Week 3 - laser cutting

PREP WORK

1. Gather random materials for testing (chocolate bars, banana, apple, tortillas, crackers, bread, eggplant).

Outline

1. *Discussion of Curiosity Handbook work since last class session*
2. Review of clay prototypes assignment
3. In-depth guided tour of the machine
4. Designing for the laser cutter
5. Operating the machine
6. Discussion of materials compatibility
7. *Materials challenge*
8. Overview of advanced techniques
9. *Sampler project assignment*

In-depth guided tour of the machine

1. Laser tube - discuss importance of power rating
2. Water cooling system
3. Optics system - watch for dust buildup on focusing laser pointers
    a. Discuss conical shape of beam
    b. Discuss kerf
4. Air assist system - small amount of focused, pressurized air is blown across workpiece to extinguish small flames. Can shift around light materials or objects.
5. Drive system - be aware of locations of motors and belts
6. Electronics and controls system
    a. Control panel - using test, pause, start/stop, Z adjustment and emergency stop
    b. Internal lighting strip on/off
    c. Water chiller on/off - **DO NOT TOUCH!**
7. Quirks and bugs

    a. Poor wiring of water chiller switch causing short and fuse to trip. **DO NOT TOUCH**

Designing for the laser cutter

1. Cutting vs engraving
    a. “Cut look” = cuts that do not go all the way through material. Effectively single-line engraves.
2. Introduction to CorelDRAW (2D CAD) - guided on-screen tour of basic functions and locations of common features
3. Units and dimensions - decide whether you want to use metric or standard and stick to it! Show how to change units in CorelDRAW.
4. Using styles as commands - hairline stroke, no fill on polygons, using colors to identify types of operations
5. Useful techniques
    a. Using text - convert text to paths
    b. Constructing complex shapes using boolean operations
6. Print design *(optional)* - verify accuracy of sizes and positions of features

Operating the machine

1. Sending design to CAM processor - selecting paths and printing to custom print driver
2. Checking for and correcting errors - carefully look over design in CAM program to make sure it matches your original design.
3. Configuring parameters
    a. For common materials, refer to printed chart.
    b. For new or experimental materials, approximate parameters and use test patterns on scrap pieces to dial in parameters.
    c. Most important parameters to know:
        i. Speed
        ii. Power
4. Download design to machine
5. Ensure new design is loaded on machine - hit “Esc” button twice
6. Insert and (optionally) secure material
7. Move laser head to the top right corner of your design
8. Focus laser on top of material - move head onto material (make sure it won’t crash!). Use Z adjustment to get red lasers to converge.
    a. Accurate focus becomes more important as material thickness increases due to kerf of beam.
9. Trace bounding box using “test” button
    a. Watch red dots to ensure that laser is consistently focused across your design. Any deviations will indicate warping in your material.

    b. If dots change significantly, try your best to minimize deviations by adjusting Z height.
10. Start the job
    a. Monitor the machine very closely at first to try to determine whether parameters you chose are effective.
        i. Are cuts going all the way through the material?
        ii. Are engraves dark/light enough?
    b. Never leave the machine unattended!
11. Pausing vs stopping
    a. *Pause* = turns off laser and stops moving head. Allows you to open hood and verify cuts/engraves in the middle of the job. Can be resumed with no ill effects.
        i. Do NOT move material!
    b. *Stop* = turns off laser and "parks" head in safe location. Very difficult to impossible to resume job where you left off.
12. Putting out fires the safe way - hit stop or emergency stop and open up hood
    a. Small fires - use Windex to extinguish flames.
    b. Large fires - use fire extinguisher
13. Finishing the job - remove material, taking care not to bump laser head.

Discussion of materials compatibility

1. **Always consult with experienced personnel at lab before attempting to cut any new materials.**
2. Important materials properties to evaluate
    a. *Flammability* - foams, corrugated cardboard and many natural materials can catch fire easily. Foams are especially dangerous as they can melt and leak into machine and stay very hot for long periods of time.
    b. *Melting* - some foams and plastics (like HDPE/milk jug plastic) will tend to melt rather than burn, which can pass through or bind to the honeycomb lattice. Some can even remain in a super-heated molten form longer than you'd expect and cause serious damage to machinery or human skin.
    c. *Chemical composition* - never use anything that contains chlorine, such as Lexan, plexiglass, PVC or polycarbonate. Certain woods such as MDF also contain dangerous chemicals that make them unsuitable for cutting. The ventilation system is not good enough to protect you or the people around you from the fumes.
    d. *Optical transmission and reflectivity* - mirrored surfaces can deflect the laser beam which can cause significant damage to the machine. Glass can refract and deflect beams as well, causing unpredictable and unintentional splitting and focusing of beam.

3. Experimentation with new materials is highly encouraged, but extreme caution and care needs to be used while doing so.

Materials challenge

1. Give students 10 minutes to walk around the nearby campus grounds and find at least 1 interesting material/object to experiment with (bark mulch, large leaves, flowers, etc).
2. Introduce wide array of materials and ask students to discuss whether each material is safe or unsafe to use and why.
3. Hand out safe materials to students at random.and have them collaborate to figure out what parameters to use
4. Have the class work together (with minimal interjection) to execute test pattern on their materials and operate machine.
    a. **Supervise closely, but do not offer to help unless absolutely necessary.**

Overview of advanced techniques

1. Raster engraving
2. Rotary attachment
3. Kerf bending
4. Joinery
5. 3D construction using 123D Make

Sampler project assignment

1. Look for interesting designs and inspiring projects on Instructables and Thingiverse.
2. Either pick a project to start with or try to create something entirely of your own design.
    a. Attribution and sources are necessary
3. Execute project by scheduling lab time and coming in outside of class to use machine.
4. Take extensive notes of successes, failures and curiosities as you work so that you can generate a very brief report and discuss findings with the class later.
5. Refer to syllabus for due date.