Shop Safety Practices and IDEA Laboratory Introduction

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IDEA Laboratory (powered by Autodesk)

https://www.youtube.com/watch?v=X69bVXh17b8 (Eddie Nguyen, EPICS fellow)
Learning Objectives

Understand the IDEA Laboratory equipment and tools
Understand safety policies for laboratory use
Identify hazards in manual fabrication processes
Use equipment safely and follow shop rules and procedures
IDEA Laboratory Usage

Synchronous during section timings: in-person for training (W3-W4) and in-person fabrication studios (W8-14)

Open studio: available W5-W15 outside of normal section timings
IDEA Laboratory COVID Guidelines

GTPD video-monitored / TA-staffed space
Reservation-required outside of your studio sections
Capacity-limited operation
Masks required for all users/staff
6-ft distancing
Forehead temperature check at entrance
Face shields made available
Safety glasses required for all users
Safety glasses can be sterilized with UV cabinet
Physical barriers between workstations – tables, 3DPs, TA stations
Large monitors for displays
Open tool checkout (power tools, batteries)
Shared User Management System (SUMS)

1. Web-accessible reservation system
2. User agreement
3. Reservation to resources required for IDEA laboratory access (outside of your in-person studio hours)
4. Reserve IDEA laboratory resources
   - Work tables (12)
   - Laser cutter (1)
   - 3D printers (5)
5. Ways to access SUMS
   - Your laptop
   - Your phone (QR codes for sign out on resources)
   - Kiosk outside of IDEA laboratory

https://sums.gatech.edu/
IDEA Laboratory: 2830 sqft
18 persons at 1/150 sqft
56 persons at 1/50 sqft
29 persons at 6’ distancing
SUMS-limited to 18 persons

IDEA Classroom: 1140 sqft
7 persons at 1/150 sqft
22 persons at 1/50 sqft
14 persons at 6’ distancing
SUMS-limited to 12 persons
IDEA classroom area
- Entrance for IDEA laboratory
- Safety glasses pickup
- 6 worktables (capacity 12 students)
- 4 PCs with Inkscape/Job Control/Cura
- TA monitoring area
- To be used for mechatronics training during W3-W4
IDEA laboratory studio area

- 6 worktables (capacity 12 students)
- 1 laser cutter, 5 3D printers
- Safety glasses dropoff (UV cabinet)
- 1 PC with Job Control, 4 PCs
- Soldering work area
- Student storage (robots, mechatronics)
- TA monitoring area
- Used for fabrication training (W3-W4) and fabrication usage (W5-W13)
Room capacity
29 persons

Electronics station
- Soldering irons
- Solder
- Wire strippers
- Electrical tape

Handtool storage
- Tape measures
- Rulers, squares
- Clamps
- Screwdrivers
- Hacksaws

Powertool station
- Power drills
- Hammer drills
- Riveters
- Jigsaws
- Batteries/chargers
- Drill bodies
- Jigsaw blades
- Philips/flathead bits
IDEA laboratory primary tools
- 1 - Trotec Speedy 300
- 5 - Ultimaker 2+
- 1 - Bandsaw
Primary Fabrication Equipment

**Laser Cutter**

- **Primary use**: 2D cut/engrave
- **Laser**: 120W, CO₂ laser (class 2)
- **Workpiece materials**: MDF (student-obtained)
- **Machine fixtures and control**:
  - Work table accessible through clear top cover plate
  - Machine interlocks
  - Keypad control pad on top right of machine
  - Exhaust system electronically connected to machine
- **Primary motion**: laser head, work table
- **Hazards**: fumes, burns (eyes/skin), flames
- **Features**: double interlock safety system (lids)

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**Exhaust system**

Caution: *Never leave the laser unattended!*

Trotec Speedy 300 with Atmos Mono Plus exhaust system (operation manual)


Primary Fabrication Equipment

Laser Cutter

Control pad
1. Z-axis positioning
2. X- and Y-axis positioning
3. Pause
4. Standby mode
5. Exhaust on/off
6. Shift
7. Job start
8. Laser emitting indicator
9. Status indicator
   - Green, Slow (0.5 Hz) – machine ready
   - Green, Fast (2 Hz) – cover opened
   - Green, On – data available

Caution: DO NOT RUN THE WORKPIECE INTO THE LASER HEAD. Always focus the laser before running it. Only use flat stock.

Trotec Speedy 300
Primary Fabrication Equipment

Ultimaker 2+

3D Printer Characteristics

- **Primary use**: fabricating 3D components
- **Workpiece materials**: 2.85 mm PLA/PHA (provided by ME2110)
- **Primary motion**: nozzle assembly, work table
- **Machine fixture**: work table
- **Typical operations**:
  - General use: students only
  - Filament replacement: ME2110 staff
  - Bed leveling: ME2110 staff only
- **Hazards**: pinch points, heated nozzle, heated bed, cuts from build removal from plate

Ultimaker 2+
https://ultimaker.com/3d-printers/ultimaker-2-plus
Primary Fabrication Equipment

IDEA Laboratory Bandsaw

Powermatic 18” Bandsaw

Band Saw Characteristics

- **Primary use**: cutting thinner pieces
- **Fixtures**:
  - Miter sled (not w/work fence) – guided straight and angled cuts
  - Work fence (not w/miter sled) – guided straight cuts
  - Push block and/or stick – support for keeping fingers out of ‘no finger zone’
- **Primary motion**: workpiece
- **Caution**: workpiece instability, no profile cuts (only straight cuts), fingers out of ‘no finger zone’, report issues/maintenance needs!
Primary Fabrication Equipment

IDEA Laboratory Drill Tools

- **Primary use**: drilling, fastening
  - Drill/Driver: drilling holes, driving smaller fasteners
  - Impact Driver: driving large or long fasteners, limits torque input to user
  - Combo Driver: both

- **Primary motion**: tool

- **Caution**: use the right tool, report batteries that need to be charged, be careful not to drill any work tables and other fixtures,

Milwaukee and Dewalt drill tools

https://www.milwaukeetool.com/Products/Power-Tools/Drilling
https://www.dewalt.com/products/power-tools/drills
IDEA Laboratory Jigsaw Tools

- **Primary Use:**
  - Straight cuts
  - Profile cuts

- **Loading/unloading tools:**
  - Remove battery from tool
  - Activate trigger lock
  - Replace blade using load/unload lever
  - Blade should face upwards as shown

- **Primary motion:** tool
- **Caution:** use cut target marker to direct cut, be careful not to saw work tables and other fixtures

Milwaukee jigsaw tools
https://www.milwaukeetool.com/Products/Power-Tools/Woodworking/Jig-Saws/2445-21
Primary Fabrication Equipment

IDEA Laboratory Hand and Power Tools

- Clamps: use to secure work and fixtures (e.g., mitre boxes) to work tables
- Mitre boxes: use to direct hand saws to make directed cuts and protect work tables
- Hand saws: use for manual and simple cuts, start cut with short feed strokes, finish cut with long continuous feed strokes
- Files: use to debur wood pieces
- Tape measures: read to 1/16”
- Scales: read to 1/8” or 1/16”
Primary Fabrication Equipment

The most important tool...

- Shop vacuums are to be used immediately after creating sawdust from wood working operations
- Return shop vacuums immediately to designated areas and coil power cord appropriately
- Leaving a mess and/or sawdust in a work area is grounds for a demerit associated with the lab stewardship grade for the course
Equipment not used this term

Lathes
Manual mills
CNC mill
Miter saw
Drill press (can be used, ask TA for training if needed)
Mechatronics Assignment

Mechatronics task sheet

Mechatronics Lab Tasks: Group 4. Name:

1. Connect 2 DC motors, 2 solenoids, the 4 switches/buttons, the IR sensor, the potentiometer, and the encoder to the board. Set up the pneumatic system as shown in the manual, and connect the 2 valves to the board as well. Study the Arduino sample code (downloaded from GitHub), and use the code to verify that every component operates correctly. Be able to explain to the TA what each of the buttons and sensors does in the context of the code.

2. Connect one momentary switch (long-armed or roller) to the Arduino board. Use the switch to control the state of the LED. When the switch is pressed and released, the state of the LED should change; i.e., if the LED is off, pressing and releasing the switch once will cause it to turn on. The LED should not turn off until the switch is pressed and released again. Hint: remember the lesson about switch debouncing!

3. Connect the rotary encoder, a DC motor and two momentary switches (long-armed or roller) to the Arduino development board. Use the readings from the encoder to control the duty cycle of the PWM signal to the DC motor. Each full rotation of the encoder should correspond to a 10% change in duty cycle (0-100). In other words, if the program is started and then the encoder is turned one full rotation, the motor should be running at 10% duty cycle; after 10 rotations, the motor should be running at full speed. While one switch is held down, the motor should spin clockwise. While the other is held down, the motor should spin counter-clockwise. When both or neither switches are held, the motor should not turn at all. Additionally, use the LEDs on the development board to indicate the direction of travel of the motor. One LED should illuminate when the motor is traveling CW and the other when the motor is traveling CCW. Use the serial monitor to display the encoder value and direction alongside the motor speed and direction.

4. Connect the IR sensor, banana plugs, and a pneumatic actuator to the Arduino development board. Extend the pneumatic actuator for 10 seconds when the IR sensor detects an object within 6 – 10 cm from its lens. You will need to calibrate the IR sensor to determine the relationship between its voltage outputs and distance. The banana plugs should function as a “kill” switch, retracting the pneumatic actuator regardless if 10 seconds have elapsed or if there is an object within the 6-10 cm range of the IR sensor.
Fabrication Assignment

PART 2. FABRICATION TRAINING AND TASK SHEET

Studio Description: This assignment is designed to teach students how to use the laser cutter, 3D printing, power tools and the bandsaw to create parts and assemblies. The final product will be a modular robot frame that can be used to complete the main design challenge that will be assigned later in the course. The lab comprises of three training modules, where small groups of students will rotate between laser cutting, 3D printing, power tools and bandsaw. During the first week, Group A will be trained, during the second week, Group B will be trained.

Studio Tasks and Deliverables:
1. Complete training. The student must attend the IDEA laboratory safety overview and training on the laser cutter, 3D printer, power tools and bandsaw given by the studio GTA. The GTA will record the student’s attendance and completion of training in Canvas. This is a mandatory requirement for this class. This training MUST be completed before the student can begin using IDEA lab equipment. During machine training you will be fabricating the following components as a group, these files are located on the ME2110 website.
   a. Robot frame platform (laser cutting)
   b. Robot frame side panel (laser cutting)
   c. Bushing (3D printing)
2. Complete fabrication and assembly of the required components. As a team, students will produce one modular robot frame according to the drawings in this document. Each subgroup (Group A, Group B) will produce half of the required components for the robot. A recommended process plan is provided that can be followed as a step-by-step process.
3. Complete Fabrication Task Sheet. Each student must individually complete the task sheet in the Studio 2 handout. The files for the task sheet will be loaded to the Canvas submission.
   a. Laser cutting training assignment: Your assignment is to generate a file for laser cutting in Inkscape. Download or create the initial robot frame CAD assembly files from the main ME2110 website. Select the platform and side panel, .slst files and generate a .dxf file from the relevant component faces. Generate a valid .ink file for laser cutting in Inkscape, and submit it with your assignment. The cut settings include a Power 85, Speed 1.5, overall 30, and a vector ordering operation with “enhanced ordering” (mutual 50, passes 30). Record the time estimate for cutting. You will need to save a .jpg file with proper cut settings. Take a screenshot of the final buildplate layout (e.g., .png, .jpg). Upload the .dxf, .ink and .jpg files and the screenshot file to Canvas.
   b. 3D printing assignment: Your assignment is to download the ‘.stl’ file, generate an ‘.obj’ file and layout a build that includes 6 total brakings (no support structures, skirt bed adhesion). 5% infill (Generic, 0.4 mm nozzle, 0.15 mm layer height) appropriately spaced such that they do not overlap with each other on the build plate. These brakings should be scaled down to 50% of the actual size in the .stl/.obj file. Record the time (i.e., hours, minutes) and material estimate (i.e., weight, filament length) for the build. Save the .stl file. Take a screenshot of the final buildplate layout (e.g., .png, .jpg). Upload the .stl, .obj and the screenshot file to Canvas.
Safety and Shop Training Procedures

1. This lecture

2. Studio this week – everyone agrees to the GWW *User Agreement* on SUMS (bring your Buzzcard)
   • Agreement document ([link](#)) is on the course website, it is each student’s responsibility to review it before studio

3. Fabrication training in studio
   • TAs certify each trained student on SUMS (bring your Buzzcard)
   • Training takes the duration of studio – being late or leaving early invalidates your training (make-up independently)
Contents

Setting scope
Rules and procedures
Equipment specific notes
Shop etiquette, cleanliness, and 5S
Enforcement
Why is Safety Important?

1. The consequences are real; everyone needs to make it home safe at the end of the day
   - Severe, life-changing injuries are possible
   - You AND everyone around you can be affected

2. Efficiency, professional skill, and courtesy
   - A safe shop is an efficient shop
   - Just like any other engineering skill, this is an important skill to leave school with
   - Coworkers and colleagues expect it of you
Stop Work Authority (SWA)

• Gives ALL workers the right to stop work that puts someone in imminent danger

• Imminent danger is any condition, activity, or practice in the workplace that could cause: (1) death/serious physical harm, (2) significant environmental harm

• If someone tells you to stop work, you need to stop the job immediately. Remember, your coworkers are trying to help keep you safe, not punish you
Stop Work Authority (SWA) - Steps

1. Stop the unsafe work. Employees are obligated to initiate a stop-work intervention with colleagues who are potentially at risk. The stop-work action should be clearly identified and initiated in a noncombative manner.

2. Investigate the cause for intervention. Affected personnel should discuss the situation and come to an agreement on behavior or action in question.

3. Correct the hazard.
   - If the hazard cannot be corrected, notify staff.
   - If the hazard is corrected, resume work.
**Misconception:** being safe, methodical, and deliberate ‘isn’t cool’

**Actuality:** In the professional world, those who don’t follow safe practices are the ones who receive criticism
Dangers of a Lathe (and Negligence)
Dangers of a Lathe
(and inappropriate Lab Wear)
A somewhat recent case...

**Yale Student Killed as Hair Gets Caught in Lathe**

By LISA W. FODERARO  APRIL 13, 2011

As a Yale undergraduate majoring in astronomy and physics, Michele Dufault was used to extreme physical environments. She worked on underwater robotic vehicles last summer as a fellow at the Woods Hole Oceanographic Institution in Massachusetts. She also traveled to Houston as part of a team of undergraduates chosen by NASA to perform a plasma physics experiment in reduced gravity.

But it was a rudimentary machine — a lathe in a campus laboratory — that erased what everyone imagined to be a brilliant future for Ms. Dufault, who also found time to mentor girls interested in science and to play saxophone in Yale’s precision marching band.
Proper PPE
Why aren’t there exceptions to the rule?

Common complaint: “But for what I’m doing, it’s not dangerous. Why do I have to follow this rule?”

Answer: Safety procedures are built to avoid judgement calls by individuals. People get tired, bored, lazy, lax, forgetful… 100% observance of rules 100% of the time removes human error.

This is especially important for young, inexperienced students in a busy, exciting environment.
Hazards in the IDEA Lab

Lathe, mill, miter saw (not used FA20)
Bandsaw, drill press (trained in person)
Laser cutter (trained in person)
3D printer (trained in person)
Hand drills, dremels, other power tools
Soldering iron, hot glue gun, heat gun
Hand saws, hand tools
Raw materials
Tripping hazards, electrical cords, blocked aisles, other personnel
Equipment fall risks
Electrical shock
General Awareness

Your actions have the potential to affect those around you
Consider the radius of effect
  • Where is/are the debris/dust/chips going?
  • If you loose purchase/miss/etc. what’s in the way?
Every tool is a potential hazard – treat it as such

This is not a hammer
it is a thumb-detector
Emergency Procedures in the Lab

1. Fire extinguishers (2), first aid (2), eyewash station (1)
   • Know where they are!

2. Safety glasses are always available

3. In case of injury:
   - If serious – call GTPD @ 404.894.2500 or 911 on a landline
     • If not serious, utilize the first-aid resources immediately available
   - Report the incident immediately to the TA on-duty
     • ALL incidents and near misses, large and small, should be reported –
       culpability is not the goal here, improving safe practices is
PPE AND PROPER LAB WEAR

• Safety glasses are required to be worn in the shop AT ALL TIMES
  o Eyeglasses must we worn with safety glasses over them unless the eyeglasses provide sufficient cover and are rated for impact resistance

• Closed-toe shoes must be worn
  o Flats, crocs, slippers are not appropriate

• Short- or rolled-up sleeves are required

• No loose fitting clothes, or jewelry such as dresses/skirts, shirt tails, neckties, scarves, shawls, watches, or keys dangling from belts...

• Long hair and beards must be tied back and UP
  o It cannot be possible for it to hang past the neckline over the shoulder

• Metal rings are not allowed to be worn

• Bags and coats should not be carried around the lab

• Ear protection is required for loud operations
Proper Lab Wear
Proper Lab Wear

Loose clothing and other hazards
LAB USE AND SAFETY

GENERAL LAB USE AND SAFETY

- SAFETY IS OUR #1 PRIORITY if ever concerned for yourself or others raise the issue immediately and let Lab staff know
  - It is not ‘un-cool’ to point out safety concerns, it is welcomed!
- KNOW ALL THE RULES and obey all posted signage
- DO NOT use equipment that you have not been trained to use by Lab staff
- Lab staff must be on-duty for students to utilize the lab
- 2 people must ALWAYS be present, in the same room, for any powered equipment to be used
- No matter the activity danger is always present in the shop – stay aware of your surroundings
- Never touch an operator or their equipment while they are working except to hit the E-stop or aid them if stuck or hurt
- Do not hurry, run, or work quickly – if you catch yourself rushing: slow down
  - Take care not to bump operators or equipment while in use
- Concentrate on your work – if you lose focus or become tired, leave
- CLEAN UP AFTER YOURSELF – a clean, organized shop is a safe, productive, and happy shop
  - No food or drink is allowed in the shop – water in a closed container is OK
  - Keep all walkways and exits clear – chairs may not be used as mobile worktables, back-packs and coats must be left up-front, extension cords must be used properly
  - Do not attempt to lift or move heavy equipment, leave that to Lab staff

GENERAL EQUIPMENT OPERATION SAFETY

- Uncomfortable? Unsure? Stop and ask for help – Lab staff are here and happy to help!
- Focus is required – do not attempt to multi-task an DO NOT look away from your work
  - No using phones or electronics while operating equipment
  - Headphones (for music) are NOT allowed
- Keep fingers clear of spinning and moving tools and blades, always have guards and guides properly engaged
- Do not wear gloves while using equipment with exposed rotating components
- Always disconnect power and engage the safety or E-stop while setting-up a work-piece, measuring a work-piece, cleaning the machine or work-piece, or changing tools
- Use proper work-holding techniques, all work being drilled or cut must be properly clamped/fixed – ‘hand-held’ is not enough
- Do not leave machines running unattended
- Metal parts on tools can be VERY HOT without appearing so
  - Use caution if you have to touch surfaces that have just been machined or abraded with powered equipment, they WILL be hot
- TA approval is required for all personal tools other than power drills, hand tools, and soldering irons
- Break, loose, or damage something? Notice something that’s not right? Mistakes happen – tell Lab staff immediately so the Lab can stay well-stocked and SAFE!
Lab Use and Safety

Using devices while a machine is on

Distracting an operator

Leaving heavy metal tools on the lathe headstock

Tripping hazards

Two operators on one machine
Laser Use Guidelines:
Always focus the laser before use
Do not run the laser if the exhaust system is malfunctioning
Do not cut unapproved materials
Do not apply downward forces to the work bed
Only operate the machine when ME2110 staff is present
Never leave the laser cutter unattended
Clean up debris in the laser cutter
Identify the fire extinguisher and fire blanket

Emergency Stops (E-stops):
There is an emergency stop wired into the lid of the laser cutter. If at any point you need to immediately stop the laser, slightly lift the lid and the laser will stop firing (this will cancel the job in process), when to use E-stop:

- If the material in the laser bed catches on fire (brief tongues of flame while the laser is firing are acceptable, but if a constant flame is started, abort the job)
- If the smoke from the material is building up in the machine and not being evacuated by exhaust system.
Laser Cutter Safety - Hazards

- **Fumes**
  - Air from the laser cutter is purified in the air filter.
  - Filter cannot remove toxic fumes caused by cutting PVC and other plastics.
  - Do not cut unapproved materials.
  - Do not cut if the exhaust system is not functioning.
  - If cutting a toxic material, evacuate the room.

- **Burns**
  - The laser is very powerful and could burn skin, which is why the lid of the laser cutter must be closed at all times, except when the laser is not running and you are inserting material.

- **Fire**
  - Fires are rare when cutting approved materials in the laser cutter, but it’s possible that the laser may ignite materials, which is why you can never leave the laser cutter. Identify the fire extinguisher and fire blanket.
  - **Small fire (< 2” flame) – momentary flames** – usually self extinguish within seconds. If not, a small flame can usually be extinguished using the fire blanket. Stop the laser cutter. Throw the blanket over the flame (if needed, push the laser nozzle out of the way first). Close the cabinet.
  - **Large fire (> 2” flame) - persistent or large flames** - the preferred method of putting out a fire would be to use the fire blanket. If you were to use a fire extinguisher it would put out the fire, but the laser cutter would most likely be rendered useless. If a fire cannot be controlled by the blanket, a fire extinguisher should be used. After use, evacuate the room and call the Fire Department.
3D Printer Safety - Guidelines

Risk of burns: There is a potential risk of burns, as the print head can reach temperatures of up to 260°C and the heated bed of up to 120°C. The nozzle of the print head is mostly surrounded by an aluminum cover to prevent contact, but we advise against reaching in machine when print head and/or heated bed are hot.

Pinch points: The Ultimaker 2 contains many moving parts, but the stepper motors do not have enough power to cause serious injuries and moving gears have been covered. Still, it is advised to only reach in the machine when it is turned off.

Exhaust: Printing pure PLA is considered safe, although good ventilation is still advised for possible unknown vapors released from coloring dyes in colored PLA.

Build removal: When using putty knives to remove builds, use work gloves to protect against slippage and cuts. Use nitrile gloves underneath work gloves for sanitary reasons.
Hand Drill Safety

Only use drills to hold tools meant for drills

Utilize proper work-holding

• Never hold your work by hand ALWAYS use clamps
• Always be aware of where your and other hands are – NEVER behind a workpiece

Use a sacrificial backing piece

• Prevents tear-through, damage to work tables

Apply light force only

Put the drill into neutral when not in use

Smoke, excessive/irregular noise, heavy vibrations, etc. are all signals to stop and figure out what is wrong
Jigsaw Safety

Keep your hands/fingers/body free of the jigsaw blade

- Make sure your body is clear of the jigsaw blade path if workpiece were to slip or fail
- Ensure that the jigsaw pad is firm and level on the surface of the workpiece before cutting

Ensure battery is disengaged when removing and installing blade or changing the angle of cut

Check that the blade is not hot when removing blade

- Handle blade with care – do not grab blade by the serrated side

Make sure workpiece is clamped to table

- Make sure table and/or clamps are clear of blade path
Jigsaw Safety
BANDSAW USE

1. Adjust guard height to 1/8-1/4” above work height
   1. Loosen guard locking screw on back
   2. Adjust height with hand wheel
   3. Tighten locking screw

2. Make the cut
   1. Fingers should stay 1.5” clear of the blade at all times
   2. Use a push-stick or sacrificial piece if necessary

3. Use foot-brake to bring the blade to a full-stop

DO NOT
- Push with great force – slight force is all that is needed
- Cut tight curves – gradual curves only
- Cut metals
- Adjust table angle without TA assistance
- Cut objects significantly larger than the table – brake them down with a hand-saw first
- Adjust any settings or open the machine
Bandsaw Safety
Hand Tools, Tools that Generate Heat

Hand tools *do* have the potential for danger
Always be conscious of how much load you are applying – never apply so much load that if you lost grip or slipped you would be out of control

Who’s in the path of danger?
Soldering irons, heat guns, hot glue guns
  - Always assume hot
  - Never use to melt materials they are not designed for
  - Do not place near paper, cloth, other flammables
  - Unplug when not in use
Hand Tool Safety

What happens when the saw slips?

Fire hazard
All electrical equipment for mechatronics in ME2110 is <12V DC

- There is high-powered equipment elsewhere in the lab

Smoke? Unplug main-power.

Treat all circuits as if they’re live

Pay attention to wires and connection points

- Minimize exposed wiring (use heat-shrink, electrical tape, proper technique)
- Keep an eye out for fatigued or cracking wiring sheaths and cables – replace as needed

Do not leave devices running indefinitely
Machine Tool Safety

Detailed safety training in studio

GWW official documents (link)
A Clean Shop...

... is a safe, happy, efficient shop.

Professional courtesy

Safety – trip/slip hazards, flammables
  • Always use cable drops directly above your workspace – stretching cords across the room is a tripping hazard

Searching for tools is a waste of everyone’s time

In industry, organization and cleanliness are strongly linked with quality control, efficiency and safety
  • 5S, TPS, aerospace shadow-boxing, etc.
Keeping the shop tidy

- Bag and coat shelf is for backpacks and coats while you’re using the lab only – not for storage

- Your mechatronics kits and robots might not fit on the shelf – then you need to take something home with you
Please report broken and damaged tools!

This is a learning environment and mistakes are expected. You will not be in trouble for reporting honest mistakes or freak failures.

Help keep the lab well-stocked, safe, and help staff identify unsafe machines.
Lab Staff

We are here to help!

If you don’t know, ask! If you’re unsure, ask! This is a learning environment, TAs and instructors are here to teach, not to scold.

You will not be marked-down or in any way discouraged from asking questions.

Failure to follow instructions from lab staff, or the posted lab safety rules is not optional.

• In severe cases, students can be asked to leave, or barred from using lab equipment.
Stay safe, and have fun out there!
Learning Objectives

Understand the IDEA Laboratory equipment and tools
Understand safety policies for laboratory use
Identify hazards in manual fabrication processes
Use equipment safely and follow shop rules and procedures
Appendix
Primary Fabrication Equipment

Engine Lathe (geared, 3 hp, 105-2000 RPM)
https://www.mscdirect.com/product/details/09517350

Milling machine (geared, 1 hp, 65-1550 RPM)
https://www.mscdirect.com/product/details/64162779
Primary Fabrication Equipment

IDEA Laboratory Lathe

**Lathe Characteristics**

- **Use**: making precision axisymmetric parts
- **Fixture**: part is clamped in chuck
- **Primary motion**: workpiece
- **DOF**: 2-axis motions (X, Z)
- **Carriage axes**: Z(left/right), X(front/back)
  - Control: handwheels
  - Position: digital read out
- **Caution**: carriage/spindle crashes, report any issues or maintenance needs!
- **Tailstock**: used for centerline drilling
  - Control: handwheel
  - Position: tailstock marked scales

Engine Lathe (geared, 3 hp, 105-2000 RPM)
https://www.mscdirect.com/product/details/09517350
Primary Fabrication Equipment

IDEA Laboratory Mill

Milling Machine Characteristics

- **Primary use**: making precision prismatic parts
- **Fixture**: part is clamped in vise
- **Primary motion**: tool
- **DOF**: 3-axis motions (X, Y, Z)
- **Table axes**: X (left/right), Y (front/back)
  - Control: handwheels
  - Position: digital read out
- **Head axis**: Z (vertical)
  - Control: hand crank (coarse), handwheel (fine)
  - Position: digital read out
- **Caution**: tool/vise crashes, report any issues or maintenance needs!

Milling machine (geared, 1 hp, 65-1550 RPM)
https://www.mscdirect.com/product/details/64162779
Primary Fabrication Equipment

IDEA Laboratory CNC Mill

3-axis CNC mill (Siemens 828D controller)
https://emco.co.uk/emcomill-e350/

G-code file

Autodesk Fusion 360 (free!)
Primary Fabrication Equipment

IDEA Laboratory Miter Saw

Mitre Saw Characteristics

- **Primary use**: cutting long/thicker lumber, angled or bevel cuts
- **Fixture**: part clamp on work platform
- **Primary motion**: tool
- **DOF**: 2-axis motions (θ, Y)
- **Head axis**: Y (in/out), θ (rotate)
  - Control: pull in/out, rotate down
- **Caution**: workpiece instability, guide/blade crashes, fingers out of ‘no finger zone’, no cross cuts allowed, report any issues or maintenance needs!

Primary Fabrication Equipment

IDEA Laboratory Miter Saw

Mitre Saw (12” Dual Bevel Sliding Compound Mitre Saw)
https://www.milwaukeetool.com/Products/Power-Tools/Woodworking/Miter-Saws/6955-20
Primary Fabrication Equipment

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Primary Fabrication Equipment

IDEA Laboratory Drill Press

Drill Press Characteristics

- **Primary use**: small/large holes
- **Fixtures**:
  - Work Platform (use clamps)
  - Vise (use clamps)
  - Drilling Jigs (use clamps)
- **Primary motion**: tool
- **Caution**: do not drill the work platform, report any issues or maintenance needs!

Wilton 2530 Drill Press

Miter Saw Safety

Keep fingers clear of the saw and out of the “no finger zones”

Do not operate saw without guards in place.

Workpieces must be clamped to work platforms before cutting

Workpieces should have their longest side resting against the vertical guides

Make sure the turn base is properly secured so it will not move during operation

Never hold the workpiece on right side of blade with left hand or vice versa
Miter Saw Safety