

## UNIT 5: MACHINES

*Introduction to Engineering & Robotics*

Unit Due Date: November 27, 2019

Welcome to the fifth unit of *Introduction to Engineering & Robotics*! This unit is all about getting experience with a range of machines and tools here in the Lathrop Engineering Lab & Makerspace. In the end, the expectation is that you learn the following:

- How to use three of the four machine options presented in this unit
- How to use computer software to prepare files for use with our various machinery
- How to learn a new tool or piece of machinery well enough to successfully make a new project with it

As we move through this unit, you are responsible for making adequate progress through the assignments, and for being done by the Unit Due Date (November 27, 2019). You are also responsible for completing ***three (3) of the four (4) options presented below***. Our unit is broken up into three main parts:

Option 1: Soldering & Electronics <i>(40 pts) Approx. 3 days</i>	
Your first option in this unit is to build a small electronic project using a kit. You'll need to learn what each of the different parts in the kit do, how to solder in order to connect them, and then complete the project by soldering all the parts in place. When you're done, you'll have a working electronics project!	<input type="checkbox"/> Electronics/Soldering Notes <input type="checkbox"/> Plan Project Assembly <input type="checkbox"/> Build Electronics Project <input type="checkbox"/> Check-off from Mr. Benshoof
Option 2: Laser <i>(40 pts) Approx. 3 days</i>	
The second project option in this unit uses our laser cutter. You'll need to first learn the basics of Photoshop to make a black-and-white image. Then, you'll transfer that image to the laser cutter and get it working! You'll be able to cut and engrave on various acrylics to create a small project for yourself!	<input type="checkbox"/> Laser Notes <input type="checkbox"/> Plan Project Assembly <input type="checkbox"/> Build Laser Project <input type="checkbox"/> Check-off From Mr. Benshoof
Option 3: G-Code <i>(40 pts) Approx. 3 days</i>	
The third option in this unit is all about G-Code. G-Code is the programming language that runs most of our machines (3D printers, laser, CNC machines), and here you can learn the details about how to program G-Code. You'll make some drawings using G-Code and then have the chance to cut your designs out of wood or sheet metal if you want!	<input type="checkbox"/> G-Code Programming Notes <input type="checkbox"/> Plan Project Assembly <input type="checkbox"/> Create G-Code Drawings <input type="checkbox"/> Check-off from Mr. Benshoof
Option 4: Vinyl Cutter <i>(40 pts) Approx. 3 days</i>	
Our fourth option is the vinyl cutter. Here you'll learn some basic Photoshop to create a black-and-white image. Then, you'll transfer your image to the vinyl cutter, find the outline, and have the cutter cut out your design. Your design can be made into a sticker or a t-shirt design!	<input type="checkbox"/> Vinyl Cutter Notes <input type="checkbox"/> Plan Project Assembly <input type="checkbox"/> Build Vinyl Cutter Project <input type="checkbox"/> Check-off from Mr. Benshoof
<b>★Achievement:</b> Complete all 4 project options (including notes and planning) by the unit deadline	

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## OPTION1: SOLDERING & ELECTRONICS

(40 pts) Approx. 3 days

The first project option is to build a small electronics project by identifying various electronics components and then soldering them into place. In this part of the unit, you'll learn what some basic electronics parts are, how to read a printed circuit board, how to assemble a simple electronics project, and how to solder. This will require patience and precision, because poorly soldered connections can ruin the project!

1. Start by watching the introductory videos on our website, *Introduction: How to Solder*, *Introduction: Electronic Components*, and *Building Your Electronics Project*. Take at least a full page of notes on these topics. Be sure to focus your notes on how to get the right pieces in place for your project, as well as the process of soldering.
2. Next, get your electronics project kit from Mr. Benshoof. Match up the parts with the *Build Diagram* to make sure that you have all the parts necessary for completing your project!
3. Identify which piece will go where when you assemble your work. Be sure to make note of:
  - a. WHICH DIRECTION your LEDs will need to be installed
  - b. WHICH DIRECTION your 9V battery clip will need to be installed
  - c. WHICH DIRECTION your sockets will need to be installed

***If you install those components backwards, your project will not work properly!***

4. Find a soldering station in the robotics room and get to work! You'll need to carefully solder every connection one at a time! Be patient, take your time, and make good soldering connections.
5. Confirm that your electronics project works properly and have Mr. Benshoof check off your completed project!

*Hints: Most of the pieces have a DIRECTION, which means you need to install them in the proper order!*

*Messy soldering ruins projects – keep your soldering connections neat and tidy!*

*If the electronics project doesn't work, it's because you put it together wrong – take your time!*

Part 1: Tasks	5 points	4-3 points	2-1-0 points
<input checked="" type="checkbox"/> Electronics/Soldering Notes	+ You took a full page of notes on soldering and the electronics project + Your notes include details on how to solder and the different electronic components that will go into the project	- Your notes are less than a full page - Your notes do not include details on soldering - Your notes do not include details on parts	- Very brief or no notes in your engineering notebook
<input checked="" type="checkbox"/> Plan Project Assembly	+ You confirmed that you had all the needed parts for your project + You made a small plan/diagram for how you will assemble your project	- You did not double check your provided parts - You did not make a plan/drawing	- No planning is apparent
	<b>30-24 points</b>	<b>23-15 points</b>	<b>14-0 points</b>
<input checked="" type="checkbox"/> Build Electronics Project	+ You completely built your electronics project + Your project works as intended + Soldered connections are neat	- You built your project but there are significant errors - Messy soldering has ruined some connections	- You did not build your project

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## OPTION2: LASER

(40 pts) Approx. 3 days

The second option in this unit is to learn how to work with our laser cutter. We have a 40-Watt laser that can cut and engrave on plastics, woods, and even glass if we do it right. The machine can work in a flat 2D space (most common) or even on round surfaces (for devoted students) like water bottles. In this option you'll learn how to create an image in Photoshop that is good for laser cutting, then you'll learn how to setup and use the laser cutter for working with acrylic.

1. Start by watching the introductory videos on our website, *How to Use Photoshop*, *Converting Your Image*, and *Using the Laser*. Take at least a full page of notes on these topics. Be sure to focus your notes on the process of using the laser and the different tools you'll need in Photoshop.
2. Next, draw – by hand – a design for something you want to make with the laser cutter. Your design should include a cut edge/border as well as an etched portion. For example, maybe you create an image like:



3. Get onto a computer and create your image in Photoshop. Your finished image needs to be:
  - a. All black & white (no color)
  - b. Saved as a .JPEG image on your jump drive
4. Transfer your image to the laser computer and drag it into the program called Corel Draw 5. Here, you need to adjust your image so that:
  - a. A cutting border outlines your image in a **hairline** border that is **red**.
  - b. Is not bigger than 6" x 6"
5. Choose File -> Print -> Print. The default printer is the laser.
6. Choose your acrylic and place it in the laser. Follow the directions in the *Using the Laser* presentation to cut your acrylic piece out! As you do so, make sure you do the following:
  - a. Define the material settings using "Lathrop Robotics Acrylic" and a thickness of 0.14
  - b. Focus the laser
  - c. Turn on the exhaust fan
  - d. Don't hog the machine – do your work and let someone else get a turn ☺

Part 2: Tasks	5 points	4-3 points	2-1-0 points
<input checked="" type="checkbox"/> Laser Notes	+ You took a full page of notes on Photoshop & the laser + Your notes include details on useful tools in Photoshop + Your notes include details on the work flow with the laser	- Your notes are less than a full page - Your notes do not include Photoshop or laser details	- Very brief or no notes in your engineering notebook
<input checked="" type="checkbox"/> Plan Project Assembly	+ You drew out your project plan in your engineering notebook + Your plan includes dimensions and desired colors	- Your plan is missing important information - Your plan has no drawing	- No planning is apparent
	<b>30-24 points</b>	<b>23-15 points</b>	<b>14-0 points</b>
<input checked="" type="checkbox"/> Build Laser Project	+ You created a complete item on the laser + Your item included a nicely cut edge as well as an etched design on the surface	- You built your project but there are significant errors - Messy soldering has ruined some connections	- You did not build your project

(40 pts) Approx. 3 days

The third option in this unit is to learn how to program G-Code. This is the most mathematical of our options, and it will allow you to program very specific tool paths for machines like our CNC Plasma cutter, CNC Router, and the Tormach mill. We'll start nice and simple here using the machine to draw pictures with G-Code, but once you get a design you like we can turn it into a physical product using one of our G-Code driven tools!

1. Start by watching the introductory videos on our website, *G-Code Overview*, *Basic G-Code*, and *Using the CNC Machine*. Take at least a full page of notes on the ideas presented; make sure your notes include details about how G-Code commands G0, G1, and G2 work! Also include details on uploading your G-Code to the CNC machine.
2. Next, create each of the following G-Code challenge pictures by first drawing out your idea by hand on graph paper, then creating the G-Code to draw the image.
  - a. Your first and last initials
  - b. A star
  - c. A smiley face
3. For each of the images you should first draw it out carefully on graph paper using only circles (or parts of them) and straight lines. Think about how the machine will have to move to create the image you are drawing.
4. Then, when your drawing is finished you need to think about how the pen will move with the machine and create each line using a G0, G1, or G2 command. You can take the coordinates right from the graph paper!
5. Now, write your G-Code in Microsoft Word or Google Docs. You'll need to save your document to your jump drive when it's complete
6. Upload your G-Code to the CNC machine using the process described in the *Using the CNC Machine* presentation.
7. Have our CNC machine draw out the patterns you've created with G-Code. Make any adjustments needed to perfect your images.

<b>Part 3: Tasks</b>	<b>5 points</b>	<b>4-3 points</b>	<b>2-1-0 points</b>
 G-Code Notes	+ You took a full page of notes on G-Code and the use of our CNC Machine + Your notes include details on how to use the G0, G1, and G2 commands	- Your notes are less than a full page - Your notes do not include details on the G0, G1, and G2 commands	- Very brief or no notes in your engineering notebook
	<b>15-11 points</b>	<b>10-5 points</b>	<b>4-0 points</b>
 Plan Project Assembly	+ You drew out your design by hand for all 3 designs + You wrote out your G-Code for each line in the design	- Your plan is missing for one of your three designs	- More than one set of plans is missing
	<b>20-15 points</b>	<b>14-10 points</b>	<b>9-0 points</b>
 Create G-Code Drawings	+ You wrote your G-Code on a computer and uploaded it to the CNC Machine + You created all 3 of your drawings from your G-Code	- You only created 2 drawings with your G-Code	- You made fewer than 2 drawings

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## OPTION4: VINYL CUTTER

(40 pts) Approx. 3 days

The final option in this unit is to learn how to work with the vinyl cutter. This machine is cool because it can cut very complex and detailed designs very precisely. When we have it cut out of vinyl sticker sheet, then you end up with a cool custom sticker. If we have it cut from heat transfer vinyl, then you can press your design onto a t-shirt! The process here will be very similar to working with the laser: we'll create an image in photoshop, transfer it to the machine, and let the machine do its work!

1. Start by watching the introductory videos on our website, *How to Use Photoshop*, *Converting Your Image*, and *Using the Vinyl Cutter*. Take at least a full page of notes on these topics. Be sure to focus your notes on the process of using the vinyl cutter and the different tools you'll need in Photoshop.
2. Next, draw – by hand – a design for two (2) cool stickers you want to try and make with the vinyl cutter. Your drawings should be reasonably good, and should include dimensions and desired colors of sticker vinyl.
3. For each sticker you'll need to get onto a computer and create your image in Photoshop. Your finished image needs to be:
  - a. All black & white (no color, no grays)
  - b. Saved as a .JPEG image on your jump drive
4. Transfer your image to the vinyl cutter computer and drag it into the program called Roland Cut Studio. Here, you need to adjust your image so that:
  - a. You only have a blue cutting border. (Right-click, choose “Image Outline” -> “Extract Contour”)
  - b. Your sticker is not bigger than 6” x 6”
5. Choose your vinyl and place it in the cutter with the sticker (color) side up. Follow the directions in the *Using the Vinyl Cutter* presentation to cut your sticker out!
6. Choose File -> Cutting... -> Print. The default printer is the vinyl cutter.
7. Repeat the overall process to make a second sticker! If you want a good challenge, try and make a sticker that requires two colors, then make two stickers that match-up like puzzle pieces for a cool multi-color effect!

Part 4: Tasks	5 points	4-3 points	2-1-0 points
 Vinyl Cutter Notes	+ You took a full page of notes on Photoshop and the use of the vinyl cutter + Your notes include details on the useful tools in Photoshop as well as the details of using the vinyl cutter	- Your notes are less than a full page - Your notes do not include details on Photoshop - Your notes do not include details on the vinyl cutter	- Very brief or no notes in your engineering notebook
 Plan Project Assembly	+ You drew out your project plans for both stickers in your engineering notebook + Your plans include dimensions and desired colors	- Your plan is missing important information - Your plan has no drawing	- No planning is apparent
	<b>30-24 points</b>	<b>23-15 points</b>	<b>14-0 points</b>
 Build Vinyl Cutter Project	+ You created 2 complete stickers on the vinyl cutter + Your stickers look nice	- You cut your stickers, but there are major errors	- You did not cut your stickers