Digital Fabrication (CNC) Basics for the RPI Architecture Shop

The acronym "CNC"(Computer Numerical Control) covers the laser cutters and the three axis mill.
Numerical control (**NC**) refers to the automation of machine tools that are operated by abstractly programmed commands encoded on a storage medium, as opposed to manually controlled via handwheels or levers, or mechanically automated via cams alone. The first NC machines were built in the 1940s and '50s, based on existing tools that were modified with motors that moved the controls to follow points fed into the system on punched tape. These early servomechanisms were rapidly augmented with analog and digital computers, creating the modern **computer numerical controlled** (**CNC**) machine tools that have revolutionized the manufacturing process.
http://en.wikipedia.org/wiki/Numerical_control

DIGITAL FABRICATION SAFETY and ETIQUETTE:

CNC equipment is controlled by human programming and WILL do what it is told. The machine does not think or make decisions beyond "I am lost" or "ouch, I went too far." **Garbage in, Garbage out.** The machine will cut the file "wrong" because YOU told it to cut it that way. Files must be properly formatted for each piece of software used for file creation.

- **Do not circumvent** interlocks(Door switches and limit switches)
- Review the file with an experienced operator, 4 eyes are better than 2.
- Be aware that a machine can move at any moment unless it is OFF.
- STOP the machine at any sign of trouble, and then notify personnel of the issue.
- **DO NOT STARE AT THE LASER**!
    - The laser light emitted from these machines is not visible to the naked eye. The light emanating from the work is the byproduct of combustion at high temperatures and is extremely bright. This light and potentially reflected and un-refracted laser light could damage your eye sight.
- **FIRE** is a real possibility in both the laser and the mill. STOP the machine(open laser door, push Estop), FIND help(shop personnel),EXTINGUISH with spray bottle.
- KNOW where the EMERGENCY STOPS are located. There is one E-Stop located in each room of the shop. EMERGENCY STOPS are for EMERGENCIES ONLY!
- Clean up your waste, RECYCLE CHIPBOARD. DO NOT LEAVE WASTE SHEETS IN LASER

1. **General CNC File requirements are as follows(LASER AND MILL):**
    a. **UNITS** in **inches** ONLY
    b. Objects to be processed are the **only** objects to be in the file
    c. Files are to be **named** with your **RCS ID**, and the name of the project. Files "cut sheet" and "mill file" are not acceptable.
    d. Files must be **SCALED** before entering the shop. Unscaled files will not be fixed and will not be cut
    e. NO BLOCKS or Xref in cad files.
    f. **Foul** file names will not be processed.
    g. Please see setup sheets for individual software exports.
    h. If you are cutting the file you are responsible for it, you will be at fault for any issues with that file. This is a very important note for "Group cutting."

2. CNC machines are to be operated only with a supervisor's permission.
3. All equipment in the shop automatically shuts down at 11pm.
4. All power equipment is locked out by touch screen security panels

ORIGIN

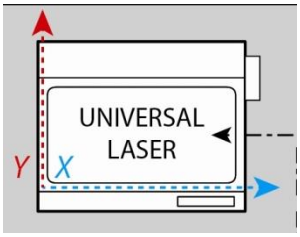
What is the **origin**? The origin is the reference point that all CNC equipment uses to reference its movement. **ORIGIN** is defined as: The point of intersection of coordinate axes, as in the Cartesian coordinate system. In the shop we also use the XY plane of the Cartesian coordinate system, some engineering software (SolidWorks and NX) use XZ plane and thus need to be rotated 90 degrees to lie on the XY plane. AutoCAD does not necessarily use an origin, another reason for importing your drawings to Rhino first. When plotted, your drawing will be in the positive quadrant of the XY plane, the **LOWER LEFT HAND CORNER is ALWAYS THE ORIGIN.**

Laser Cutting General guidelines

Although the lasers use DXF and DWG files, Rhinoceros is best able to join and prepare a file for laser cutting. It may seem strange, but Rhino will create a better DXF than AutoCAD. AutoCAD will export splines which can be an issue with both laser cutters. Rhino breaks these lines up into smaller lines that the machines can understand more reliably.

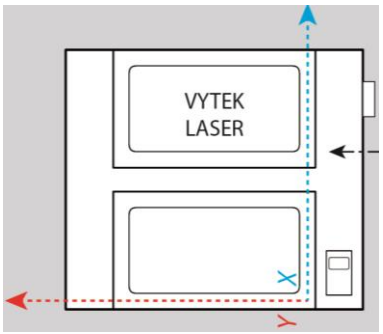
1. Rhino files must be exported properly. See Rhino Export Manual for details
2. Autocad uses a print driver to "plot" to the laser cutter. Colors are used to denote power levels.
    a. Green = CUT FIRST Same as CYAN
    b. CYAN = CUT Most powerful per material
    c. YELLOW = SCORE Not as deep as cut used mostly in chip
    d. RED= ETCH Lightest setting used for labeling
    e. WHITE = NO PLOT Will be ignored in the Universal, converted in the Vytek print driver
3. Files must be efficiently made. Cut files must share lines when at all possible
4. **OBJECTS must not be within ½" of the edge.**
5. **OBJECTS must not touch the white border**(The universal will not stop cutting when transiting after a white line/cut line intersection.)
6. Files MUST contain the WHITE Material Border AND the BED SIZE of the intended machine.

Universal Laser Specifications



1. Will cut up .25" MDF and interior glue plywoods
2. Will cut up to .25" acrylics
3. Bed size is 18"x 32"
4. The ORIGIN is in lower left hand corner as shown.

Vytek Laser Specifications



1. Will cut up to 3/8 MDF, ¾" Plywood (interior glue)(maximum thickness cuts are done rarely and require removal of the honeycomb)
2. Will cut up to 1/2" Acrylics
3. File will be processed with a script that will do the following:
    a. Create layers by color
    b. Places respective colors on respective layers
    c. Makes white lines dark blue and makes that layer "NO PLOT"
4. Without the script, white lines will be rastered and this will ruin your cut
5. The X and Y axis are **rotated counter clockwise 90 degrees** when looking at the doors, as shown.
5. **Dense** plots that are 48 x 48 must be subdivided. It won't cut in 30 minutes.