

Four Week Session: CAD Techniques

Lesson Title: CAD Techniques

Created By: WPI Student Team

Length of Session: 1 hour

Subject: CAD

Number of Instructors: at least 1

Lesson Number: 1

Intended Age: 18+

Last Updated: March 3, 2023

Purpose of Session:

In SolidWorks there are many small features that students can use to improve their design. The purpose of this session is to introduce students to some of these concepts to provide them more techniques to use in their own designs.

Prescribed Learning Outcomes:

Students will gain experience using SolidWorks and learn about some of the features it offers.

Instructional Objectives:

- Students will learn about fillet feature.
- Students will learn how to assign a material to a part.
- Students will learn how to use assemblies/subassemblies.
- Students will learn about the different ways to mate components.
- Students will learn how to use linear patterns.
- Students will learn how to troubleshoot errors in their sketch.

Prerequisite Concepts and Skills:

Students have experience with CAD in the past. It does not have to be extensive, but they have used CAD to make a part in the past.

Materials and Resources:

Instructor	Students
Laptops with SolidWorks installed.	Laptops with SolidWorks installed (if possible).

Lesson Activities:

Instructor	Students	Time Allotted
<u>Introduction</u> Instructor introduces themselves and explains in a sentence what students will be learning during this session.	Students arrive.	5 minutes
<u>Body</u>		

Students are broken into smaller groups, and each given a laptop with SolidWorks open. One person in each group is assigned at the lead engineer (this person is responsible for using the computer).	Students rearrange themselves so that everyone can see the screen and the lead engineer can access the keyboard.	5 minutes
The instructor has everyone create a new assembly and new part within the assembly. The instructor review creating a part (sketch, extrude, cut extrude, adjusting dimensions).	The lead engineer follows these steps with the rest of the group watching and providing support.	10 minutes
Once the sketch is completed, the instructor shows students how the fillet feature can be used to round the corner of the component. The instructor then demonstrates other shapes, such as circles, polygons, hexagons, etc. that can be used.	The lead engineer follows these steps with the rest of the group watching and providing support.	5 minutes
Once each group was successful the lead engineer switches.		
Instructor then has the students create another part and shows them how to mate it to the first part. At this time the instructor also shows students the different ways to mate components, as well as how to delete mates.	The lead engineer follows these steps with the rest of the group watching and providing support.	15 minutes
Once each group was successful the lead engineer switches.		
Instructor then shows students the pinball design and explains how fillets and mates were used to show them the possibilities of such features. The instructor then also shows students how to change the material of the part they are working on.	The lead engineer follows these steps with the rest of the group watching and providing support.	5 minutes
The instructor shows students how to create linear patterns using the parts they already created. Instructor also	The lead engineer follows these steps with the rest of the group watching and providing support.	5 minutes

shows the peg board in the pinball machine as an example. Once each group was successful the lead engineer switches. Instructor explains that sometimes as you are editing a design there are errors with the mates and sketch. In these situations, it helps to look at what was wrong to figure out what may be over or underdefined. Then the instructor shows students the different ways to define a sketch in sketch and how over defining can cause errors and how to fix this. Once each group was successful the lead engineer switches. <i>*Ideally students are in groups of 4 or less. If there are more, the lead engineer can switch more often.</i> <i>*More information about doing these specific steps can be found on the website if the instructor is not familiar with SolidWorks.</i>	The lead engineer follows these steps with the rest of the group watching and providing support. <i>*Students are given time as a group to experiment with these new tools to create shapes. Students should take turns being the lead engineer during this time.</i>	5 minutes
<u>Conclusion</u> Review the key ideas from the lesson and ask students: <i>1. What did you learn?</i> <i>2. Do you have any questions?</i>	Students have a chance to share what they learned and ask any questions they may have about the lesson.	5 minutes

Four Week Session: Obstacle Building

Lesson Title: Obstacle Building

Lesson Number: 2

Created By: WPI Student Team

Subject: Engineering Design

Intended Age: 18+

Length of Session: 1 hour

Number of Instructors: at least 1

Last Updated: March 3, 2023

Purpose of Session:

This session will provide students with additional hands-on engineering experience. They will get the chance to play with the interactive display.

Prescribed Learning Outcomes:

Students will be able to expand on their CAD experience and learn how their design translates into the real world through laser cutting.

Instructional Objectives:

- Students further their understanding of other applications of engineering.
- Students gain experience in engineering design with more constraints.
- Students practice using CAD to design their ideas before they build them.

Prerequisite Concepts and Skills:

Ideally students would have attended the first session, but this is not required.

Materials and Resources:

Instructor	Students
Laptops with SolidWorks installed. Plywood Laser Cutter Any miscellaneous scraps of materials that students could incorporate into their design. Obstacle Examples These can be 3D printed/laser cut or can use ones that have been created by other students in this space.	-----

Lesson Activities:

Instructor	Students	Time Allotted
<u>Introduction</u> Instructor introduces themselves and welcomes everyone. Instructor reminds students of the introduction to CAD from last session. Preferably ask student what they remembered to engage them and review the core concepts from that lesson. Students are then told they will have a new engineering design challenge. This session they will be creating an obstacle for the pinball machine. Students are shown the pinball machine. The instructor demonstrates how to play.	Students arrive. Students ask questions and participate as requested.	5 minutes
<u>Body</u> The instructor demonstrates the how the obstacle effects the path of the marble. Use a variety of obstacles and show how they can be placed in different ways on the board. Students are divided into teams. Each team is given a laptop with SolidWorks open and a lead engineer is assigned. (The lead engineer will be the one to touch the laptop.) Instructor quickly review the SolidWorks skills from the previous session and students are told that when using the laser cutter, the design will always be 1/8th inch thick, and each part needs to be printable in 2D. Students are instructed to stop CADing. Instructor shows them how to save each part as a DXF file and transfer this to the laser cutter.	Students are given the opportunity to move around obstacles and experiment with different example obstacles. Students work in teams to design their own obstacle. Each student group then prints their obstacle.	5 minutes 20 minutes 15 minutes

<u>Closure</u> Review what they learned today focusing on the importance of drawing before you create and working with others. Can also review what it was like to work with limited materials, and on a surface with constraints.	Students are given a chance to share what they learned and ask questions.	5 minutes
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Four Week Session: Light Detector Circuit

Lesson Title: Light Detector Circuit

Lesson Number: 3

Created By: WPI Student Team

Subject: Musical Lights

Intended Age: 18+

Length of Session: 1 hour

Number of Instructors: at least 1

Last Updated: March 3, 2023

Purpose of Session:

The purpose of this session is to teach the introduction to using Arduinos with LEDs and analog components.

Prescribed Learning Outcomes:

Students will learn how to use Arduinos with LEDs and analog components.

Instructional Objectives:

- Working with Arduinos
- Working with LEDs and variable resistors to achieve a light detector.

Prerequisite Concepts and Skills:

It is recommended that students entering the session have a basic understanding of coding and circuitry.

Materials and Resources:

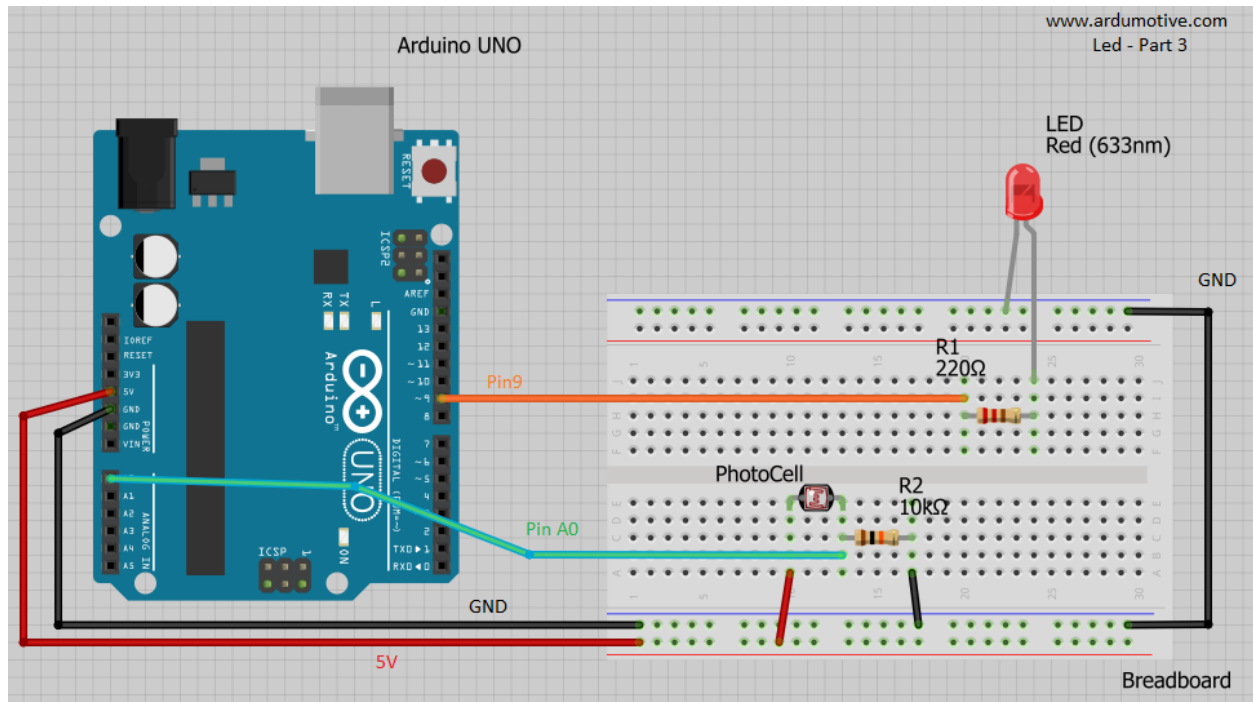
Instructor	Students
Laptop with Arduino downloaded. Arduino Nano Photoresistor LED strip Wires Open-Access Code: 1. WORKING_LEDs 2. Photoresistor 3. Photoresistor_LEDs The instructor should be walking the students through the coding with the open-access code as a reference. The students should be writing the code on their own.	Laptop with Arduino downloaded. Arduino Nano Photoresistor LED strip Wires

Lesson Activities:

Instructor	Students	Time Allotted
<u>Introduction</u> The introductory display should be created prior to the session and should show the successful setup. As a light flashes over the photoresistor, the LEDs turn on. Show students that it functions and express that it is what they will be performing today. Have them set the board, processor, and port up accordingly in the Arduino application.	Students will set up their board, processor, and port accordingly in the Arduino application.	10 minutes
<u>Body</u> LEDs stand for light-emitting diodes and work based on an inputting voltage from a power source. The LED strip used today are a bunch of LEDs connected in series, meaning that they all take the same amount of current. 1. The LED strip connects to a 5V supply, ground, and a digital pin from the Arduino (D4 is used in the open-source code). The first open-source code to use is the simple LED-on code. Walk students through how to write the simple code, compile, and export it to the Arduinos. The LEDs should light up. 2. A photoresistor is a type of resistor whose resistance value changes depending on the amount of light striking its surface. By setting up a voltage divider with another resistor, the outputting	Students will be writing the WORKING_LEDs code, guided by the instructor. Students will be writing the Photoresistor code, guided by the instructor. They will then observe the change of voltage outputted from the photoresistor in the serial plotter.	10 minutes 10 minutes 10 minutes

voltage of the circuit will change as the light striking the surface of the photoresistor changes* . Students should observe this change in voltage with the serial plotter. 3. Now students will write the open-source code that incorporates the photoresistor with the LEDs. As the photoresistor circuit outputs a datum at a threshold specified in the code, the LEDs will turn on. Students should mess around with the threshold value using the serial plotter for reference.	Students will be writing the Photoresistor_LEDs code, guided by the instructor. They should mess around with the threshold value using the serial plotter for reference.	10 minutes
<u>Closure</u> Congrats! You linked together analog and digital design! This is not far off base from what is going on with the musical lights. Tune in next session for how the musical lights work! <i>*Ensure that students understand the basic idea of voltage dividers: by having two resistors in series, each resistor will take a fraction of the input voltage that is directly proportional to their comparative resistances. For example, a $5k\Omega$ resistor will take 1/3 of the voltage when put in series with a $10k\Omega$ resistor. See diagram of the breadboard connection below.</i>		10 minutes

Diagram of Breadboard Connection:



Sourced from:

<https://www.instructables.com/How-to-use-a-photoresistor-or-photocell-Arduino-Tu/> .

Four Week Session: Musical Lights

Lesson Title: Musical Lights

Created By: WPI Student Team

Length of Session: 1 hour

Subject: Musical Lights

Number of Instructors: at least 1

Lesson Number: 4

Intended Age: 18+

Last Updated: March 3, 2023

** Note that this session heavily reflects the single session facilitated by the WPI Makerspace Team.*

Purpose of Session:

The purpose of this session is to teach students how the musical lights display works using Arduinos with LEDs and microphone chips.

Prescribed Learning Outcomes:

Students will learn how to use Arduinos with LEDs and microphones.

Instructional Objectives:

- Coding with Arduino.
- Working with LEDs and microphones to create the musical light display in the makerspace.

Prerequisite Concepts and Skills:

It is recommended that students should have prior knowledge of working with Arduinos and LEDs. These skills were acquired in the previous session.

Materials and Resources:

Instructor	Students
Laptop with Arduino downloaded. Arduino Nano Microphone chip LED strip Wires Open-access code: 1. WORKING_LEDs 2. WORKING_MIC 3. WORKING_MIC_LEDs	Laptop with Arduino downloaded. Arduino Nano Microphone chip LED strip Wires

The instructor should be walking the students through the coding with the open-access code as a reference. The students should be writing the code on their own.	
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Lesson Activities:

Instructor	Students	Time Allotted
<u>Introduction</u> Display the musical lights installation in the makerspace, express that students will learn how this works. Have students set up their board, processor, and ports correctly in the Arduino application.	Students will set up their board, processor, and ports correctly in the Arduino application, guided by the instructor.	10 minutes
<u>Body</u> LEDs stand for light-emitting diodes and work based on an inputting voltage from a power source. The LED strip used today are a bunch of LEDs connected in series, meaning that they all take the same amount of current. 1. The LED strip connects to a 5V supply, ground, and a digital pin from the Arduino (D4 is used in the open-source code). The first open-source code to use is the simple LED-on code. Help students write, compile, and export it to the Arduinos. The LEDs should light up. 2. The next section involves the microphone chip. Microphones take in audio data and convert it to electric data (voltage data). As the sound entering a microphone	Students will set up the breadboard to incorporate the LEDs and will write the WORKING_LEDs code, guided by the instructor. Students will set up the breadboard to incorporate the LEDs and will write the WORKING_MIC code, guided by the instructor. They will then open the serial plotter and observe the waveforms exiting the microphone.	10 minutes 10 minutes 10 minutes

increases, the voltage leaving it increases. Students should now write the simple microphone open-source code to get their microphones connected to the Arduino (using the A1 pin). Open the serial plotter to observe the inputting data from the microphone. 3. Now students will write the open-source code that incorporates the microphone with the LEDs. As the microphone outputs a datum at a threshold specified in the code, the LEDs will turn on. Students should mess around with the threshold value using the serial plotter for reference. It should be noted to students that this is the fundamental setup for the musical lights. The only difference is that there are more patterns and a low pass filter embedded in the final coding. Students should be welcome to investigate the code for the musical lights installation, which is also accessible from the website.	Students will set up the breadboard to incorporate the LEDs and will write the WORKING_MIC_LEDs code, guided by the instructor. Students should mess around with the threshold value using the serial plotter for reference.	10 minutes 5 minutes
<u>Closure</u> Congrats! You linked together analog and digital design! This is an interesting take on electronic and musical design.		5 minutes