Swarthmore College

MakerSpace Safety Manual

For the MakerSpace's Woodshop and Digital Fabrication Lab

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Mission

It is the mission of the MakerSpace at Swarthmore College to provide a digital and analog learning environment to be used by all willing departments, clubs, students, faculty and staff. With both a digital fabrications lab and woodshop/workroom we are able to provide space, equipment and services that may not be otherwise available to a department or program. It is our hope that this unique and interdisciplinary space will facilitate a confluence of ideas across departments and individuals. The exchanging of diverse areas of knowledge and varying ideas is central to innovation. The entrepreneurial spirit thrives in the MakerSpace through exposure to new means of making and thinking. The Makerspace is a place of free flowing ideation. We encourage experimentation, prototyping and ambition.

Code of Conduct

At the MakerSpace, you have the freedom to explore 3D fabrication technology and the privilege to use the space, shop, and machines. By using the equipment here you agree to the following:

1. I will be respectful of others. This includes:
    a. Not printing weapons or offensive material.
    b. Not stopping another person's print midway to start my own.
    c. Only using one printer at a time(unless granted permission).
    d. Giving priority to research and class related projects.
2. I will use this space responsibly by:
    a. Not using materials wastefully.
    b. Following all safety and machine handling protocol.
    c. Asking MakerSpace technicians for help when issues arise.
    d. Cleaning up after myself.

Thank you for complying to the terms outlined here.

Purpose

This document aims to provide a clear set of rules and guidelines to ensure safety and proper use of the woodshop and digital fabrications lab. It outlines procedures and policies to be implemented by the manager and monitors.

Emergency Contacts

x8333—Security Extension from campus phone: This is your first point of contact while on campus. Security is trained to navigate emergency help to where it is needed on campus.

610-328-8333—Security phone number from non-campus phone: Technicians must have this programmed into their phone in case needed.

x8281—Non-emergency security contact: This can be used if someone needs assistance but it is not an emergency. Example some would like an escort home.

Standards

The information within this document was developed according to various OSHA standards and by referencing *Baylor University Shop Safety Manual*, *University of Washington's General Woodshop Safety: Unit 1*, The University of Washington Section on *Laser Cutter Safety and* Epilog laser Fusion M2 32/40 Laser System Manual Model 13000/14000.

Image Caption

Use of Shops and Labs

Everyone using the MakerSpace shops must comply with the rules and requirements outlined in this manual. The sections *General Safety Rules for the Woodshop, Before working and Rules While Working* are required reading before being trained in the shop. Individuals must go through proper training with either the instructor or shop manager before using any tool, machine or piece of equipment. They will then be checked off for that particular piece of equipment and will be allowed to use it during designated open shop/lab hours.

- Everyone must sign in when using the space.
- No one may use equipment before they have gone through training.
- No one may use woodshop Machines outside of designated open hours, regardless of training.

Open hours are when either the Manager or trained student technicians are present to assist and monitor the use of the shop.

Some classes may be granted access to the shop, but not machines, outside of designated Monitored hours. See section on Class Access.

Note: All training on Woodshop machines is the responsibility of the Faculty or Manager. Students are not authorized to train or sign off users.

Appropriate attire including PPE (Personal Protective Equipment) is necessary for all work in the shop. Proper attire is specified within this manual,

Users must be alert and attentive when working in the shop and must immediately report any concerns regarding shop safety, machines or equipment to the manager or supervisor.

Scheduling

The Makerspace is open to all departments, programs and individual students. Access may be limited at times during scheduled classes, or workshops. We request that classes wishing to use the lab contact the MakerSpace manager at least a week in advance to discuss their needs. Open hours will be posted, walk-ins are welcome, though individuals wishing to use particular equipment may wish to schedule times with the MakerSpace manager.

When in the space, respect the machines and others around you. Remember that 3D prints may take many hours and could overlap with other scheduled events. Prints may be delayed until after the scheduled event.

Student Monitors

Student monitors have been trained in shop and lab equipment. They will work alongside the manager and independently as hosts for open shop and lab hours.

- Student Monitors will not certify others on shop machine safety, that is the responsibility of the manager.
- The table saw, planer, and jointer will be off limits to all students, monitors included, unless under direct supervision of the manager. These machines will have separate locks from the main power shut off.
- NOBODY - including shop certified Monitors - is permitted to work in the shop alone.

As Monitors you are responsible for the safety of students and the proper use of equipment while on duty. Monitors should be familiar with and prepared to enforce the rules laid out within this manual and will also have basic duties such as shop maintenance and cleaning. During open hours your priority is to assist the other users, not your own work.

Monitors will have card access to both the Digital Fabrications Lab and the Woodshop. Woodshop monitors will have card access to the machine power. With this power comes great responsibility. Even with card access it is expected that you, like all other students, faculty and staff, obey the open hours, working within those time frames.

Monitors cannot work outside of open hours, grant access to those not allowed or turn the machine power on outside of their specified monitor hours. Card access to machine power will be limited to scheduled open hours only.

Some classes may be granted card access to the Woodshop to complete class projects. Access is limited to 9am to 8pm, and users may only use hand tools during this time.

Monitors will have access to class lists of students and classes who have been granted access will be provided. A list of people and what machines they have been trained on will also be provided. (Access List)

Class Access

Access to the MakerSpace may be granted to classes that are using the space on a regular basis and need additional time to complete projects. If you get a request please refer the person to the Manager who can approve access. Access will only be granted for the use of space and basic hand tools, not machines.

Students who have been granted access to the Makerspace for a class **must** obey the rules laid out in this manual. They cannot allow other users into the space. They cannot prop doors, tamper with machinery/locks, or use anything they are not trained on. It is important that users exercise even greater caution when working outside of monitored hours.

Such access is a privilege and will be revoked if abused. Users are expected to clean up after themselves, respect the space, equipment and scheduled open hours or events. Monitored hours, classes and any event takes precedence over their personal work time. These hours will also be limited from 9am-8pm at which point card access will stop.

General Safety Rules for the Woodshop

1. Faculty and or staff are in charge of ensuring proper use and maintenance of machines, tools and equipment. As well as instituting rules regarding safety, training and use of woodshop.
2. Only trained persons will be allowed to use the tools, machines and equipment.
3. Training should be scheduled in advance with the MakerSpace manager Jacqueline Tull, (x5575) and will be provided by the Makerspace manager. Training will be documented upon completion.
4. The woodshop will be kept clean and well organized.
5. Safety Information, Shop Rules and Emergency Exits will be clearly posted.
6. Individuals operating machines may not listen to music, or wear headphones.
7. Cell phone use is not permitted while using Woodshop Machinery.
8. Horseplay is forbidden.
9. PPE (Personal Protective Equipment) and Attire:
    a. Always wear safety goggles when in the woodshop, regular glasses do not protect your eyes, our safety goggles should fit over your glasses.
    b. Use ear protection when using machinery, or when present while others are using loud machinery.
    c. Close-toed shoes are required at all times while in the Wood Shop (no ballerina flats or high heels).
    d. Do not wear loose or baggy clothing. Roll up sleeves and tuck tassels on sweatshirts. Shirts must be tucked in.
    e. Tie hair back completely.
    f. Do not wear loose jewelry or watches.
    g. Pants are prefered.

h. Dust Masks are recommended.

i. Do **Not** wear gloves while operating woodworking machinery.

10. Machines will be checked routinely and placed out of order if:

    a. Guards are damaged or missing.

    b. The machine is not operating properly.

    c. Machine power cords are damaged or not grounded properly.

11. NEVER

    a. Work in the shop alone.

    b. Work outside of designated shop hours (hours will be posted).

    c. Use a machine you are not signed off/trained on.

    d. Use a damaged machine or one designated out of order.

    e. Leave a machine while it is running.

    f. Leave a machine while the blade is moving (even if you have turned it off, wait for the blade to stop).

    g. Use a machine if you are impaired (drowsy, on medication, under the influence of drugs or alcohol).

    h. Never Ever Rush.

12. ALWAYS

    a. Be alert and attentive.

    b. Wear proper attire including PPE.

    c. Ask any questions you have regarding the safe use of the space, tools, equipment and machines.

    d. Use common sense.

    e. Inspect machines before use.

f. Adjust Guards for safe use.

13. All Injuries should be reported. Anyone injured must seek appropriate medical treatment.
14. Anyone working in the shop must be familiar with the Emergency Shutoff system and emergency phone numbers.
15. All incidents must be reported to Public Safety—x8333. Public Safety will provide forms and procedures.
16. Incidents will be reviewed by the manager and if applicable the student monitor/faculty/staff on duty at the time of the incident to determine if further action regarding the student, equipment or policy is needed.
17. Privileges to the MakerSpace can be revoked.

Personal Protective Equipment - Woodshop PPE

Personal Protective Equipment	Required	Recommended
Safety Glasses with Side shield Or Safety Goggles 	✔	
Face Shield with Safety Goggles 		✔
Dust Mask 		✔
Gloves (Gloves should **NOT** be worn while operating woodshop Machines) 	✗	✗
Ear Plugs/Ear Muffs 		✔
Closed-Toe Foot Wear 	✔	

Before Working

1. Make sure you remember how to use the machine.

    A. Do not use any equipment you are not certified on. Monitors will have access to a list of authorized users.
    B. Run yourself through what you plan to do and how with both the material and machine.
    C. Ask questions if you have any.
    D. Make sure your material is properly marked.

2. Inspect the machine or tool before you turn it on

    A. Check for damage.
    B. Frayed or broken power cords.
    C. Loose knobs or levers.
    D. Jammed or stuck material in the machine.
    E. Dirt and debris which may damage the machine, material or impede proper use.
    F. Make sure you know where the off switch is.
    G. Make sure you are not working alone.
    H. Make sure you are signed off for use.
    I. Make sure you have proper attire and PPE.
    J. Check that all proper ventilation, blowers, and guards are on.

Rules While Working

1. Pay Attention.
2. NO Headphones (headphones do not count as ear protection), music or distractions.
3. Focus on what you are doing, but be aware of your surroundings.
4. Be patient.
5. Do not ever ever rush.
6. Do not leave a machine while it is running.
7. Do not leave a machine while the blade is still moving, even if off.
8. If a machine has levers or knobs painted green then only those painted in green can be adjusted on that machine.
9. Unplug a machine before making any modifications or adjustments.
10. **Never** remove clogged material from a machine while it is running.
11. Emergencies—Call Public Safety at x8333.
12. If material is jammed in a machine and possible to remove without risking safety, Shut Off and unplug the machine before removing the material.
13. Do not hesitate to use the emergency shut off if someone is in danger.
14. Contact Public Safety if needed, numbers are posted by phones—x8333.
15. Public Safety non-emergency phone # (610)-328-8281.
16. No more than 8 people may work in the wood shop during student monitored hours.
17. Student monitors are in charge and have the authority to limit or restrict the use of machines and the space to those who are not following proper safety procedures.
18. Respect the space, rules, machines, others and Student Technicians.

Injury or Illness

In the case of an accident or injury the first point of contact is Public Safety, (x8333), they will send someone to assist and contact an ambulance or appropriate response if necessary. Student employees are not required to provide medical assistance, but they are expected to contact public safety.

Injury or illness

- Immediately call Public Safety at x8333, or 610-328-8333
- Note any medical alert information which may be present on medic-alert jewelry, and report it to the dispatcher.
- Do not move an injured person unless absolutely necessary.
- Stay with the victim and assist as necessary until help arrives.

Reporting an Injury

1. If an injury does occur requiring more than a band aid, contact public safety.
2. Public Safety will file a report.
3. If employees, including student employees, are injured, they will fill out a workers compensation form.
4. Non employees (ex. other students using the space) will fill out a personal injury form.
5. Public Safety will send all reports to Jinny Schiffer: the Environmental Health and Safety Officer, and Human Resources.

Safety Data Sheets

1. Woodshop SDS
2. Digital Fabrication Lab SDS

WoodShop Machines

Band Saw Vertical

Potential Hazards

1. Contact with the blade is the most common cause for injury. Material is fed manually through the machine. Pay close attention when operating.
2. Loose clothing, jewelry, and hair could catch on moving parts on the machine.
3. Flying Debris. Chips and sawdust will be expelled from the machine when operating. Eyes are most vulnerable and eye protection must always be worn.
4. Exposed pulleys. Belts and pulleys move rapidly, and like the blade, can catch loose clothing, jewelry and hair. Never open any cover plate while the machine is running or plugged in.
5. Inhalation of Dust, wear a dust mask and turn on the dust collector to minimize.
6. Electrical shock, check for frayed cords before using. DO NOT use a machine with frayed cords.

Key Controls

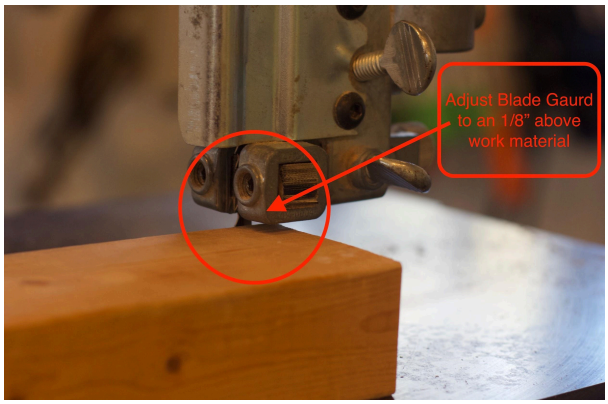
1. Power Shut off. Power to the machines can only be turned on by designated and trained technicians.
2. It can only be turned on during specified hours.
3. Power to the machine shuts off automatically 15 mins after technicians shift.

Operating Precautions

1. Proper Attire. Closed toed shoes, no loose clothing, hair or jewelry.
2. PPE. Safety glasses, ear protection and dust mask are recommended.
3. Only to be used if trained and signed off on by the manager.
4. Check machine before beginning.
5. On machines with knobs and levers painted green, do not adjust any knob or lever **not** marked in green.

Band Saw Specific

1. While Machine is off, adjust blade guard to 1/8” above work material.
2. While operating hold material firmly and flat against table.
3. Start the machine then bring material into contact with the moving blade. Do not place material against blade before turning on the machine.
4. Use a push stick if needed to prevent hands from getting close to the blade.
5. Keep hands on either side of the blade path, not directly behind.
6. Make release cuts, also known as relief cuts, before making intricate or tight curved cuts.
7. If the blade breaks, or comes free from guides or rollers immediately shut off the machine. Do not open any cover or guide. Get a monitor or manager to assist.
8. If the blade binds or get stuck in stock, immediately shut off the machine. Gently remove the material from the blade after it stops moving.
9. If debris gets stuck in the machine, shut off the machine. Remove waste from the machine, with brush if possible, after the blade stops. Do not remove jammed material from the machine while it is running.
10. If you see sparks while operating the machine, slow down or stop cutting.
11. Once finished shut off machine, wait by the machine for the blade to stop moving, then clear off table with brush.



Belt/Disc Combination Sander

Potential Hazards

1. Contact with the sanding disc or belt is the most common cause of injury. Material is worked manually across the abrasives, therefore pay close attention when operating.
2. Nip Points. There are exposed nip points where the worktable meets the abrasive belt/disc. Fingers and stock can be caught in these nip points.
3. Loose clothing, jewelry, and hair. There are multiple moving parts on the machine which can catch and pull in any loose material.
4. Flying Debris. Chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable and eye protection must always be worn.
5. Belts and pulleys move rapidly and like the disc can catch loose clothing, jewelry and hair. Never open any cover plate while the machine is running or plugged in.
6. Inhalation of Dust, wear a dust mask and Always turn on the dust collector.
7. Electrical shock, check for frayed cords before using. DO NOT use a machine with frayed cords.

Key Controls

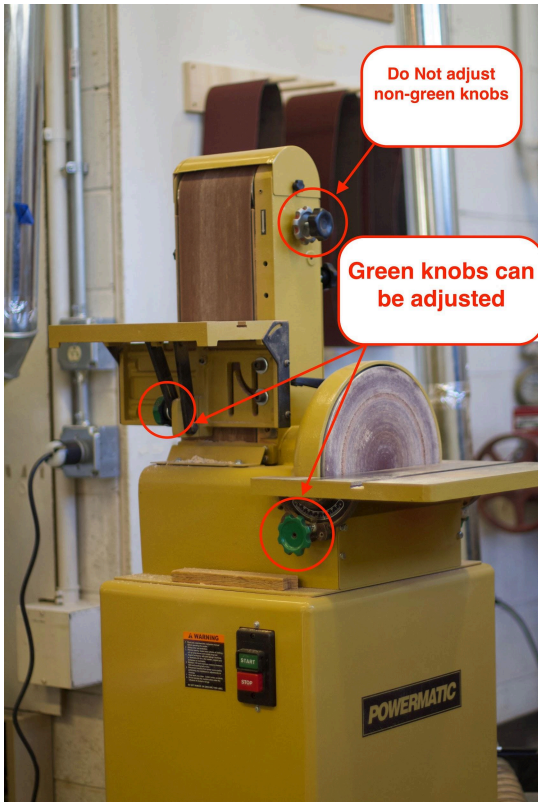
1. Power Shut off. Power to the machines can only be turned on by designated and trained technicians.
2. It can only be turned on during specified hours.
3. Power to the machine shuts off automatically 15 mins after a technician's shift.

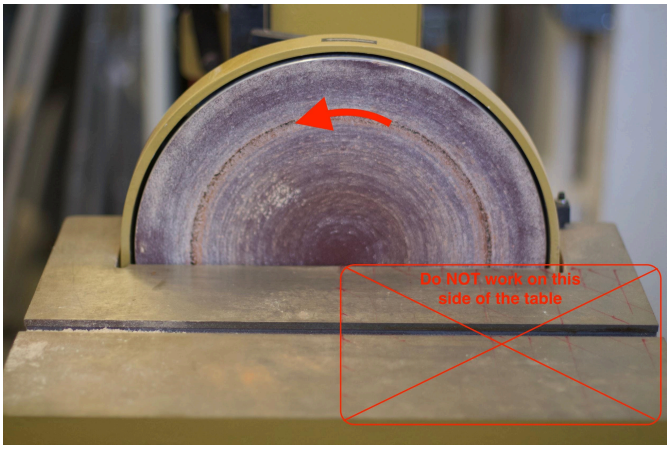
Operating Precautions

1. Proper Attire. Closed toed shoes, no loose clothing, hair or jewelry.
2. PPE: Safety glasses and ear protection are required, and dust mask is recommended.
3. Only to be used if trained and signed off on by the manager.
4. Check machine before beginning, as specified in "Before working, Section 2."
5. Do not adjust any knob or lever not marked in green.

Belt/Disc Combination Sander Specifics

1. Keep hands clear from abrasives and use a jig or holding device when possible.
2. Start the machine then bring material into contact with the moving abrasives. Do not place material against abrasives before turning on the machine.
3. Do not force material into abrasives.
4. Do not sand small pieces by hand. Use tools and push sticks to hold material.
5. On the disc sander only use the table half where the disc travels in a downward motion. The side of the bed with upward motion is marked in red.
6. Do not sand in one place. Move material back and forth along abrasives.
7. Wait for machine to reach full speed before sanding.
8. Do Not adjust or clean machine while it is running.
9. Never leave machine while it is running.
10. Once finished, shut off machine, wait by the machine until abrasives have stopped moving, then clear off table with brush or vacuum.





Drill Press

Potential Hazards

1. Loose clothing, hair or jewelry can get snagged in the rotating drill bit.
2. Contact with rotating drill bit can cause injury.
3. Flying Debris: chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable and eye protection must always be worn.
4. Exposed pulleys. Belts and pulleys move rapidly and, like the blade, can catch loose clothing, jewelry and hair. Never open any cover plate while the machine is running or plugged in.
5. Being hit by the key left in the drill chuck when turned on, use of a spring-loaded chuck key reduces this risk.
6. Improperly secured wood or material spinning.
7. Inhalation of Dust.
8. Electrical shock. Never use a machine with a damaged or frayed cord.

Key Controls

1. Power Shut off. Power to the machines can only be turned on by designated and trained technicians.
2. It can only be turned on during specified hours.
3. Power to the machine shuts off automatically 15 mins after technician's shift.

Operating Precautions

1. Proper Attire: Closed toed shoes, no loose clothing, hair or jewelry.
2. PPE: Safety glasses..
3. Only to be used if trained and signed off on by the manager.
4. Check machine before beginning, As Specified in "Before working, Section 2."
5. Make sure all materials are properly clamped and secure.
6. Make sure the drill press is aligned with the hole in the table, that the bit is secure and centered in the chuck.

Drill Press

1. Make sure your work is clamped and secure before drilling.
2. Make sure the drill bit is properly and securely fit into chuck, use chuck key.
3. Make sure drilling speed is appropriate, Speed Chart is on left hand side. **Never adjust speed while the machine is turned OFF.**
4. If the material breaks free from the table, hold down shut off switch and wait for it it to stop moving, then remove the jammed piece.
5. Start the machine, then bring the drill bit slowly down into the material.
6. Do not force the drill bit.
7. While Drilling, withdraw drill bit regularly to remove waste material.
8. Wait for machine to reach full speed before drilling.
9. Keep hands away from moving parts.
10. When finished drilling a hole walk the drill back up, do not allow it to retract freely.
11. Do Not adjust or clean machine while on and running.
12. Never leave machine while it is running.
13. Once finished, shut off machine, wait by the machine until drill bit has stopped moving then, remove drill bit, replace chuck key and clean off table with brush.
14. Clean drill bit and return to proper place.

Sliding Compound Miter Saw

Potential Hazards

1. Contact with the blade is the most common cause for injury. Material is often held manually down and operators must make sure they are aware of their hand placement at all times.
2. Loose clothing, jewelry, and hair. There are multiple moving parts on the machine which can catch and pull in any loose material.
3. Flying Debris. Chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable and eye protection must always be worn.
4. Bowed, warped or improperly positioned wood.
5. During sliding cuts the blade can kick forward when making more contact with the back of a board than the front.
6. Exposed pulleys. Belts and pulleys move rapidly and like the blade can catch loose clothing, jewelry and hair. Never open any cover plate or guard while the machine is running or plugged in.
7. Inhalation of Dust.
8. Electrical shock.

Key Controls

1. Power Shut off. Power to the machines can only be turned on by designated and trained technicians.
2. It can only be turned on during specified hours.
3. Power to the machine shuts off automatically 15 mins after technicians shift.

Operating Precautions

1. Proper Attire. Closed toed shoes, no loose clothing, hair or jewelry
2. PPE. Safety glasses, eye protection
3. Only to be used if trained and signed off on by the manager.
4. Check machine before beginning, As Specified in “Before working, Section 2.”
5. Do not adjust any knob or lever if you are not sure of its function.
6. Check wood for bowing, crowning and nails before making a cut.
7. Ask for assistance before cutting any bowed or warped wood so it can be positioned correctly.

Sliding Compound Miter Saw Specifics

1. Before making a cut make sure the fence is not impeding the motion of the blade, **especially** for compound miter cuts.
2. Make sure all knobs and levers are tight and secure.
3. Reposition body if needed for a safer cut.
4. While operating, hold material firmly and flat against table and fence, never free-hand.
5. Start the machine, then bring the blade down slowly to make the cut. **Do not** abut material against the blade then turn on the machine.
6. Make sure hands are away from the blade and the cut can be made comfortably, no crossed arms.
7. Allow the blade to come to a complete stop before retracting the blade or removing material.
8. When making sliding cuts start at the outermost end of the cut, bring the blade all the way down, and push the blade back toward the fence.
9. Always make sure the wood is secure to avoid tip up.
10. Keep hands on either side of the blade, not directly in front.
11. If the blade binds or gets stuck in stock, immediately shut off the machine, when the blade is stopped gently remove the material from the blade.
12. If debris or off cuts get stuck in the machine, shut off the machine and remove waste from the machine with a brush or piece of wood if possible. Do not remove jammed material from the machine while it is running. Do not pass hands under the blade.
13. Once finished Shut Off machine, wait by the machine until the blade has stopped moving, then clear off the table with a brush or vacuum.

Table Saw

Potential Hazards

1. Contact with the blade is a common cause for injury. Material is often held manually down and operators must make sure they are aware of their hands placement at all times.
2. Loose clothing, jewelry, and hair. There are multiple moving parts on the machine which can catch and pull in any loose material.
3. Kickback, on a table saw: the blade rotates towards the operator, who pushes wood into the blade. Improperly held or warped wood can be thrown back, with great force, at the operator.
4. Flying Debris. Chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable and eye protection must always be worn.
5. Exposed pulleys. Belts and pulleys move rapidly and the blade can catch loose clothing, jewelry and hair. Never open any cover plate or guard while the machine is running or plugged in.
6. Inhalation of Dust.
7. Electrical shock.

Key Controls

1. Lock out cord to ensure only used while supervised.
2. Power Shut off. Power to the machine can only be turned on by the Makerspace Manager.
3. It can only be turned on during specified hours.
4. Power to the machine shuts off automatically 15 mins after technicians shift.

Operating Precautions

1. Proper Attire. Closed toed shoes, **no** loose clothing, hair or jewelry.
2. Wear comfortable and stable shoes with good grip.
3. Don't keep items in shirt pockets.
4. PPE: Safety glasses, eye protection, ear protection.
5. Only to be used if trained and signed off on by the manager.
6. Check machine before beginning as specified in "Before Working, Section 2."
7. Use a push stick for anything 6" wide or less.
8. Check wood for bowing, crowning, nails, screws, and dampness before making a cut.
9. Always ask for assistance with any bowed material. Position bowed wood so it is the most secure. Severely warped wood should not be cut.

Table Saw Specifics

1. The Saw Stop Table saw is equipped with a mechanism capable of sensing the difference between wood and flesh.
2. Never use the miter gauge or sled and fence together.
3. Set blade height no more than an 1/4" above work material.
4. Never back a board out of a cut.
5. Make sure the adjustments areas are tight and secure.
6. Reposition body if needed for a safer cut.
7. While operating hold material firmly and flat against the table and fence, never free-hand.
8. Start the machine, then bring the material into the moving blade. **Do not** abut material against the blade then turn on the machine.
9. Make sure hands are away from the blade and the cut can be made comfortably, no crossed arms.
10. Push material all the way through, making sure it is fully cut and past the blade.

11. Never remove hands from the material while it is still in contact with a moving blade.
12. Always make sure the wood is secure to avoid tip up.
13. Keep hands on either side of the blade, not directly behind.
14. If the blade binds or gets stuck in stock, immediately shut off the machine (this can be done with a knee if the shut off switch is difficult to reach), then gently remove the material from the blade.
15. This is not a table for assembling or glueing, it should be kept clean and clear.
16. Never make adjustments while the blade is moving.
17. Lower the blade below the table when finished.
18. If debris or off-cuts get stuck in the machine, shut off the machine and remove waste from the machine with a brush or piece of wood if possible. **Do not** remove jammed material from the machine while it is running.
19. Once finished, shut off the machine, wait by the machine until the blade has stopped moving, then clear off table with brush or vacuum.
20. Develop a habit of turning the machine off with your knee, this will be helpful if you even need to shut off the machine in the middle of a cut.

Panel Saw

Potential Hazards

1. Contact with the blade is a common cause or injury. Material is often held manually down or pushed through, and operators must make sure they are aware of their hands placement at all times.
2. Loose clothing, jewelry, and hair. There are multiple moving parts on the machine which can catch and pull in any loose material.
3. Flying Debris. Chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable, and eye protection must always be worn.
4. Bowed, warped or improperly positioned wood can cause the saw to move erratically.
5. Kick up, after a cut. Wood can shift back into the path of the blade, let the blade stop before retracting the saw.
6. Exposed pulleys. Belts and pulleys move rapidly and like the blade can catch loose clothing, jewelry and hair. Never open any cover plate or guard while the machine is running or plugged in.
7. Inhalation of dust.
8. Electrical shock.

Key Controls

1. Power Shut off. Power to the machines can only be turned on by designated and trained technicians.
2. It can only be turned on during specified hours.
3. Power to the machine shuts off automatically 15 mins after technicians shift.

Operating Precautions

1. Proper Attire. Closed toed shoes, no loose clothing, hair or jewelry.
2. PPE. Safety glasses, eye protection.
3. Only to be used if trained and signed off on by the manager.
4. Check machine before beginning, as Specified in “Before working, Section 2.”
5. Do not make adjustments while the machine is plugged in.
6. Check wood for bowing, crowning, screws and nails before making a cut.
7. Ask for assistance before cutting any bowed or warped wood.

Panel Saw Specifics

1. Make sure all knobs and levers are tight and secure.
2. Reposition body if needed for a safer cut.
3. While operating, hold material firmly and flat against the fence, and make sure it is resting evenly along the bottom rails.
4. Start the machine then bring the blade down slowly to make the cut. **Do not** abut material against blade then turn on the machine.
5. Make sure hands are away from blade and the cut can be made comfortably, no crossed arms.
6. Position the cord so that it is free from your arm, and from the path of the blade. You should be able to bring the blade all the way down without the cord disrupting you.
7. Allow the blade to come to a complete stop before retracting the blade or removing material.
8. Push saw down all the way to make sure the blade has cut completely through the wood.
9. Always make sure the wood is secure and flush.
10. Keep hands on either side of the blade, not directly in front.
11. If the blade binds or gets stuck in stock, immediately shut off the machine, when the blade has stopped, gently remove the material from the blade.
12. If debris or off-cuts get stuck in the machine, shut off the machine and remove waste from the machine with a brush if possible. Do not remove jammed material from the machine while it is running.
13. Once finished, Shut Off machine, wait by the machine until the blade has stopped moving then clear off the table with a brush.
14. Retract the saw manually. Do not allow it to return freely.

Jointer

Potential Hazards

1. Contact with the blade is a common cause for injury. Material is often held manually down and operators must make sure they are aware of their hands placement at all times.
2. Loose clothing, jewelry, and hair. There are multiple moving parts on the machine which can catch and pull in any loose material.
3. Flying Debris. Chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable, and eye protection must always be worn.
4. Bowed, warped or improperly positioned wood can cause the wood or jointer to move erratically.
5. Kick up, after a cut wood can shift back into the path of the blade, let the blade stop before retracting the wood.
6. Exposed pulleys. Belts and pulleys move rapidly and like the blade can catch loose clothing, jewelry and hair. Never open any cover plate or guard while the machine is running or plugged in.
7. Inhalation of Dust.
8. Electrical shock.

Key Controls

1. Approved and authorized persons ONLY can operate equipment.
2. Training to be done and documented by the Makerspace Manager.
3. Appropriate department supervisors shall ensure unauthorized persons do not have access to machines.
4. Follow all safety warnings given in the OEM's Operating Manual.
5. A visual pre-operation inspection should be done prior to use.
6. Equipment to be operated ONLY with required guarding in place. There MUST be a self-adjusting or automatic guard over the cutting head. A guard must also be in place that will cover the portion of the cutting head that is back of the fence.
7. Ensure the three blades that make up the cutting head are tight and sharp, and without defects.
8. Cord should be checked for cracks or worn areas. Remove from operation if cord is damaged or if plug does not have proper grounding (3-prong).
9. Personal Protective Equipment (PPE) shall be worn as detailed in table on page 6.
10. NOTE: Gloves are not to be worn while operating a jointer.
11. Follow proper Lock out procedures (CFR 1910.147)

12. NOTE: If the device is plugged in and the plug is under exclusive control of the person performing the work, unplugging the machine will suffice. If the person performing the work needs to leave the machine before work is complete, proper LOTO procedures are to be followed.
13. Install awareness devices (signage, barriers, etc.) around saw.
14. Operators are not to wear loose fitting clothing (short sleeves preferred), jewelry (including rings and watches) or gloves. Pants are recommended.
15. Instruct operators with long hair to secure in a cap, tie, or hair net.

Operating Precautions

1. Stock should be pushed through the machine using two push pads or a push pad on the front of stock and a push stick on the rear of the stock.
2. It is recommended NOT to use a jointer on the following:
   -The face of pieces of wood that are less than 1⁄2" thick, as they can splinter and break.
   -The edges of pieces of wood that are 3⁄4" or less as they can vibrate split and cause a safety hazard.
   -Any piece of stock that is less than 12" long. The material must be long enough to bridge the jointer throat and have complete support on the bed or you could be injured.

3. Adjust the cutter head so that no more than 1/8" is removed at a single pass.
4. Adjust the width of the table to match the width of the stock. You want to minimize the amount of exposed cutting blade to reduce risk of your hand coming into contact with the moving blade.
5. Ensure the fence is locked down in the correct position.
6. Stand on the left, beside the jointer, not behind or in line with your material. You will have more control over your material, will not have to reach so far, and will not be hit by the material if it is thrown from the machine.
7. Do not start the machine with the wood contacting the cutting blades.
8. To reduce risk of kick-backs:
   a. Avoid use of very poor quality lumber. There should be no loose knots, splits, or structural defects. Also, there should be no nails, screws or other foreign objects in the stock.
   b. Ensure the blade height is correctly set, and blades are in good condition.
   c. Avoid deep cuts. Make multiple passes using a less aggressive cut to achieve a desired surface.
9. Ensure your work area is clean and uncluttered, and sufficient space is given to the operator using the machine.
10. Keep the machine properly oiled and serviced.

Planer
Applicable Standards

Potential Hazards

1. Point of operation – Contact with the cutter head blades is a common cause for injury. Material is often held manually down, and operators must make sure they are aware of their hands placement at all times.
2. Loose clothing, jewelry, and hair. There are multiple moving parts on the machine which can catch and pull in any loose material.
3. Flying Debris. Chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable and eye protection must always be worn.
4. Bowed, warped or improperly positioned wood can cause the saw to move erratically, or the wood to become stuck.
5. Exposed pulleys. Belts and pulleys move rapidly and like the blade can catch loose clothing, jewelry and hair. Never open any cover plate or guard while the machine is running or plugged in.
6. Inhalation of Dust.
7. Electrical shock

Key Controls

1. Approved and authorized persons ONLY can operate equipment.
    a. Training to be done and documented by the Makerspace Manager.
    b. Appropriate department supervisor shall ensure unauthorized persons do not have access to machines.
    c. Follow all safety warnings given in the OEM's Operating Manual.
2. A visual pre-operation inspection should be done prior to use.
3. Ensure all guarding is in place. Equipment to be operated ONLY with required guarding in place.
    a. Ensure the blades that make up the cutting head are tight and sharp and without defects.
    b. Cord should be checked for cracks or worn areas. Remove from operation if cord is damaged or if plug does not have proper grounding (3-prong).
4. Personal Protective Equipment (PPE) shall be worn as detailed in table on page 6.

5. Machines designed for a fixed location shall be securely anchored to prevent walking or moving of the machine.
6. Follow proper Lock out procedures (CFR 1910.147).
    a. NOTE: If device is plugged in and the plug is under exclusive control of the person performing the work, unplugging the machine will suffice. If person performing the work needs to leave the machine before work is complete, proper LOTO procedures are to be followed.
7. Install awareness devices (signage, barriers, etc.) around saw.
8. Operators are not to wear loose fitting clothing (short sleeves preferred), jewelry (including rings and watches) or gloves.
9. Instruct operators with long hair to secure in a cap, tie, or hair net.

Operating Precautions

1. Work piece will be fed automatically into the planer. Do not reach into cutter head area while machine is running.
2. Adjust the cutter head so that no more than 1/8" is removed at a single pass.
3. Make sure knives and infeed rollers are properly adjusted and set as per the instructions in the OEM's operating manual.
4. Use different sections of the infeed when using the planer in order to avoid uneven wear of cutting blades.
5. Do not change speeds while planing.
6. For best results, one face should be trued up on a jointer prior to planing and the side that has been trued up should be placed face down.
7. Do not stand in line with the work piece.
8. Do not start the machine with the wood contacting the cutting blades and allow cutting head to reach full speed before feeding in work piece.
9. To reduce risk of kick-backs:
    a. Avoid use of very poor quality lumber. There should be no loose knots, splits, or structural defects. Also, there should be no nails, screws or other foreign objects in the stock.
    b. Ensure table height is correctly set and blades are in good condition.
    c. Avoid deep cuts. Make multiple passes using a less aggressive cut to achieve desired surface.
10. Ensure work area is clean and uncluttered and sufficient space is given to the operator using the machine.

11. Keep the machine properly oiled and serviced.

Hand Tools

Right Angle Grinder

Applicable Standards

Potential Hazards

1. Contact with the disc is a common cause for injury. The machine is held manually and brought to the material.
2. Loose clothing, jewelry, and hair. There are multiple moving parts on the machine which can catch and pull in any loose material
3. Flying Debris. Chips and sawdust will be expelled from the machine when operating. The eyes are the most vulnerable and eye protection must always be worn.
4. Grabbing on edges. Some bits grab more than others, which can catch on edges causing the grinder to jerk.
5. Sparks, when cutting or grinding metal the disc will throw off a lot of sparks. Be aware of where they are going, they can cause ignition to materials, cause harm to eyes, and burn through clothing or skin.
6. Exposed disc. The discs move rapidly and can catch loose clothing, jewelry and hair. Never remove the guard.
7. Improperly secured bits/disc.
8. Incorrect disc for job.
9. Broken or cracked discs.
10. Inhalation of dust.
11. Electrical shock. Cords can become cut or frayed during use if not positioned properly.

Key Controls

1. Power Shut off. Power to the machines can only be turned on by designated and trained technicians.
2. It can only be turned on during specified hours.
3. Power to the shop shuts off automatically 15 mins after technician's shift. Grinders are to be returned to the Makerspace Manager after use.

Operating Precautions

1. Proper Attire. Closed toed shoes, no loose clothing, hair or jewelry.
2. PPE. Safety glasses, eye protection, face shield, ear protection, gloves and dust mask.
3. Only to be used if trained and signed off on by the manager.
4. Check machine before beginning, as Specified in "Before working, Section 2."
5. Do not make adjustments while the machine is plugged in.
6. Make sure material is secure and stable. The rotation of the grinder can cause the material to move unpredictably if not secure.

Right angle Grinder Specifics

1. Selecting the correct discs.
    a. Make sure the disc is the appropriate diameter for the grinder.
    b. Make sure the disc is not too worn for safe operation.
    c. Make sure the disc is not cracked or broken.
    d. Make sure the disc is rate for the correct speed of the grinder.
    e. Make sure the disc is designed for your material type and purpose, examples: Metal, wood, stone, grinding, cutting, sanding.
2. Make sure the handle, guard and disc are secure and tight.
3. Make sure the locking washers are appropriate and ordered properly for the specific disc being used.
4. Avoid wearing gloves unless absolutely necessary to protect hands. Only wear close fitting gloves, keeping hands away from the grinding wheel.
5. Wear a dust mask appropriate for the material being worked on.

6. Reposition body if needed for a safer cut or grind.
7. While operating always use two hands, one on the body of the grinder the other on the handle.
8. Start the machine then bring it into contact with the material. **Do not** abut material against blade then turn on the machine.
9. Make sure the guard is on, covers at least 180 degrees of the blade and is positioned between the hands and the disc.
10. Always unplug the machine when changing discs.
11. Do not over tighten, this can cause damage to the discs.
12. When using a cutting disc, use the edge not the face of the disc.
13. Do not force the disc, which can cause discs to break and shatter.
14. Do not place the grinder disc-down while it is still rotating.
15. Reposition body around work if need be, do not reach or lean more than needed.
16. Shut the grinder off when moving, DO Not move your body and operate the machine.
17. Be aware of debris kicked off by the machine.
18. Make sure nothing flammable is in line of sparks during work on metal.
19. Always make sure the work piece is secure and stable.
20. Do not keep body directly behind discs, to minimize risk of injury in the event of kick back.
21. Always be mindful of the cord location.
22. If a disc binds or gets stuck in stock, immediately shut of the machine, when the disc has stopped, remove the disc from the material.
23. If debris or off-cuts get stuck in the machine, shut off the machine and remove waste from the machine with a brush if possible. Do not remove jammed material from the machine while it is running.
24. Once finished, shut off the machine, wait until the disc has stopped moving, then set it down and unplug it.
25. Return the grinder and clean up area.

General Safety Rules for the Digital Fabrications Lab

Faculty and/or staff are in charge of ensuring proper use and maintenance of machines, tools and equipment, as well as instituting rules regarding safety, training and use of the lab.

1. Trained monitors will assist in the set up and running of tools, machines and equipment.
2. Training will be required for the Laser System. It can be achieved through individual appointments or during group training sessions. Training will be documented upon completion.
3. The lab will be kept clean and well organized.
4. Safety Information, Lab Rules and Emergency Exits will be clearly posted.
5. Individuals operating machines may not listen to music, or have headphones.
6. Horseplay is forbidden.
7. Machines will be checked routinely and placed out of order if:
    a. Guards are damaged or missing.
    b. The machine is not operating properly.
    c. Machine power cords are damaged or not grounded properly.

18. NEVER
    a. Work outside of designated shop hours (hours will be posted).
    b. Use a machine you are not signed off on.
    c. Use a damaged machine or one designated Out of Order.
    d. Leave the Laser Cutter/Engraver while it is running.
    e. Use a machine if you are impaired (drowsy, on medication, under the influence of drugs or alcohol).

f. Never, ever, rush.

19. ALWAYS

    a. Be alert and attentive.

    b. Wear proper attire including PPE.

    c. Ask any questions you have regarding the safe use of the space, tool, equipment and machines.

    d. Use common sense.

    e. Inspect Machine before use as specified in “Before Working, Section 2.”

20. All Injuries should be reported. Anyone injured must seek appropriate medical treatment.

21. Anyone working in the lab must be familiar with the safety system and phones.

22. All incidents must be reported to Public Safety at x8333. Public Safety will provide forms and procedures for reporting.

Reservations and Scheduling

Reservations must be made for large groups or for long periods of use at least a week in advance. Open Hours Consultations Sign up

Walk-Ins are welcome, but it may be in one's best interest to schedule an appointment.

Be prepared with a document for printing/engraving. Software for CAD, vector, and photo editing is available on all computers in the Media Center.

Lab Hours are available on the Swarthmore College MakerSpace website where one can also sign up for 30 min time slots.

Digital Fabrication Machines

Epilog Laser System Fusion M2

Ultimaker 3

Ultimaker S5

Markforged Onyx Pro

Wazer Waterjet Cutter

This Sections was prepared using The Epilog laser Fusion M2 32/40 Laser System Manual Model 13000/14000. As well as referencing The University of Washington Section on Laser Cutter Safety.

Laser Cutter/Engraver

Manual

Epilog Technical Specifications

Swarthmore College's Laser Cutter is a 50 Watt Epilog Fusion M2 C02 Laser.

"A laser cutter is a cutting device which focuses a high energy laser beam onto a material resulting in a high quality and dimensionally accurate cut. These devices can be used to cut, etch, engrave, or drill a variety of materials. They are often easily affordable and easy to use causing the use of laser cutters by schools, hobbyists, small businesses, makerspaces and universities to expand significantly.

Laser cutters are normally fully enclosed systems that prevent laser operation unless the safety interlocked doors are fully closed. They typically contain a carbon dioxide (CO2) laser that produces invisible laser radiation at a wavelength of 10600 nm in the infrared spectrum." (EHS University of Washington, 2017)

Classification

"Since they are a fully enclosed and interlocked systems, laser cutters are normally low-risk, Class 1 lasers in accordance with ANSI Z136.1 Safe Use of Lasers. These devices are safe when used as designed, without manipulating the safety features, and are exempt from UW laser registration and other control measures.

HOWEVER, the lasers embedded inside the enclosed system are often Class 3B or Class 4 lasers, which emit high energy laser beams capable of causing serious eye and skin injury if the beam is not contained within the device. Therefore, safety interlocks should never be bypassed without permission from Radiation Safety." (EHS University of Washington, 2017)

Potential Hazards

1. This laser is a Class 2 laser product and is an invisible and powerful laser that can cause severe damage to the eyes and skin if the beam is not contained within the device.
2. The machine, when operated under normal circumstances, will fully contain the laser beam.
3. Toxic Gases—Some materials are banned because they produce very toxic or poisonous fumes. See the section on Banned Materials
4. Flying Debris. Although the laser will shut off automatically if the lid is open, safety glasses should be worn when operating the machine.
5. Hot or sharp objects, some materials can get very hot or break/cut with sharp edges, gloves should be worn when removing material from the machine.
6. Fire. The high intensity laser beam can cause material to burst into flame. The following are fire and safety guidelines as recommended by Epilog.

Fire Safety As recommended by Epilog

Epilog Fire and Safety

a. "Your laser system uses a high intensity beam of light that can generate extremely high temperatures when it comes into contact with the material being engraved, marked or cut. Some materials are extremely flammable and can easily ignite and burst into open flame, setting the machine afire.
b. This open flame is very dangerous and has the potential to destroy not only the machine, but the building in which it is housed. Experience shows that vector cutting with the laser has the most potential to create an open flame.
c. Many materials are susceptible to igniting; however, acrylic (in all its forms), has shown to be especially flammable when vector cutting with the laser.
d. Please read the following warnings and recommendations and follow them closely at all times.
e. The following tips will help reduce fire hazards with your laser engraving system:
f. Never operate the laser system unattended.

g. ALWAYS keep the area around the machine clean and free of clutter, combustible materials, explosives, or volatile solvents such as acetone, alcohol, or gasoline.
h. ALWAYS keep a properly maintained and inspected fire extinguisher on hand. Epilog recommends a Halotron fire extinguisher or a multi-purpose dry-chemical fire extinguisher. The Halotron extinguisher emits a clean, easily removable substance that is not harmful to the mechanics or wiring of the laser system. Other dry chemical extinguishers can sometimes emit a sticky, corrosive powder that is very difficult to clean up.
i. ALWAYS use the Air Assist feature when vector cutting.
j. BE CAREFUL when vector cutting - Many materials have the potential to burst suddenly into flames – even materials with which you might be very familiar. Utilizing the Air Assist feature will reduce the instance of flare-ups when working with flammable materials such as acrylic and wood.
k. KEEP YOUR LASER SYSTEM CLEAN – A build up of cutting and engraving residue and debris is dangerous and can create a fire hazard in its own right. Whenever you are vector cutting there is the potential for small pieces to fall through the vector grid and collect in the table tray. These small pieces present a very dangerous fire hazard, especially if they are allowed to collect over time. Since most users cut wood and acrylic, these small pieces that fall into the table tray act just like kindling and can ignite and start a fire.
l. NOTE: To clean your tray, remove the vector grid and clean out the table tray using a cloth, small brush or vacuum cleaner.
m. Lastly, make sure the exhaust blower you are using receives proper maintenance. Periodically clean the exhaust blower and duct system to remove built-up debris. If you detect odor while engraving, or smoke in the cabinet is visible in the area of the lens carriage, inspect the exhaust system for leaks and obstructions. Inspect and clean the exhaust ports in your machine to ensure there are no obstructions within the machine itself. Use a wire brush to clean the plenum and exhaust port of your machine." (Epilog Laser, 2014)

Laser Cutter/Engraver Order of Operations

1. Turn on Machine.
2. Turn on air Compressor.
3. Turn on Extractor/Ventilation.
4. Lower Bed.
5. Measure material thickness, make sure you are not assuming its dimensions and thickness.
6. Place test material, of the same material type (and thickness for Vector cuts), in bed being careful not to hit the laser.
7. Focus the laser to material.
8. Open Adobe Illustrator and set the dimensions to your test piece.
9. Open or create a test file in Adobe Illustrator.
10. Make test run.
11. Lower bed and check test, make adjustments if needed.
12. When ready for final print:
13. Lower bed and place in material.
14. Focus the bed.
15. Open file in Adobe Illustrator and set “Art Board” dimensions to materials size.
16. “Art Board” refers to the board size you set in Adobe Illustrator.
17. Make sure any Vector cuts are set to .001 and image editing is done.
18. Select print.
19. Epilog printer.
20. Preferences.
21. Setup.
22. Set Epilog print driver to appropriate settings, see Settings Sheet.
23. Make sure you also set the dimensions to the same as your work piece.
24. Select print.
25. You may have to repeat steps 21-25 to get the dimensions correct in the printer interface.
26. When ready hit print, you will need to go to the control panel on the Epilog machine. When your file name appears on the control screen, select “Go.”
27. The Print you just sent should automatically be quede to the top, but check and make sure it is the correct job.
28. If it is the correct file, hit “Go” and watch the laser for flare-ups and candle flames.

29. If a flame continues to burn as the laser moves away from the flame's location, IMMEDIATELY hit the emergency stop button on the machine and follow the appropriate steps to put out the flame (see Fire Protocol section on page x).
30. After the job is complete, lower the bed, allow all vapors and smoke to clear the interior of the machine, open the machine and remove your pieces.
31. Vacuum small debris from beneath the vector grid if applicable.
32. Turn off laser cutter, exhaust, and air compressor before leaving.

Operating Precautions

1. Make sure the machine, blower and extractor are on.
2. Never leave the machine while it is running.
3. Pause the machine if necessary.
4. Stop the machine's operation if necessary.
5. Pause the machine if you smell or see excessive smoke, vapors, or flame.
6. Wear eye protection.
7. Know where the blanket and fire extinguisher are, and be familiar with them.

Materials

Banned Materials

Banned Material	Danger/Toxin	Cause/Damage
Chlorinated Plastics PVC, Vinyl, Pleather and other artificial leathers, Sintra a PVC foam board, Kydex a polyvinyl plastic sheet	Emit Chlorine Gas when cut	Toxic gas that also damages machine parts
Polystyrene (foam)	Emits Styrene and gas catches fire easily	Toxic fumes and a high risk of fire
Polypropylene (foam)	Emits Styrene and gas catches fire easily	Toxic fumes and a high risk of fire
PET Plastics containers (Polyethylene terephthalate)	Emits Benzene	Carcinogen
ABS	Emits cyanide gas and melts	Toxic fumes, can easily catch fire
HDPE (High Density Polyethylene) Milk bottle plastic	Melts and can produce fumes	Can Catch fire and produce harmful fumes
Wax	Melts	Melts and can catch fire or cause damage to machine

Polyoxymethylene (POM) Brands are: Delrin, Celcon, Ramtal, Duracon, Kepital, and Hostaform	Emits caustic fumes when	Can cause cancer
Pressure Treated wood	Emits dangerous fumes	Never burn Pressure Treated wood anywhere it is treated with copper based pesticides
Galvanized Metal	Emits Toxic fumes	Zinc Oxide fumes are very dangerous
Mirrored Surfaces	Does not cut well	Mirrors or very polished and reflective surfaces can reflect the laser, resulting a bad or no cut and potential damage to the machine
Thick (>1mm) Polycarbonate/Lexan	Cuts very poorly, discolors, catches fire	Polycarbonate is often found as flat, sheet material. The window of the laser cutter is made of Polycarbonate because *polycarbonate strongly absorbs infrared radiation!* This is the frequency of light the laser cutter uses to cut materials, so it is very ineffective at cutting polycarbonate. Polycarbonate is a poor choice for laser cutting. It creates long stringy clouds of soot that float up, ruin the optics and mess up the machine.

CO2 Laser Material Compatibility

Material Settings for 50 Watt Laser

Laser Materials for sale

3D Printers

Save CAD files as .STL to a USB Drive or to your google drive.

uPrint SE Plus

uPrint SE Plus Manual

The uPrint SE Plus is a high performance specialized printer for printing with ABS(Acrylonitrile Butadiene Styrene) a type of thermoplastic commonly used for 3D printing. ABS is a more durable, and finicky plastic than PLA(Polylactic Acid), which is what our five Ultimakers print with.

ABS is a sturdy and durable plastic that is slightly flexible and heat resistant. It is often used for products that will be subjected to physical strain, hinges, gears and other mechanical objects.

The uPrint SE Plus prints with a soluble support material SR-30 a (Synthetic thermoplastic polymer) that can be dissolved in a heated bath with a PH level of 10. This makes for a more consistent print and easy clean up.

The uPrint has a build plate of 8”x8” and a maximum height of 6” so make sure your objects will fit within the print box.

The uPrint SE Plus is run through a slicing software called GrabCAD. A slicing software literally slices the CAD design and converts the .stl into a G-Code that the machine can read and run. In the slicing software layer height, or resolution, can be adjusted as well as generating support material, scaling, copying and other basic and custom features for printing. This software is not available on all computers although it is free to download.

Slicing Software

GrabCAD

Potential Hazards

1. VOCs or Volatile Organic Compounds are released during extrusion. Not all VOCs are toxic and they vary material to material.
2. ABS is considered far more toxic than its user friendly counterpart PLA.
3. Burns—ABS is extruded at temperatures between 225-240 degrees celsius. The material, nozzle tip and print core are extremely hot.
4. Cuts when removing Support Material, the implements used to remove support material can be very sharp as well as the support material itself. Use gloves.
5. Flying Debris —When removing support material sharp pieces can break, snap and fly off, wear eye protection.
6. Chemical and heat burn when using the Support Cleaning Apparatus:
    a. The SCA reaches a temp of 71 degrees Celsius or 160 degrees Fahrenheit
    b. The bath has a PH of 10.

Operating Precautions

1. Do not extrude at temperatures higher than recommended. The higher the temperature is above a filaments glass point the more VOCs are released.
2. ABS printers should be vented and filtered to keep air clean and free from fumes and nanoparticles.
3. Use caution when hands are near the print nozzle.
4. Keep hands clear when the machine is operating, pause the machine if needed.
5. Wear Gloves when handling any hot parts, examples are the nozzle, print core or even heated print beds.
6. Wear gloves, safety glasses and use caution when removing support material.
7. When operating, the Support Cleaning Apparatus, SCA, wear gloves and safety glasses.
    a. The solution has a PH of 10 and reaches 160 degrees Fahrenheit.
    b. This can burn skin, eyes and even damage clothing.
    c. Lower and remove printed object from the bath slowly to minimize splashing.
8. Cleaning and renewing the SCA solution will be done or supervised by the manager.
    a. When performing maintenance on the SCA, an apron and face shield should be worn in addition to gloves and goggles.
9. All waste solution must be contained within the plastic carboys with machine. Environment health and safety will remove the spent solution.

Ultimaker 3

Ultimaker 3 Manual
Ultimaker S5 Manual

The MakerSpace has 3 Ultimaker 3 printers set up with PLA (Polylactic Acid) a thermoplastic polyester and a water soluble support material PVA(Polyvinyl Alcohol). These machines can print a variety of materials, but are mostly used to print PLA.

There is also now 2 Ultimaker S5 printers. These are very similar to the Ultimaker 3 except that they have a much larger build volume.

PLA is an eco-friendly, non-toxic, biodegradable plastic derived from plant matter, often corn starch. It is however more brittle and less durable than ABS.

PLA is a safe and easily printed material ideal for any object that doesn't require great structural strength.

The Ultimaker 3 build plate is **7.75"x7.75"** with a maximum height of 7.25" so make sure your objects will fit within the print box.

Ultimaker S5 build volume 330 x 240 x 300 mm (13 x 9.4 x 11.8 inches)

The Ultimaker 3 is run through a slicing software called Cura. A slicing software literally slices the CAD design and converts the .stl into a G-Code that the machine can read and run. In the slicing software layer height, or resolution, can be adjusted as well as generating support material, scaling, copying and other basic and custom features for printing. This software is not available on all computers although it is free to download.

Slicing Software

Cura

Potential Hazards

1. VOCs or Volatile Organic Compounds are released during extrusion. Not all VOCs are toxic and they vary material to material.
2. PLA is considered relatively safe in regards to the toxins released during extrusions
3. Burns—PLA is extruded at temperatures between 195-205 degrees celsius. The material, nozzle tip and print core are extremely hot.
4. Cuts when removing Support Material, the implements used to remove support material can be very sharp as well as the support material itself. Use glove
5. Flying Debris —When removing support material sharp pieces can break, snap and fly off, wear eye protection.

Operating Precautions

1. Do not extrude at temperature higher than recommended the higher the temperature is above a filaments glass point the more VOCs are released.
2. Use caution when hands are near the print nozzle.
3. Keep hands clear when the machine is operating, pause the machine if needed
4. Wear Gloves when Handling any hot parts, examples are the nozzle, print core or even heated print beds.
5. Wear gloves, safety glasses and use caution when removing support material

Onyx Pro

Onyx Pro Manual

The Onyx Pro by MarkForged is a specialized printer great for printing durable parts to be used as mechanical prototypes and possibly functional parts.
It prints with a “Nylon PA6 copolymer with a chopped carbon blend as the base-plastic for the Fused Filament Fabrication (FFF) printing process.” Within the Nyon base it can also print a continuous Fiberglass filament for added strength and wear resistance. This process is called Continuous Filament Fabrication (CFF).

Nylon is a semi-flexible and strong plastic made more rigid but also much more durable with the addition of the an internal Fiberglass skeleton. Since this machine is designed specifically for high strength prototyping or functional parts it only prints in one material and in one color, Onyx black. The Onyx filament is 2x stronger than ABS and printing with inlaid Fiberglass can make it 5x the strength of Onyx alone.

The Onyx Pro build volume is 320 mm x 132 mm x 154 mm or roughly 12.5”x5”x6”, which is important to keep in mind when designing parts.

The Onyx Pro is run through a slicing software called Eiger. A slicing software literally slices the CAD design and converts the .stl or in this case .MFP (MarkForged Print) into a G-Code that the machine can read and run. In the slicing software layer height, or resolution, can be adjusted as well as generating support material, scaling, copying and other basic and custom features for printing. The specificity of this machine however, means that the slicing software has a limited number of settings. This software is cloud based allowing anyone with a log in to use it and for teams to quickly share, alter and modify parts.

Slicing Software

Eiger Login

Potential Hazards

6. VOCs or Volatile Organic Compounds are released during extrusion. Not all VOCs are toxic and they vary material to material.
7. Nylon is considered relatively safe in regards to the toxins released during extrusions
8. Burns—Nylon is extruded at temperatures around 240 degrees celsius. The material, nozzle tip and print core are extremely hot.
9. Cuts when removing Support Material, the implements used to remove support material can be very sharp as well as the support material itself. The Onyx will bond to the specialized very well use caution and a glove.
10. Flying Debris —When removing support material sharp pieces can break, snap and fly off, wear eye protection.

Operating Precautions

6. Do not extrude at temperature higher than recommended the higher the temperature is above a filaments glass point the more VOCs are released.
7. Use caution when hands are near the print nozzle.
8. Keep hands clear when the machine is operating, pause the machine if needed
9. Wear Gloves when Handling any hot parts, examples are the nozzle, print core or even heated print beds.
10. Wear gloves, safety glasses and use caution when removing support material

Other Softwares

3D Software

3D Printing Services

3D Scanners

Eincan-Pro +

Einscan-Pro + Manual

The Eincsan-Pro + is a versatile scanner that can be hand held for larger objects or used with a tripod and turntable to achieve higher quality detail for smaller objects.

Using “structured-light phase-shifting technology” the scanner triangulates relative positions on the object to build up an image. The scanner runs through and is monitored by the software, so it must hooked up to and used with an appropriate computer. Software Login

3D scans creates a point cloud to be that can be turned into a “watertight” file or mesh of the object being scanned. This mesh can then be imported into CAD programs for alteration/use and converted to an .stl for 3D printing.

Scanning Volume— Using the fixed scan feature an object about 200X200X200mm or a 7.87-inch cube can be scanned. Used as a handheld scanner it can scan objects up to 700X700X700mm or a 2.3-foot cube.

Potential Hazards

1. Flashing lights—The Scanner uses multiple bright flashing lights. Anyone with sensitivity to this should use caution or avoid using the scanner.

Operating Precautions

1. Flashing Lights—Make sure you and those around you are not sensitive to flashing lights when using this scanner.

References

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