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
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

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

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
Primary Fabrication Equipment

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!

Mitre Saw (12” Dual Bevel Sliding Compound Mitre Saw)

https://www.milwaukee-tool.com/Products/Power-Tools/Woodworking/Miter-Saws/6955-20
Primary Fabrication Equipment

IDEA Laboratory Miter Saw

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

IDEA Laboratory Bandsaw

Powermatic 18” Bandsaw


Band Saw Characteristics

- **Primary use:** cutting thinner pieces
- **Fixtures:**
  - Mitre sled (not w/work fence) – guided straight cuts and angled cuts
  - Work fence (not w/mitre 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 Press

Wilton 2530 Drill Press

https://www.grainger.com/product/WILTON-3-4-Motor-HP-Bench-Drill-Press-5XT44

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!
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
Primary Fabrication Equipment

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
Mechatronics Assignment

Mechatronics task sheet

Mechatronics Lab Tasks: Group 4, Name: 

1. Connect 2 DC motors, 2 solenoids and 2 valves to the drive board. Connect all the sensors to the sensor board. Study the LabVIEW programming template, and use the template to verify that every component operates correctly. In addition, look at the other VHs that are in the template, run them, and be prepared to briefly discuss what they do.

2. Follow the steps in this video: https://youtu.be/AkJ_b8o6C7C. As with all programs you create, be prepared to answer any questions about it.

3. Connect a potentiometer to the sensor board. Using the knob on the potentiometer, have it incrementally turn on the myRIO LEDs as you turn the knob; starting with LED0 and continuing until all 4 LEDs are lit. Use a chart to display the sensor voltage data continuously.

4. Connect a monostable switch to a Digital Input and have the DC motor run at full speed when the switch is held down and turn off when the switch is depressed. Each time the switch is pressed turn on LED for 1 second. The 1 second starts the moment when the switch is pressed, e.g. the LED will turn off after 1 second even if the switch is still held down.

Hint: Connect the switch to a Digital Input, read its value of the Digital Input when the button is pressed and the value of digital input when the button is released.

5. Connect two micro switches, the banana plugs and one pneumatic cylinder. The program starts with the cylinder retracted. The program starts by touching the banana plugs together. When switch one is pressed, the cylinder should extend and remain extended after the the switch is released. When the other switch is pressed, the cylinder should extend and remain retracted. This loop continues while the banana plugs are held together. If the banana plugs are released at any time the cylinder is retracted immediately. The loop starts from the beginning when the plugs are reconnected. Set this program to run automatically on startup (without being connected to the computer).

6. Connect two solenoids and two micro switches. When one micro switch is pressed, one solenoid is activated for 4 seconds and then released. When the other micro switch is pressed, the other solenoid is activated for 1750 ms and then released. When one actuator is active, the other cannot be activated. Use LED1 and LED2 to indicate when each actuator is active.

Hint: It may help to use "Elapsed time" and "Time Delay" Express ELL.

7. Connect 2 solenoids and two micro switches. At the beginning, have 1 solenoid activated. Once each switch has been pressed at least once and in any order (they don’t have to be held down together), the first solenoid will be de-activated and the second one will be activated for 5 seconds. After that, the cycle starts over. Two LEDs of your choosing will show states of the switches at all times (even when the first solenoid is off and the second is on).

* Step each program with a button you create on the front panel, unless stated otherwise.

Checklist for Group 4: 

<table>
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<tr>
<th>Task</th>
<th>DATE</th>
<th>Task</th>
<th>DATE</th>
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<td>3.</td>
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CREATING THE NEXT

16
Fabrication Assignment

GEORGIA INSTITUTE OF TECHNOLOGY
ME 2110 Creative Decisions and Design, Spring 2020
Fabrication and Inspection

Assigned: 13 January 2020
Due: 10 February 2020 (at start of lecture)

Description: Understanding the role of quality in design and fabrication is a critical element of a successful engineer. You are asked to produce components to a specification and the customer will accept or reject your parts based on a formal drawing given to you as part of the contract. The dimensions that you must report are also marked in the attached images in this document. Provide a report of your final parts’ quality in the tables provided. Record a measurement of each marked dimension as produced. Please use a pen to record your measurements. Do not fill in the TA Measurement column, this will be filled in by a studio TA or instructor. The TA will indicate using an ‘X’ if each dimension is within specification (pass) or out of specification (fail). The ranges given in the inspection portion of the grading rubric refer to the difference in the student’s stated measurement compared to the feature as measured by the studio TA or instructor.

Requirements: This page should be filled out with the requested information and uploaded to Canvas before the deadline. You must turn in your finished components with this assignment.

Student Name and Section: ___________________ TA Grader: __________

Tray Side:

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<th>Dimension</th>
<th>Tolerance</th>
<th>Pass</th>
<th>Fail</th>
<th>Student Measurement (in.)</th>
<th>TA Measurement (in.)</th>
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Motor Coupling:

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<th>Tolerance</th>
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<th>Student Measurement (in.)</th>
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<td>±0.008”</td>
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Fabrication Assignment

DIMENSIONS ARE IN INCHES TOLERANCES:

\[
\begin{align*}
XXX & \pm .005 \\
XX & \pm .01 \\
X & \pm .1
\end{align*}
\]
Fabrication Assignment

**Project: ME 2110**
**Title: MOTOR COUPLING**

**Dimensions and Tolerances:**
- Holes: Ø0.750 ±0.005, Ø0.500 ±0.005
- A: 0.25 ±0.05
- B: 0.05

**Material:** Delrin Plastic Rod 5/8" A

**Drawn By:** A. Schauer
**Scale:** 2:1
**Sheet:** 1 of 1

**Operation 1 (Step 3 - 6):**
- Check Bore
- Face Square
- Drill hole

**Operation 2 (Step 7):**
- Turn Partially
- Turn Down Progressively
  - 1) Turn to final dia.
  - 2) Face to shoulder

**Figure 1. Visual Process Sequence for Small DC Motor Coupling**
Fabrication Assignment

Assignment Rubric (HW4)

 Assignment Grading Breakdown: Below is the rubric for the assignment. Each component (coupling, mount) constitutes 50% of this assignment. The following rubric will be used.

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<th>Score</th>
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<td>1 pieces of stock consumed</td>
<td>15%</td>
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<tr>
<td></td>
<td>2-3 pieces of stock consumed</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>3 pieces of stock consumed (maximum is 3)</td>
<td>0%</td>
</tr>
<tr>
<td>Accuracy (20%)</td>
<td>0 marked dimension not to specification</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>1-2 marked dimensions not to specification</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>3 marked dimensions not to specification</td>
<td>10%</td>
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<tr>
<td></td>
<td>≥ 4 marked dimensions not to specification</td>
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</tr>
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<td>Appearance/Finish (5%)</td>
<td>Part free of burrs, splinters, divots, extra features</td>
<td>5%</td>
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<tr>
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<td>Part not free of burrs, splinters, divots, extra features</td>
<td>0%</td>
</tr>
<tr>
<td>Inspection (10%)</td>
<td>0-1 measurements not within allowable deviation</td>
<td>10%</td>
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<tr>
<td></td>
<td>2-3 measurements not within allowable deviation</td>
<td>5%</td>
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<tr>
<td></td>
<td>≥ 4 measurements not within allowable deviation</td>
<td>0%</td>
</tr>
<tr>
<td>Total (50%)</td>
<td>Maximum score per part</td>
<td>50%</td>
</tr>
</tbody>
</table>

Digital Calipers

Tape Measure
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. Machining 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)

4. Safety assessment on Canvas
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, drill press (trained in-person)
Bandsaw, miter saw (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
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
IDEA Lab Layout And Critical Equipment

- Do not enter without closed toe shoes (classroom included)
- Leave all coats and bags at the front of the lab
- Acquire safety glasses immediately
- Know where emergency equipment is located

Note: IDEA lab/classroom are video-monitored
PPE AND PROPER LAB WEAR

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

• **Closed-toe shoes** must be worn
  - 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**
  - 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
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
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
Hand Drill Safety
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
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
   o Push with great force – slight force is all that is needed
   o Cut tight curves – gradual curves only
   o Cut metals
   o Adjust table angle without TA assistance
   o Cut objects significantly larger than the table – brake them down with a hand-saw first
   o 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
Electrical Safety

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