Using the CMPE118 Laser Cutter

Overview:

As part of the CE118 course, you will use a MornTech MT-L1290 CNC laser cutting machine. This is a precision machine that allows you to cut geometry from a two-dimensional .ai and .cdr files into MDF, acrylic, and foamcore. It is an ideal tool for cutting intricate shapes with sharp internal corners. It is also excellent for creating quick prototypes and for building things that can be assembled from 2D (and essentially flat) components.

The laser cutter is a very powerful tool, and therefore can be very dangerous. Use it with care and caution. This current model has a 48”x36” bed with a 60W CO2 laser. It fires a laser into the material to burn away a cut or etch a surface. It is very precise (+/- .001”) with ~.030” cut width. The best way to think of it is as a printer, except instead of outputting ink of various colors, it outputs cuts at various speeds and powers.

To use it, you start with an .ai drawing. Using CorelDRW/LaserWorkInterface software, you convert this drawing into a series of cuts. You then “print” it directly onto your chosen material.

This SOP (Standard Operating Procedure) goes over the safety procedure, set-up procedure, and operating procedure. Please use only materials listed in this SOP on the laser cutter. Any other materials must be authorized by the TAs or instructor (not tutors). This SOP will later include tips and tricks for errors as well as advanced techniques. For now, however stick to the basics.
SAFETY:
The laser cutter is a very powerful tool, and therefore can be very dangerous. Use it with care and caution. Some basic rules are:

1. There is a black rectangle on the floor around the laser cutter, called the “watchbox.” There MUST be at least one person in the watchbox whenever the laser cutter is powered up.
2. DO NOT start the laser cutter alone. Always have at least 2 people when setting up.
3. Using the laser cutter when tired is not recommended. Using the laser cutter while tipsy (or worse) will result in an immediate ban from the fabrication lab for the remainder of the quarter.
4. DO NOT remove the “Do Not Touch” plate on the control panel.
5. DO NOT use the laser cutter without the blower on. The blower reduces the risk of fire.
6. IF anything odd happens during your cut or you collide the head with something, immediately notify the TAs of the details and PUT A NOTE on the laser cutter. Do not attempt to fix it yourself.
7. Do not use any materials other than those documented in this SOP without the express permission of the TAs or instructor.

FIRE SAFETY
In all cases, fires in the laser cutter have been caused by unattended operation (even when the users were in the same room, but not paying attention to the laser cutter). DO NOT LEAVE THE LASER CUTTER UNATTENDED. PERIOD.

While it is not unusual for there to be a flame for the first few seconds or on a small part, it is a concern if there is a persistent or growing flame. FOAMCORE is especially flammable, any material can catch on fire under certain circumstances. Be careful with parts with lots of intricate detail that are very close to each other or jobs that take a long time to complete.

In order for fire to persist, three things are required: (1) heat source, (2) fuel, and (3) airflow. In the laser cutter, the heat source will be the laser, the fuel will be the material, and the airflow will be caused by the blower. Removing these three things will put out the fire. Small fires are very easy to put out (think candle), but they will grow into big ones if you do not act promptly. You have time to stop and think clearly, but you will need to take actions to put out the small fires BEFORE they grow into big ones.

- If you have a persistent flame that is more than 2 inches tall or lasts for more than 5 seconds, STOP THE LASER CUTTER by pressing PAUSE. Use the UP arrow key to move the head to the top of the bed. Do not turn the laser cutter off.
- If the flame is small and unthreatening (smoldering/smoking/candle like), remove the material from the laser cutter and extinguish the flame (blow it out, let it burn itself out, put it on the floor and stomp on it, take it outside and pour water on it).
- If the flames are growing or become taller than 6 inches, and you cannot safely remove the material from the laser cutter, turn off the laser cutter and use the fire extinguisher to put it out.
- Call 911 after using the fire extinguisher, even if fire is out.
EYE SAFETY
The greatest danger in using any laser is to your retina. The amount of power concentrated on a very small area will create a permanent blind spot in your vision. The laser cutter is equipped with safety interlocks to disable the beam when the lid is opened.

During certain calibration procedures, or when cutting oversized objects, the interlocks may be bypassed (this is not usual, and you should not be doing this without express oversight from the TAs and Instructor). When operating the laser “in the clear” you should make sure to clear the room of all other people, and use the laser safety goggles in the case by the laser cutter.

OPERATIONAL SAFETY
Make sure you re-read the above sections several times to make sure you completely understand them. Do not operate the laser cutter alone, and do not leave it unattended (this includes being nearby but not paying attention to it). If you cannot see the beam, then the laser cutter is effectively unattended.

Re-read the list at the top of this section. Make sure you understand it and why these are there.

Have a plan. Before you start cutting, have a plan for what you will do if things go wrong. Ask yourself hypothetical questions about what you would do “if” for various scenarios, and make sure you can execute your plan. For example, if you plan in case of fire is to use the fire extinguisher, make sure you know where it is, read the instructions on it so you know how to use it, etc.

At the time that things are going wrong, you won’t be able to make clear headed decisions. Having thought through them before gives you the ability to execute your plan without having to make decisions in the moment.

Lastly, do not panic. The laser cutter machine is designed to be extremely safe to the users. You might damage the machine, but are very unlikely to hurt yourself unless you really are being very careless. In general, you have time to evaluate the situation, and then calmly execute your plan. If your plan did not help, re-evaluate and come up with a new plan. Keep your interventions simple, and get help as soon as you can (often post event).
Starting the LaserWorks software interface:

1. Begin by logging into the computer with your ADCRM account.
2. Open CorelDRW.
3. Check to see if the LaserWork icons are present (they won’t be there on your first run, and they sometimes disappear).
   
   If they are not visible:
   a. From the menu bar, click Tools -> Macros -> Run Macro
   b. In the drop-down menu, select “global macros RLaser 15V6”
   c. In the menu that appears, select “UserInit”
   d. Click run.
   e. The buttons should appear as a floating window. Drag them to the toolbar, as shown in the screenshot above.
      i. If this fails, try right-clicking the toolbar and checking the “LaserWorks” option.
4. Open your .AI file (File -> Open, or open the file from the file explorer).

Setting up your CorelDraw document for laser cutting:

1. In Corel Draw, make sure your page size is your material size. You can change the dimensions in upper left corner of the screen (see image below). If you change the dimensions, drag your virtual parts to the upper-left corner or your template.

2. Change the color of your parts to reflect your material choice (see GENERAL SETTINGS TABLE FOR OPTIONS). Do not use the above image’s color scheme.
3. Draw a bounding box around your parts:
   a. Select the rectangle tool. (If there are any popup menus, click OK)
b. In the “Object Properties” panel, click the pen tab. This displays a menu with line properties. Change the color to green – the standard color for bounding boxes.

c. Drag a rectangle around your parts. Try to get it as close as possible to the edges of your parts. If necessary, use the black square handles to resize it.

4. Draw test cut rectangles:
   a. Again, select the rectangle tool.
   b. Select the color blue – the standard color for test cut shapes.
   c. Draw small rectangles for test cuts. They should be inside your bounding box, but not inside any of your parts. Put one at each of two opposite corners of your bounding box.

Here is a layout with a good bounding box and test cuts:
Using the LaserWorks interface:

1. Once your document is set up, click the LaserWorks button (the one you made when you ran the LaserWork macro).

2. This will bring up the LaserWorks interface (note that in this image, the settings are NOT ones you should use – you’ll change them shortly):

   a. If the text in this window is gibberish, it means the language setting reverted to its default (Chinese). To turn it back, select what would otherwise be the “config” tab, it’s
b. then find the “language” drop-down menu and select English.

3. Check the Machine menu to ensure your “Axis Mirror” and “Laser Head” settings match those in the image below. (Axis Y Mirror checked, Laser head in top left corner).

4. Next, you will assign behaviors to each layer (each color is a layer).
   a. Double-click a color to bring up the “layer parameters” window.
   b. There are four settings you’ll want to change for each layer. See the General Settings Table for more details about what settings are good for each material.
      i. If “Is Output” is set to “No”, the laser cutter will ignore that layer.
      ii. “Speed” controls how fast the laser cutter head moves.
      iii. “Processing Mode” should be set to “Cut”.
      iv. “Min Power” and “Max Power” should be set to the same thing (either 0 or 98).
   c. All other settings should be set as shown in the image.
d. Click “OK” to exit the window.

5. Set all your colors to match this table (Note material specific cut settings are at the bottom).

<table>
<thead>
<tr>
<th>Color</th>
<th>Speed:</th>
<th>Power:</th>
<th>Purpose:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>300</td>
<td>0</td>
<td>Bounding box. Ensures your cut is in the right place on your material.</td>
</tr>
<tr>
<td>Blue</td>
<td>Same as Material</td>
<td>98</td>
<td>Test Cut. Ensures you have the right cut speed for your material.</td>
</tr>
<tr>
<td>Red</td>
<td>600</td>
<td>15-48</td>
<td>Etching. Advanced Technique</td>
</tr>
</tbody>
</table>

**Material-specific settings:** (note that you may need to tweak these)

<table>
<thead>
<tr>
<th>Color</th>
<th>Speed:</th>
<th>Power:</th>
<th>Material:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>6.5</td>
<td>98</td>
<td>MDF (.200)</td>
</tr>
<tr>
<td>Yellow</td>
<td>65</td>
<td>98</td>
<td>Foamcore (3/16)</td>
</tr>
<tr>
<td>Orange</td>
<td>6.5</td>
<td>98</td>
<td>Acrylic (.250)</td>
</tr>
</tbody>
</table>
Operating the Laser Cutter:

1. Before you begin, open the lid and make sure the laser cutter workspace is ready: The cutting bed should be free of debris and material. The fire extinguisher should be within easy reach.
2. Turn on the Laser Cutter using the surge protector. Plug in the blower if necessary.
3. **DO NOT PROCEED UNTIL YOU'VE ENSURED THE BLOWER IS ON.**
4. From here on, someone should be in the watchbox until the machine is turned off.
5. **Place the material on the laser cutter bed.**
   a. Do Not Bump the laser cutter head with the material when doing so.
   b. Move the material to the upper left corner of the bed.
6. **Set the origin**
   a. Use the arrow keys to move the head to the upper left corner of where you want to cut on the material.
   b. Move the material if necessary to make minute adjustments.
   c. Press “Origin” on the control panel. This tells the laser cutter that its current head location should coincide with the top-right corner of your document.
7. **Close the lid**
   a. Gently pull down on the center handle or ribbon.
   b. Pull it to the left to get it to sit well. It will not cut if not fully closed.
8. For the next three steps, one teammate should be at the computer, and one should be at the laser cutter control panel, watching the cutter head and ready to press the start/pause button. The blower is loud, so make sure that you can communicate over the noise.
9. **Trace the bounding box.** This allows you to preview the area in which the laser will cut and make sure everything is set up well without damaging your material.
   a. Make sure all your cuts are selected by pressing ctrl-A
   b. Turn the output of your Green bounding box to “yes” and all your other colors’ outputs to “No.”
   c. Press the Download button to download your print to the laser cutter.
   d. DONT PRESS START ON THE SCREEN as it immediately starts the cutter.
      i. **IF the computer operator accidentally presses Start:**
         1. The teammate in the watch box should press start/pause immediately.
         2. The teammate should then press escape and gently reprimand their partner.
   e. A pop up box will emerge. Give the project a name eight letters or less and press ok.
f. A pop up box will tell you if you are successful. 

  g. Close the LaserWork Interface after sending a file. 

  h. Teammate in the watchbox will see file count increment by one. 

  i. Teammate in the watchbox will double check to ensure nothing is in the head’s path. 

  j. Teammate in the watchbox should press start. The Laser cutter will outline the cutting area. 

  k. Adjust the material as necessary and hit start to repeat the bounding box. 

10. Cut Test Cuts. This ensures you are cutting at the correct speed for the material. It also ensures you don’t start large fires with this material. 

    a. Change your settings so Blue test cut output is on and everything else is off. Ensure the blue speed matches your material speed. 

    b. Repeat b-h from step 8. 

    c. Teammate in watchbox presses start, and their finger does not leave start/pause button. 

    d. HIT PAUSE IF YOU SEE ANY SIGNS OF FIRE OR COLLISION. 

    e. Check if your cuts can pop out. If they cannot: 

       i. Move your test cuts on your sketch by duplicating the rectangles and then deleting the old ones. Don’t retrace half-cut lines – this is not an effective test. 

       ii. Adjust your test cut speed and try again. Repeat until they fall through. 

11. CUT YOUR PIECE. Everyone’s favorite moment! 

    a. Turn the output of your material color to Yes and everything else to no. 

    b. Make sure your components are all selected in the preview box (they should be red). 

       i. If not press CTRL-A. 

    c. Repeat steps b-h from step 8. 

    d. Make sure everything looks good. 

    e. Teammate in watch box hits start and hand does not leave start/pause button for a minute. 

    f. If you see flame for more than 2 seconds, press pause and then esc. Something is wrong with your material. 

    g. Teammate in watch box will not leave watch box FOR ANY REASON and will keep checking on the material until it is done. 

    h. Once done, wait ten seconds before opening the door. This allows the smoke to clear out. 

    i. Test to make sure all material has cut by pressing down on the material. If pieces break out, it has cut. If they don’t, rerun the cut on the pieces that don’t cut out. (You will need to change the color of the other pieces). 

Shutting Down the Laser Cutter: 

1. Remove all your parts from the laser cutter. Make sure no small parts are left on the bed. While you can throw away small (less than 4”) pieces inside the lab. Use non-138 trashcans for large materials. 

2. Check bed to ensure nothing is left on it and leave the lid open.
3. Click “File” and then select “Delete All Files”. Press Enter to delete all the files, thus making life easier for the next users.

4. Turn off laser cutter. Blower will take 10 seconds to turn off.

5. Log out of your account (NOT “switch user”).

6. Take your cut parts OUTSIDE of BE-138 to assemble and test. Do NOT litter small parts around on the tables and floor.