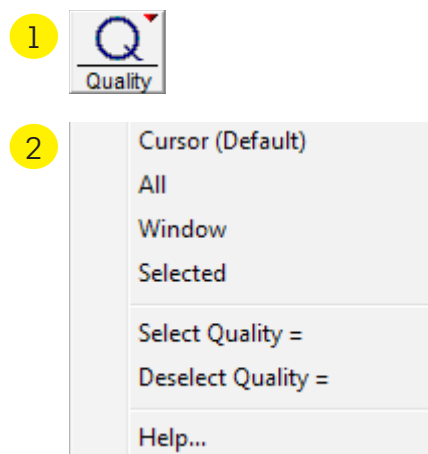
Check your work

After assigning line quality, deselect all. Each line will be assigned a color that represents a type of cut or traverse.

**Note**: Use **Heads Up Traverse** (dashed green lines).

Make the Lead In/Lead Out lines

1. Right-click **Lead i/o** from the **Draw** menu.
2. Select **AutoPath (Advanced & Configure)...** from the sub-menu.
3. The left side of the window allows you to select tool path options.
4. The right side displays your file and toolpath.

On occasion, a small cutoff piece can flip up and come in contact with the head. Choosing a toolpath that has fewer possible collisions is best practice. In some cases, it may be required to create custom Lead i/o lines. See Shop Staff.

The start and end of the toolpath can be changed by selecting any of the 9 green (start) or red (stop) buttons.

+ It is common to start the toolpath in the lower left corner.

Click **Go!** to save your settings.
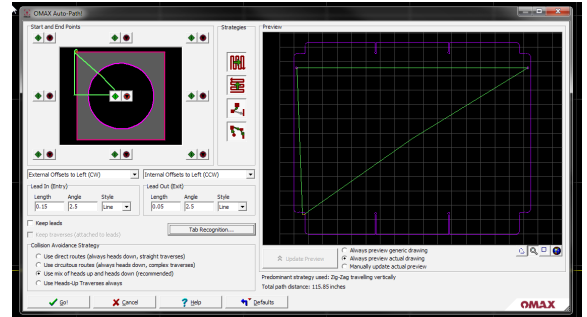
Tabs

Tabs are short gaps that don't get cut, in order to keep small parts attached to the workpiece. The tabs prevent the piece from moving during the cut or falling into the tank.

1. Right-click **Lead i/o** from the **Draw** menu.
2. Select **Create Tab** from the sub menu.
3. As your mouse approaches a cut line, the tab will jump to the line.
4. Click to place the tab.
   ▸ Usually two or three tabs will keep a piece from moving.
   ▸ Place the tab in an area that will make it easy to remove, such as on a straight section. A tab in a tight corner may be difficult to remove.
   ▸ Be sure to place the tab on the **waste** side of the part.

For a perfect hole, place the tabs inside the circle.
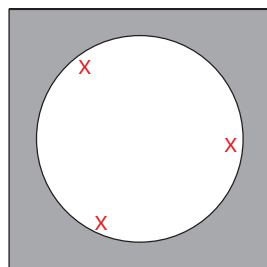
For a perfect disc, place the tabs inside the square.
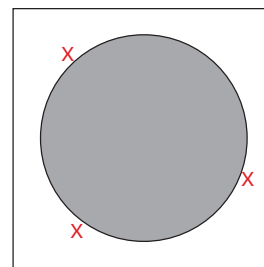
Create the toolpath

1. Click the **Path** icon in the **Special** menu.
2. Your cursor will change to a + and the words "PICK START".
3. Click the beginning of the lead in line that you created earlier.
   - ▶ This should be lower left, outside of your cutting area.

Inspect the toolpath

Inspect the toolpath to ensure that you'll be cutting on the correct side of the line.

Your cut line will be displayed in the color that corresponds to the quality, and traverse lines will be green.

The thick red line with a dotted center displays two things:

+ Dotted center
   - ▶ Displays the actual path of the jet.
+ Thick red line
   - ▶ Displays the kerf (the material removed by the jet).
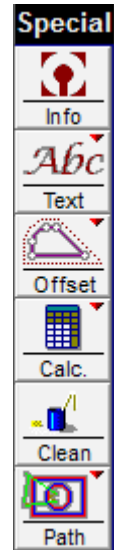
If the toolpath is cutting on the wrong side of the line, there are two common possibilities:

+ There's a gap in the geometry.
   - ▶ Follow the toolpath by eye and look for a gap where the toolpath doubles backs on itself.
   - ▶ Fix the gap with the provided tools and re-create the toolpath.
+ The software chose the incorrect side to cut on.
   - ▶ Right-click the **Lead i/o** button and select **Swap Lead Direction**.
   - ▶ Click to select the lead in line to be swapped.
   - ▶ Recreate the toolpath.

Save the file

When you are happy with the results, click the save button.

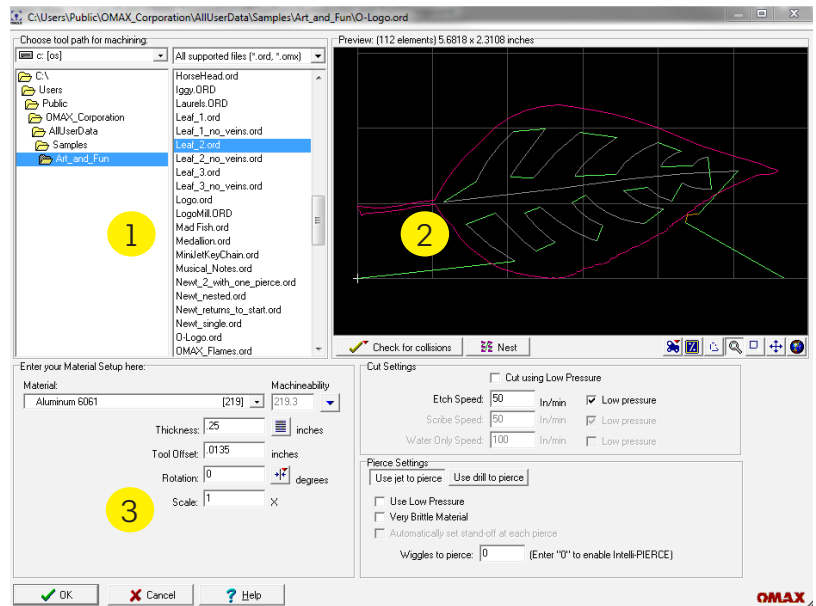The file should be saved as an ORD (Omax Routed Data) file, which can be opened in Omax Make.

USING OMAX MAKE

+ Open Omax Make from the desktop.
+ Select File > Open (Change Path Setup)...

Opening a part with Omax Make

The Open File dialog box has three panels you should pay close attention to.

1. File Navigation
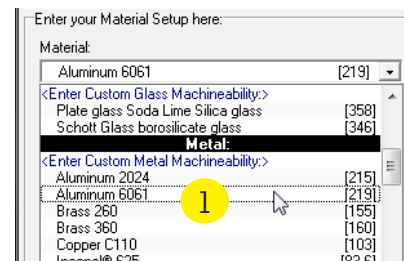2. File Preview
3. Material Settings

Open the part

+ Use the File Navigation Panel to open your ORD file.
  ▸ Confirm you have selected the correct file with the preview.

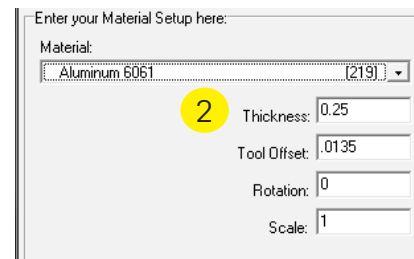
Select your material

1. Select your material from the list.
+ Materials are listed by category (metals, woods, plastics...).
+ If your exact material is not on the list, see Shop Staff.

Set the material thickness

1. Use a digital caliper to measure the thickness of the material.
2. Enter the value in decimal inches.
3. Click **OK**.

The software is now ready to control the waterjet and cut your parts.

Notes on increasing the accuracy of the cut:

As the mixing tube wears, the kerf will grow larger. If your parts need to be held to a tight tolerance, you may need to adjust the *Tool Offset*.

Cut a 1" square from your material and measure it with calipers or a micrometer. If it in undersized, increase the value in the Tool Offset field by 1/2 the error.

For example, if your 1.000" circle measures 0.998", increase the tool offset by 0.001".

Prepare the machine

1. Push the green power button on the side of the cabinet.
   - ▸ **Do not** turn on the pump with the rotary switch yet.
2. Check the scale next to the garnet hopper.
   - ▸ If it is low, see Shop Staff.
3. Close the exhaust valve on the garnet tank.
   - ▸ The handle should be perpendicular to the pipe.
4. Lift the garnet hopper handle (under the lid) and hold it.
5. Open the air valve on the garnet tank.
   - ▸ The handle should be parallel to the pipe.
6. The garnet hopper handle should stay up, and sealed.
7. Replace the lid.
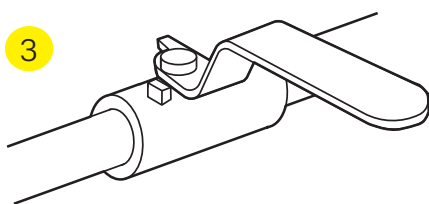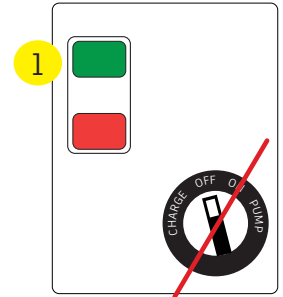
When the handle is perpendicular to the pipe, the air flow is off.
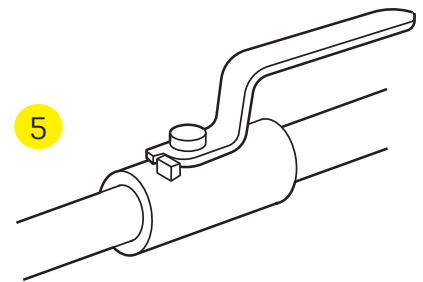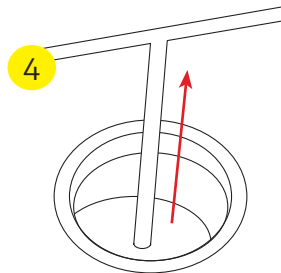
When the handle is parallel to the pipe, the air flow is on.

Moving the nozzle

Note: The nozzle is fragile and expensive. Check the area before moving the nozzle, and make sure there are no obstacles.

+ Raise the nozzle before moving it.

There are two methods to move the nozzle:

+ Keyboard keys
   - ▸ The **arrow keys** move the nozzle in X & Y (hold **shift** for rapid moves).
   - ▸ **Page Up/Down** move the nozzle in Z (use **7** or **1** on the keypad for rapid moves)
+ Onscreen buttons
   - ▸ There are buttons for X, Y and Z onscreen.
   - ▸ Note: Be careful using the buttons; it is possible for the machine to lag behind the button clicks and keep moving after you want it to stop. This can be a serious problem for -Z (down) movement.
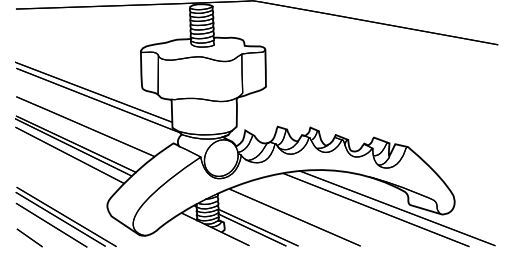
Load the material

+ The slats in the tank can be sharp and rusty; wear cut resistant gloves.

Place the material flat on the slats. If there is any danger of contacting the nozzle with your material, move the head far out of the way.

All material must be mechanically secured.

Workholding - small pieces

Use the curved clamps to hold the material to the table.

+ Use at least 3 clamps.
+ Thin material can be backed with 3/4" plywood to reduce warping.

Workholding - large pieces and full sheets

+ Use the curved clamps to hold the sheet to the table.
  ▸ Use at least two clamps on the bottom **and** left edges.
  ▸ If the workpiece is large enough, clamp the top and/or right edge as well.

See Shop Staff if you need assistance.
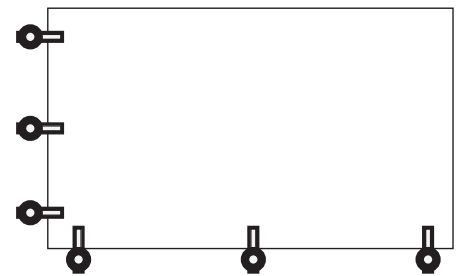
Ensure the toolpath clears the clamps.

Set the Z offset for the nozzle

The nozzle needs to be just above the material you are cutting. If the nozzle is too low and comes in contact with the material, water will flow backwards into the garnet tube and the machine will stop cutting. It's OK to set the nozzle a bit higher than normal if you like. The cut quality may be slightly lower, but it lowers the chance of clogging the garnet tube.

1. Move the nozzle over your material.
2. Place the Z Height gauge under the tip of the nozzle.
3. Slowly lower the nozzle until the gauge just slides under it.
4. Click the **Zero Z Height** button on the left.
   ▸ **Do not** click the Go To 0 button on the right.
5. Confirm that the display reads 0.
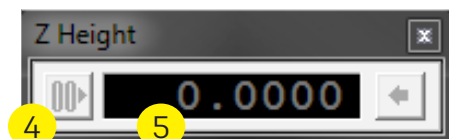
Set Path Start

Path Start is where the controller will start the first move in your geometry. When you created the toolpath you selected the starting point.

The next step will tell the controller where that point exists in physical space.

Omax calls this **Path Start**, but other machines call it Home, User Home, User Zero or G54.

Do not confuse Path Start and User Home.

1. Move the nozzle to your start point (**Path Start**) on the material.
2. Click the **Zero** button next to **Distance from "Path Start"**.
   ▸ Although the two "Zero" buttons look the same, they have very different reactions.
   ▸ **Do not** click the upper button.

Check for collisions

If you have an area where you may contact a clamp, or if you aren't sure if your material is large enough, you can send the nozzle to a specific place on the geometry.

1. Raise your Z to a safe height.
2. Right click **Begin Machining**.
3. Left click **Go To Spot On Path**.
4. Click the spot in your geometry where you want the nozzle to go.
   ▸ **The nozzle will travel there in a straight line.**
5. Hover your finger over the **Pause** button on the controller.
6. After the nozzle has moved, click **Close** in the dialog box.

Repeat these steps for any point that may pose a danger of collision.

Return to Path Start

Note: If you fail to return to Path Start before you begin cutting, the machine will start cutting from its current location (your current position will become Path Start).

1. Raise the head to a safe Z.
2. Use the keyboard to move the nozzle back to your Path Start position.

Note: Omax uses the term **User Home** differently that most other manufacturers.

Do not use any of the User Home buttons unless instructed by Shop Staff.
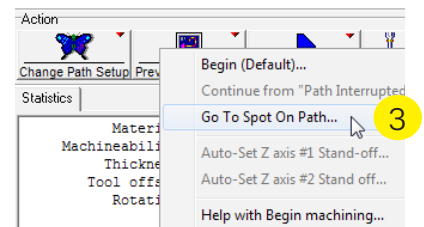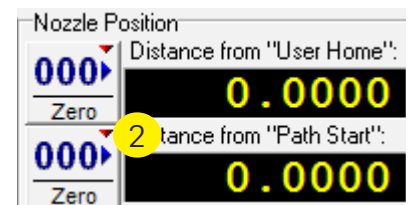
Final preparations

1. Return the nozzle to Z Zero.
   - ▶ If the Z Height display does not show 0, click the **Go to Z1=0** button to lower the nozzle.
2. Flip down the yellow rubber cover on the nozzle.
3. Raise the water level.
   - ▶ Use the lever on the console to bring the water level to about 1/4" above your part.
   - ▶ You may not want to flood some materials like wood. See Shop Staff before cutting material that isn't submerged.
4. Install the shields.
5. Turn the pump to **ON**.
   - ▶ Use the rotary switch on the pump box.
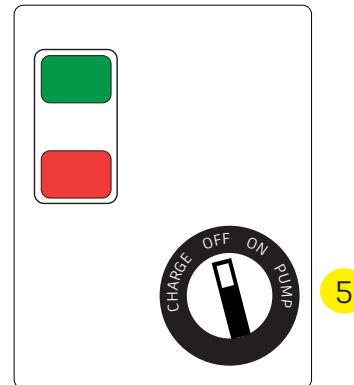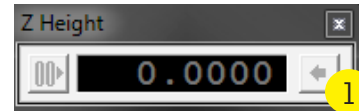
NEVER PUT YOUR HANDS PAST THE SHIELDS WHEN THE PUMP IS ON.

Before you cut

Allow the pump to warm up for at least a minute before cutting.

Spend that time checking each item on the following list:

1. The workpiece is securely clamped.
2. There's enough garnet in the hopper according to the scale.
3. The garnet hopper air valve is on.
4. The nozzle is close to the top of workpiece.
5. The Z Height is 0.
6. The nozzle is at Path Start
7. The Distance to Start Path is 0.
8. The water level is above the workpiece.
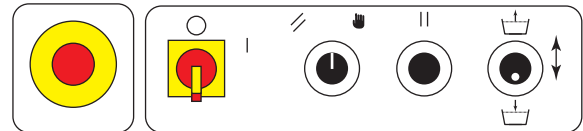9. The shields are installed.

Make the cut

1. Click the **Begin Machining** button.
2. Stay near the Pause button on the console.
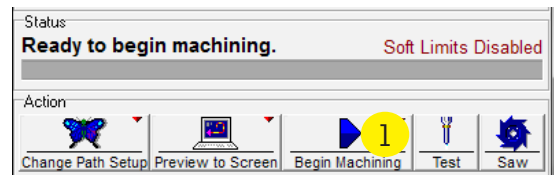
Pause & E-Stop

Use the **Pause** button for a controlled pause in cutting.

+ Pause stops movement and shuts off the pump.
+ Using pause will allow you to restart the job gracefully.

Use the **E-Stop** in case of emergency.

+ The E-Stop stops all movement by cutting power to the controller and pump.
+ The controller will lose all locations and calibrations.

E-Stop   Pause

Restart the job after a pause

+ Stop the pump before making adjustments inside the enclosure.

1. Restart the pump.
2. Raise the nozzle to a safe height.
3. Use the **Go To Spot On Path** function (page 13) to select a point just before you pressed pause.
4. Press **OK** to traverse to that spot.
5. Lower the nozzle to **Z0**.
6. Click **Continue**.
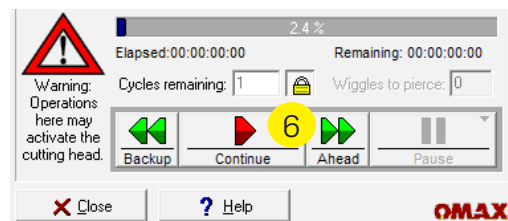
Break down the original material to fit into the storage rack or recycling bin

The Saw function is used to cut down large pieces of material quickly without programing the waterjet.

+ Large pieces of reusable material should be cut into square or rectangular pieces and placed in the storage rack.

+ Pieces too small to reuse should be cut down for easy recycling or disposal.

In this example, the star is the project. The red lines should be saw cut and the square materials placed in the rack.

The area surrounding the star is trash or recycle, depending on the material. Cut it into small enough pieces to not dominate the bin.
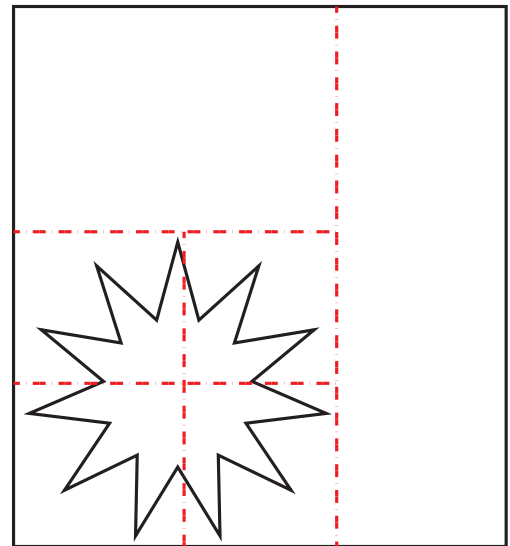
Using the Saw

1. Ensure that the nozzle is at Z0.

2. Move the nozzle to the place you want to start the cut.

3. Click the **Saw** button.

4. Click the compass to tell the jet which direction to go.

5. Enter the number of inches you want the jet to travel.

6. Click the **Go!** button and the jet will start up and saw the workpiece.

   ▸ The jet will move the desired distance in a straight line.
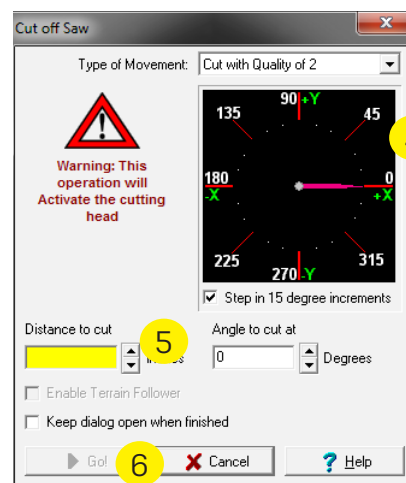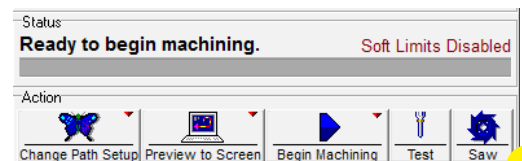
AREA AND MACHINE PREPARATION

1. Use Fusion's 2D Pathing to create a cut file.
   ▶ Or prepare a DXF with Omax Layout.
2. Load the material onto the bed.
3. Secure the material to the bed.
4. Set the material type and thickness in Omax Make.
5. Set the Z offset.
6. Set the Path Start.
7. Check the toolpath for potential collisions.

WEAR CUT RESISTANT GLOVES WHEN LOADING & UNLOADING MATERIAL.

MAKING THE CUT

1. Return to Path Start.
2. Return to Z0.
3. Turn on the air for the garnet hopper.
4. Install the shields.
5. Adjust the water level.
6. Turn on the pump.
7. Click Begin Machining.
8. Stay close to the Pause button.

INSTALL THE SHIELDS BEFORE STARTING THE OPERATION.

CLEANUP

1. Use the saw feature if needed.
2. Turn off the pump.
3. Clean the workpiece with the hose.
4. Put scraps in the recycle or trash.
5. Clean and put away the clamps.
   ▶ Hose off the clamps.
   ▶ Place them in the bin on the pump house or on the controller.
6. Hose down the machine to remove any garnet buildup.
7. Raise the water level to cover the slats.
8. Mop up any water spilled on the floor.
9. Release the air from the hopper.

TURN OFF THE PUMP BEFORE REMOVING MATERIAL FROM THE BED.