**BACKGROUND**

We have as a resource for the CMPE-118 class a 30 Watt LaserPro Explorer II Laser Cutter/Etcher. This is a very cool machine that allows you to cut geometry from a two-dimensional CAD file into sheets of various wood and thermoplastic based materials (but NOT metal). 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.

Its 30-watt laser can cut through materials up to 1/4” thick (very dependent on the speed and type of material), and it can also score or etch the surface of the material without cutting through. The maximum size that the Laser Cutter can cut is 20” x 32” (the table is larger, but on our specific machine, the leftmost 3 inches are not accessible.)
to the laser). The maximum speed at which the head can move is over 100 inches/minute, but again, it varies depending on the material and thickness you are cutting.

The Laser Cutter is connected to a PC that has the Laser Cutter software drivers on it. As far as the PC is concerned, the Laser Cutter looks exactly like a USB plotter. The large difference is that the Laser Cutter uses a CO₂ laser rather than pens in order to etch/cut the material. There are a few tricks to the driver that will be outlined in this document in order to produce the best cuts.

The Laser Cutter is a very expensive and delicate machine, please treat it as such. There are only a few materials that we have tested in the Laser Cutter, and appear in the list of “Approved Materials” that is found immediately below. Please DO NOT cut anything that does not appear on that list: certain materials will damage the optics by depositing on the lenses and mirrors, and these are very expensive (and take a long time) to replace. Please DO NOT violate this rule—it will ruin the resource for all of us who use it.

**APPROVED MATERIALS:**

1. **ACRYLIC**—Thicknesses up to 3/8” (this might require 2 passes)
2. **MASONITE**—Thicknesses up to ¼”
3. **MDF**—Medium Density Fiberboard, Thicknesses up to ¼”
4. **Foamcore**—Thickness up to ¼” (it is a bit stinky, but cuts very fast).

Remember that dimensional materials are NOT accurate, though they tend to be very consistent. That is, ¼” MDF is not ¼” thick (it will be thinner). This is done to save material in the manufacturing process, and is true for all materials that you will buy. The best may to know the material thickness is to measure it. Use the calipers for this purpose.

DO NOT cut or etch any non-approved materials in the Laser Cutter. Certain materials will release poisonous fumes when cut with the laser. We would rather not explore these materials, and the ones that are known to be BAD are: Polycarbonate, Teflon, Plywood, FR4. Be careful with your source Acrylic, Polycarbonate looks just like it, and you can only tell once you start to burn it. Polycarbonate will start to bubble and blister rather than cut. Stop the cut IMMEDIATELY if you see this happening. Teflon releases a poisonous gas, plywood gums up the works from the glue. If you have any doubt about your material, do NOT put it in the laser cutter.

**PREPARING A DRAWING:**

The Laser Cutter has been used successfully with CorelDraw, and that is the program we recommend for running the actual Laser Cutter. CorelDraw is a strictly 2D program (though it is a fairly nice one). Use SolidWorks for your 3-D modeling and your virtual prototyping, but once you have finished and are ready to make your parts, export your drawing of your parts as an Illustrator .ai file for importation into Corel (SolidWorks is available on the BE-113/115 computers). Put that file on a flash drive or your Dropbox. See the “Exporting to Corel” document for details.
Setting up CorelDraw: if this is your first time using Corel, see the “Setting Up Corel Draw” document on the class website.

Things that you want to cut should be in red, and the things you want to etch should be in green or black. All other colors are going to be ignored by the Laser Cutter. All red lines need to be set to hairline within Corel.

The way the Laser Cutter works is fairly simple in theory: lines that are 0.001 inches or narrower are cut, lines that are thicker than 0.01 inches are etched. This is done at the driver level (this is where the colors come in, as well). The beam width of the cutting laser is 4.5 thousandth of an inch, and distributes evenly to both side of the cut, that is, a circle that you cut out will be 0.9955 inches in diameter (4.5 thousands less than 1”), and the hole will be 1.0045 inches in diameter (4.5 thousands larger). Thus, there will be a 0.009 inch gap between the two of them if you put it together. Remember this kerf width when you design slots and tabs to fit parts together (also, see the comment above about the dimensions of stock that you buy).

In order to export your SolidWorks drawings to a format the Corel likes, see the “Exporting to Corel” document for details. You should draw a black bounding box around your parts in Corel (set to hairline thickness) that you will first cut to make sure the parts fit on your material.

**PRINTER DRIVER:**

The details of how the laser cuts are all contained within the printer driver. This is accessed from the PRINT dialog box, which should have the printer set as: LaserCutter. Click in on the PRINT button, which will bring up print dialog box:
Note that in this example, we have an issue. This is denoted by the yellow warning in the issues tab. In this case, the drawing is out of bounds (as you can see), but clicking on the issues tab will explain it.

Fix all of your issues, and then press the preferences button next to the Laser Cutter tag:
This brings up the Laser Cutter Properties window. In the Advanced tab, you can choose either home mode (laser always starts from 0,0) or relative mode (cutting starts from current location).

In this panel, you want to leave the scaling off, POSITION MODE should be home (this tells the Laser Cutter to start at 0,0 and cut as you have it drawn on the page). Make sure the BORDER is unchecked, and the VECTOR FUNCTION is set to VECTOR SORTING (this will cut the inside parts out first, which is good because the part will drop otherwise). Keep everything else unchecked.

Choose the PEN tab and open that up:
• For the **BLACK** color, set the pen on VECTOR and AIR, set the speed at 50% and the power at 100%. This is the setting for your bounding box.
• For the **RED** color, set the pen to VECTOR and AIR, set the speed to 0.4% (for ¼” MDF), set the power to 100%, and the PPI to maximum (it will change to X).
• For the **GREEN** pen, set the pen to RASTER and AIR, set the speed to 50%, and the power to 50%. This is for etching.

Click OK, and click print. The file will be transferred to the Laser Cutter, and will show up on the Green LCD screen at the front right corner of the machine. Every time the laser cutter is turned off and on, it needs to have the USB cable unplugged and replugged in (this is a Windows issue).

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**CUTTING THE SHAPES OUT**

At this point, you have set up your file, drawn a black bounding box, turned on the Laser Cutter, and printed your file to it. The next step is set up the material and test that you can fit your parts onto your material. This consists of a few necessary steps. The first thing required is to position the material, then do an auto-focus (adjusting for material thickness), cut your bounding box, and finally cut out your parts. First, a few caveats:

1. Place your material on the bed. Try to ensure that it is flat on the cutting grill and pushed into the upper left corner.
Manually move the head over the center of your cutting area and push the AUTO FOCUS button. The laser cutter will move the bed in the z-axis up and back down, stopping in the correct position. Press BACK to get out of auto focus mode.

**WARNING:** Make sure that the plunger is over your material. If you miss, the bed will hit the limit switch and stop moving. At this point, **DO NOT SHUT OFF THE LASER CUTTER**—go grab one of the TA's. Alternately, push BACK, out of autofocus mode, push one of the arrow keys (lightly) until you are in move mode, and then use the buttons to move the bed down (Z-down).

Make sure that you print just the bounding box alone. This will show you where your parts are going to be.

a. Turn off the GREEN and RED colors in the PEN menu by unchecking the VECTOR box, and unchecking the AIR box.
b. You can cut the bounding box with the lid up so that it won’t actually mark your material, and watch the red pointing laser as it goes around. If you close the lid, the bounding box is going to be marked onto your material by the laser.
c. Note that if you have doubts about the settings to cut through your material, change the speed settings of your bounding box until you cut it through completely on all sides.

Once you are satisfied that you are going to have all of your parts on your material (see step 3), then reprint your parts with the GREEN and RED turned back on.

a. Turn on the GREEN and RED colors in the PEN menu by checking the VECTOR and the AIR boxes.
b. Do NOT cut without the AIR turned on. If you do not hear the blower go on, something is wrong. Stop cutting (push the STOP button), and verify settings, and try it again.
c. Close the lid (and the front door), and push the START button. The laser will turn on and start to cut your part. If you do not hear the blower go on, something is wrong. Stop cutting (push the STOP button), and verify settings, and try it again.

Watch and marvel at the technology. **DO NOT LEAVE!** You MUST stay with the LaserCutter until it is done cutting. All fires have happened when people have left the machine unattended.

After the cut is complete (the laser will beep to let you know it is done), you may remove your parts. Always wait until the blower has stopped (approximately 10 seconds post cutting) to open the lid.

Clean up: remove your parts. Throw away all little cuttings in the garbage can. Do NOT leave cut up boards in BE-138, take them with you. Collect all of your belonging, and remember to log off the computer. Last note: do not, under any circumstances, assemble to test fit your parts on the tables in BE-138.

Please try to keep the laser cutter and the surrounding lab clean. The more cutting that occurs, the more ash will accumulate on the mirrors and lenses, eventually requiring slower passes to cut through the same thickness of material. Do NOT attempt to clean it out, instead ask one of the TAs or the Professor to take care of it. Remember, if you break the LaserCutter, everyone is out of luck.
PARTING THOUGHTS

Please be careful with this, and DO NOT PANIC. Unless you start a real fire in the Laser Cutter, don’t even think of using the fire extinguisher. You will ruin the machine. In other words, the vast majority of the time, everything is going to be fine, and be patient if something is happening that you don’t expect.

With the lid closed, this machine is a class IIIA laser (it won’t harm your eyes). You can stop the laser firing at any time by opening the top lid. If that does not do it, there are a pair of safety goggles near the laser cutter, put those on and then open the lid again. If the beam does not stop firing, turn off the power. If it still doesn’t stop, unplug it.

There is a PAUSE button on the cutter. Use it if you have to. Once you guys get through the class, you will be able to use the Laser Cutter for your Capstone projects, so try not to break it.

RULES OF USE

1. Use of the laser cutter is a privilege not a right. Not following these rules will result in a permanent ban.
2. DO NOT use the laser cutter if you have not been trained. At this point you have been trained only if you have taken 118 or have been trained by Max Dunne, Gabriel Elkaim, Bryant Mairs, or Pavlo Manovi.
3. An alumni of 118 CANNOT train someone unless they have cleared it with a current trainer first.
4. If at any point during its use you are unsure of what you are doing stop and ask for help.
5. Fill out the sign-in sheet and keep it accurate.
6. Do not prop the door open or allow someone to do so.
7. Leaving the door propped even if you are not the one who propped it is the same as if you left the door propped open.
8. Turn off the machine once you are done cutting.
9. Use of the laser cutter is currently on the honor system.
10. Abuse of the cutter will result in stricter rules up to and including requiring someone authorized being there during its use.

Lastly, please clean up after yourselves. Scrap should be disposed of in rubbish bins. If the rubbish bin is full, take it out and empty it, and then clean up. Sweep the area clean, and make sure that all small bits wind up in the trash, not on the floor.

Keep BE-138 neat and tidy. Don’t bring in food, don’t leave parts lying around. Don’t make us call your mother and tell her that she raised a slob. We will.