Protohaven

Class Notes

Laser 101: Basic Operation

Clearances

Rabbit Large Format Lasers

Contents

Welcome

Welcome to the Introduction to Lathe class at Protohaven!

Shop Rules

Be Safe

- Get safety clearances
- Wear protective equipment
- Watch and reset equipment after use
- Never use equipment that is red-tagged

Take Care of Each Other

- Be aware of your surroundings
- Don't use a tool if it poses a danger to someone else

Take Care of the Tools

- Get tool clearances
- Do not alter of use equipment beyond limits
- Notify staff when maintenance is needed

Keep the Shop Clean

- Clean up after yourself
- Return tools to their original locations

Tool Status Tags

Every tool at Protohaven has a status to let you know if the tool is safe to use.

If the tool status is *green*, the tool is safe to use. All features should be expected to work, and no extra care should need to be taken while using the tool.

If the tool status is *yellow*, the tool may still be used, but with extra caution. The information on the physical tag or in the online maintenance history will indicate what special care needs to be taken while using the tool. If the physical tag and the maintenance log disagree, alert a tech.

If the tool status is *red*: **DO NOT USE THE TOOL**. The tool is not safe to use. The information on the physical tag or in the online maintenance history will indicate what fixes are pending, and when a repair is expected.

Some tools in the shop are explicitly green tagged to let you know they are working. Other tools in the shop are not explicitly green tagged when they are working to reduce sign fatigue. If you are in doubt about the status of a tool with no visible tag, check the Protohaven website for the tool status page:

`https://www.protohaven.org/equipment/`

Filing a Tool Report

If you are using a tool, and the tool becomes unsafe, damaged, or is not working properly, you must notify a tech. The tech may instruct you to submit a tool report:

`https://airtable.com/appbIlORlmbIxNU1L/shrluff2WSzy8c3xd`

Notifying the tech will help us keep signage up to date, and make sure the users who come in after you have all the information they need to use the tool safely, even if they don't use discord.

Safety

If you feel unsure of something, feel free to ask!

Introduction

Learning Objectives

Terminology

Tools

Large Format Laser

The Large Format Laser can etch or cut various materials with precision.

Notes

Safety

- Do not leave the laser running unattended.
- Keep the laser door closed during normal operation.
- Make sure the fan is running before cutting or etching.

TODO: anything about laser safety?

Common Hazards

Some materials may heat up enough from the laser to combust. In case of a small fire, use the water spray bottles to quickly douse any small flames.

Some materials may produce toxic gas when cut or etched. Make sure the material you are cutting or etching is not listed in the Prohibited Materials subsection.

Depending on the material, laser cutting may produce sharp edges. Always handle materials carefully after they have been cut.

Care

Use care when opening and closing the cover; do not let the cover slam closed. The shock of letting the cover fall freely onto the chassis can damage the laser tube.

Materials

Protohaven carries a small selection of acrylic and plywood sheets for use with the large format lasers.

A list of Sources for Materials is included in the References section.

Prohibited Materials

Some materials are dangerous to etch or cut in the laser cutter: the process may cause a fire hazard, or introduce dangerous gasses into the studio space.

The following materials are prohibited for use in the laser cutter:

Prohibited Material	Hazard
Any material containing a halogen	Fluorine, Chlorine, Bromine, etc...
Artificial Leather	
AVS	
Butadiene-acrylonitrile Rubber	
Chlorinated Plastics	
Coated Carbon Fiber	
Dry Moly Lube	

Prohibited Material	Hazard
Easyweed Electric Heat Transfer Film	polyurethanes
Epoxy Resin	Formaldehyde, Hydrogen Cyanide
Fiberglass	
Foam Core	
Foamular Extruded Polystyrene Insulation	
Galvanized Metal	
HDPE	
Laser Rubber	Hydrogen Cyanide
Lexan	
Mirrored Surfaces	
Moleskine Notebooks	
Neoprene	
Nylon	
Oracal 651	Contains PVC, Lead, Chromium
Polycarbonate	
Polymer Clay	
Polypropylene	
Polyurethane	
Pressure Treated Wood	
PTFE	
PVC	
Rock Salt/Table Salt	Chlorine
Sculpey	
Silicone conformal coating spray from MG Chemicals	contains halogens
Siser P.S. Film	polyurethanes
Siser StripFlock P.S. Film	PVC
Spandex & Stretch	contains polyurethane
Speedball Art Speedy Cut, Speedy Cut Easy and Speedy Carve	PVC at minimum
Styrofoam	
Teflon	
Uncured Powder Coating	
Vinyl	

Approved Materials

Approved Material	Cut	Etch	Warning
3M 200MP Adhesive Transfer Tapes	✓	✓	
Abalone Shell	✓	✓	
Acrylic	✓	✓	Mirrored Acrylic reflective side down
Cardboard	✓	✓	
Cardstock	✓	✓	

Approved Material	Cut	Etch	Warning
Cellulose Acetate Butyrate	✓	✓	
Ceramic		✓	
Ceremark Metal Marking Compound		✓	
Chipboard	✓	✓	
CobalTex RF	✓	✓	wash hands after handling the cut edges of this fabric to help prevent ingesting the metal dust
Corian	✓	✓	
Coroplast Brand Corregated Polypropylene	✓	✓	watch for melting; bulk polypropylene is not approved
Cotton	✓	✓	Watch for fire.
Cotton Denim	✓	✓	Stretch denim has Spandex and is prohibited.
Delrin	✓	✓	
Depron Foam	✓	✓	
Easyweed Glow in the Dark Heat Transfer Film	✓	✓	
Eco-fi™ Specialty Craft Felts	✓	✓	
EVA copolymer	✓	✓	
Felt	✓	✓	Watch for fire.
Foamboard/Foam Core	✓	✓	HIGH FIRE RISK: The entire job must be monitored closely.
Freezer Paper	✓	✓	Raw polyethylene is not approved
GE Silicone Caulk	✓	✓	
Glass		✓	
Hemp	✓	✓	Watch for fire.
Kaolin Clay (claybord)	✓	✓	
Kapton Film	✓	✓	FPC and HN variants only
LDF	✓	✓	
Magnetic Sheets	✓	✓	
Marmoleum	✓	✓	
MDF	✓	✓	
Metal (painted/anodized)		✓	The laser must not be used over 50% power in this scenario. Reflections can damage the optics.
ModPodge Gloss	✓	✓	
Mylar	✓	✓	
Natural Cork	✓	✓	Only cork without adhesive backing. All artificial cork must be approved separately.
Natural Leather	✓	✓	
Non-Chlorinated Rubber	✓	✓	
Painter's Tape	✓	✓	
Paints and Thin Spray Coatings (thinner than powder coating)		✓	

Approved Material	Cut	Etch	Warning
Paper	✓	✓	
Peelable Solder Mask (latex)	✓	✓	
PET Plastic	✓	✓	
PETG Plastic	✓	✓	
PLA Plastic	✓	✓	
Plaster of Paris		✓	
Plasti-dip		✓	
Plexiglass	✓	✓	
Plywood	✓	✓	
Polybutylene Terephthalate	✓	✓	Must not contain brominated fire retardant
Polypropylene Tape	✓	✓	
Polystyrene	✓	✓	Watch for fire.
Rowmark LaserMAX	✓	✓	
Siser Glitter Heat Transfer Film	✓	✓	
Speedball Art Linoleum	✓	✓	
Stone		✓	
Suede	✓	✓	
Wood	✓	✓	
Wool	✓	✓	Watch for fire.
Worbla BlackArt	✓	✓	
Worbla FinestArt	✓	✓	
Worbla TranspArt	✓	✓	

Parts of the Laser Cutter

Basic Operation

1. Set Up the Laser
2. Workholding
3. Focus the Lens
4. Set the Origin
5. Set up the Job in LightBurn
6. Run the Job on the Laser
7. Cleaning Up

Set Up the Laser

1. Turn on the large format laser.
2. Make sure chiller is powered on and working.
   Look for the green status light on the front of the chiller.
3. Make sure the exhaust fan is running.
4. Carefully open the lid.
   The lid is heavy; letting the lid slam closed will damage the laser.

5. Secure the workpiece to the grid.
   use the provided mounting magnets to hold the workpiece in place.
6. Position the laser head over the workpiece.
   Use the directional buttons to move the laser head across the bed.

Workholding

Use magnets to secure the workpiece to the grid.

Make sure that the laser's path won't cause the laser to cut the magnets, or for the laser head to crash into the magnets.

Focus the Lens

Use a focus block on the workpiece to set the height of the lens and bring it into focus.

1. Press the **Z/U** button to change to bed height control.
   *The screen will display a menu with **Z move** highlighted in blue.*
2. Press the ← (right arrow) and → (left arrow) buttons to align the height of the lens carriage to the focus gauge.
   The right arrow lowers the bed, and the left arrow raises the bed.
3. Press the **Esc** button to return to the main menu.

Set the Origin

1. Position the laser head over the workpiece at the location you want the cut or etch to start.
   Use the directional buttons to move the laser head across the bed.
- *Optional:* Press the **Pulse** button to verify the exact location.
2. Press the **Origin** button to set the origin point for the job.

Set up the Job in LightBurn

These steps detail loading a single vector art file into LightBurn, and using that file to run a job with the laser. LightBurn is capable of much more: with LightBurn, we can load, manipulate, and compose multiple images into one job. For more about LightBurn, please see LightBurn.

(Load art into light burn) (Set the reference origin in lightburn)

Run the Job on the Laser

1. Check the footprint of your job.
   In LightBurn, press the MUMBLE button to command the laser to trace out the box boundary of the job, or the MUMBLE button to trace out the exact boundary of the job. The laser will trace out the area of the job. Make sure that the traced path does not leave the media, or run over any of the magnets.
2. Press the start button.
3. Monitor the machine until the job is complete.
   While the job is running, remain nearby the laser to make sure nothing goes wrong.

Cleaning Up

1. Power off the Laser.

2. Reset any modified computer settings to default.
3. Vacuum the interior so material does not build up beneath the honeycomb.
4. Recycle waste in the single-stream scrap bins.

Report any maintenance needs or concerns at protohaven.org/maintenance, or by alerting a shop tech on duty.

If the single-stream scrap bins become full, alert a shop tech.

Reference

Sources for Materials

Approved Material	Sources
Acrylic	https://www.amazon.com/acrylic-sheet/s?k=acrylic+sheet
Cellulose Acetate Butyrate	https://www.chempoint.com/products/eastman/eastman-cellulose-esters/cellulose-acetate-butyrate/cab-171-15
Ceremark Metal Marking Compound	https://www.cermarkusa.com/
Chipboard	https://www.dickblick.com/products/all-purpose-chipboard/
CobalTex RF	https://lessemf.com/product/cobaltex-fabric/
Freezer Paper	https://www.amazon.com/Reynolds-Kitchens-Freezer-Paper-Square/dp/B000BZYCNK
ModPodge Gloss	https://www.michaels.com/mod-podge-gloss/M10047536.html
Painter's Tape	https://www.amazon.com/ScotchBlueTM-Painters-Tape-Core-Yd/dp/B00004Z4DU
Plexiglass	https://www.amazon.com/Source-Thick-Inches-Acrylic-Plexiglass/dp/B004DYW31I

Software

LightBurn

Help and Tutorials

LightBurn software has a YouTube page (`https://www.youtube.com/@lightburnsoftware7189/`) with lots of content to help with projects. For those new to laser cutting and etching, these videos are a good place to start:

- Getting Started With LightBurn: Set up & First Project
  `https://www.youtube.com/watch?v=v3RDzOrlCTM`
- LightBurn UI Walkthrough
  `https://www.youtube.com/watch?v=uzFsrUwONbw`
- LightBurn Cut Settings
  `https://www.youtube.com/watch?v=nybhYtjElQU`

Concepts

Image Types

For computers to work with image data, the image data needs to be *encoded* in some way so that the computer can understand it. There are many approaches to encoding visual data, but most of them fall into two categories:

- raster images, where the image is encoded as a grid of dots
- vector images, where the image is encoded as a collection of objects

Raster Images

Raster images are composed of lots of dots: a rectangular grid of points, each point encoded with color information. If we zoom way in on a raster image, we'll see that it's made up of this grid of dots. In the following image, we can see from the zoomed in portion of the image that it's made up of lots of tiny dots of color:

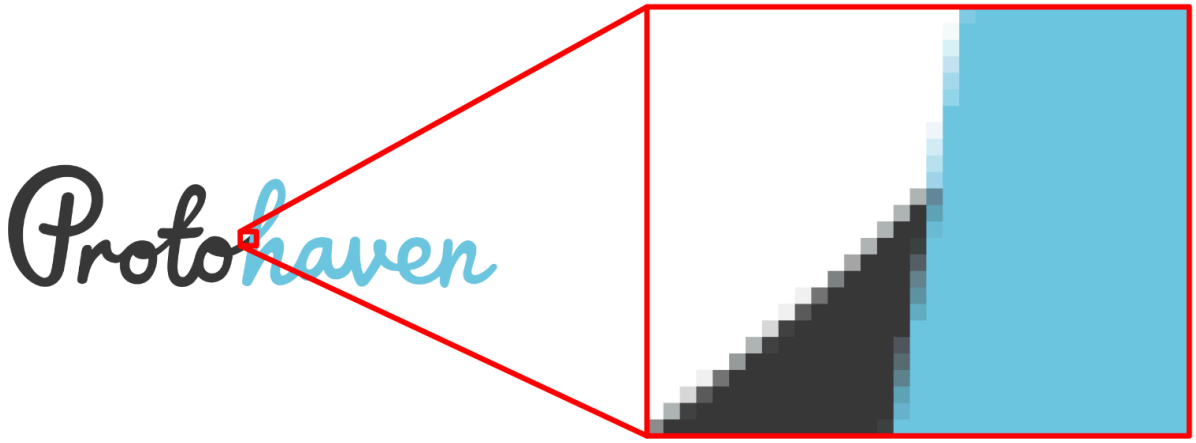

Figure 1: A small section of a raster image, magnified.

These dots are often referred to as *pixels*.

The number of pixels we have in an image partially determines its quality. The more dots in the image, the better the image will look (to a degree) and the more we'll be able to adapt it for a variety of uses: we can, for example, scale up an image with lots of pixels and still have it look reasonable for most applications.

Raster images are useful for rich graphics: photographs, non-technical line art, etc. Raster images are particularly good for photographic material.

Raster images are a poor choice for transmitting text (particularly if scaled), or vector art like line drawings, schematics, etc.

Common file formats like `.jpeg`, `.gif`, and `.png` are all image raster data.

Vector Images

Vector images are built from logical instructions. In a raster image, a line might be encoded as a string of dots on the grid. In a vector image, a line is encoded as a logical

connection between two points. A nice property of vector images is that they scale very well: they can be re-rendered with precision at any size. In the following image, we can see in the zoomed in portion of the image that there is no loss in precision or quality of the image:

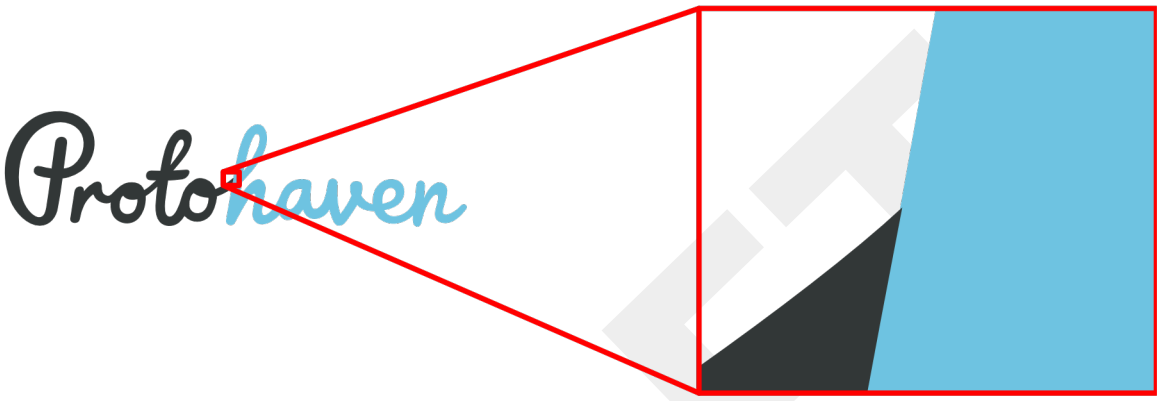

Figure 2: A small section of a vector image, magnified.

Vector graphics are made of *objects*.

The objects in a vector graphics file logically describe the visual contents of the file. For example, the file my specify that at a particular coordinate on the canvas there is a square, filled in with a particular color. The information is not encoded in dots, like a raster image: the image contents are described instead by a collection of objects that describe an image.

Vector graphics are useful for any image that requires precision: vector formats are good choices for infographics, technical line drawings, schematics, and similar art.

Vector graphics are also useful for any art that has a text component: labels, legends, titles, etc. With a vector graphic, the text is also stored as vectors (the glyphs of the font, or objects derived from it), and the image can be scaled without any loss of quality for the text or the art.

Common file formats like `.ai`, `.dxf`, and `.svg` are all image vector data.

Resources