

Four Week Session: Introduction to CAD

Lesson Title: Introduction to CAD

Lesson Number: 1

Created By: WPI Student Team

Subject: Engineering Design

Intended Age: 15-17

Length of Session: 1 hour

Number of Instructors: at least 1

Last Updated: March 3, 2023

Purpose of Session:

Students will be introduced to the concept of computer aided design. They will be provided with practice drawing out their ideas and understand how they can create some basic shapes in 3D.

Prescribed Learning Outcomes:

Students will better understand the engineering design process by being able to draw out their ideas before they create them.

Instructional Objectives:

- Students will learn how to create a sketch in SolidWorks.
 - Students will learn about many of the shapes SolidWorks provides.
- Students will learn how to extrude a sketch.
- Students will learn how to create a hole in their component.
- Students will gain experience practicing each of these techniques.
- Students will learn what an assembly/subassembly.

Prerequisite Concepts and Skills:

There are no prerequisites for this class.

Materials and Resources:

Instructor	Students
Laptops with SolidWorks installed. Paper Pens/ Pencils Projector (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. Instructor explains to students that drawing out a design can help engineers build things. Students are given pieces of paper and pencils.	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). Instructor shows students how to create a new part, pick a plane, and sketch a rectangle on it. Instructor then uses smart dimension to show students how to adjust the size of their shape. The instructor then demonstrates other shapes, such as circles, polygons, hexagons, etc. that can be used. Once each group was successful the lead engineer switches. Instructor then shows students how to extrude the shape to different lengths and different directions. Once each group was successful the lead engineer switches. Instructor shows students how to create another sketch on their existing part. They show the students how to draw a circle and adjust the size using smart dimensions.	Students rearrange themselves so that everyone can see the screen and the lead engineer can access the keyboard. The lead engineer follows these steps with the rest of the group watching and providing support. The lead engineer follows these steps with the rest of the group watching and providing support. The lead engineer follows these steps with the rest of the group watching and providing support.	5 minutes 10 minutes 10 minutes 10 minutes

Once each group was successful the lead engineer switches. Instructor shows students how to extrude cut and adjust the dimensions. Once each group was successful the lead engineer switches. Instructor then shows students how to create a new assembly with the part they just created. Students add one more part to the assembly and mate it with one wall of the design. The instructor then shows the pinball machine design with the subassemblies to show the capabilities of combining parts and organizing your design. <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.	5 minutes
		5 minutes
		5 minutes
Conclusion Review the key ideas from the lesson and asks the following questions: 1. What did you learn today? 2. Do you have any questions?	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: 15-17

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 upon their CAD experience and learn how their design translates into the real world through laser cutting.

Instructional Objectives:

- Students further their understanding of 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:

Teacher	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 how the obstacles effect 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 reviews 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: Coding Games!

Lesson Title: Coding Games!

Created By: WPI Student Team

Length of Session: 1 hour

Subject: Coding

Number of Instructors: at least 1

Lesson Number: 3

Intended Age: 15-17

Last Updated: March 3, 2023

Purpose of Session:

The purpose of this session is for students to be introduced to coding and coding techniques.

Prescribed Learning Outcomes:

Students will understand that coding exists, and anyone can do it!

Instructional Objectives:

- Creativity in technological design.
- Basic coding techniques.

Prerequisite Concepts and Skills:

There are no required skills or known concepts prior to this session.

Materials and Resources:

Instagram	Students
Laptop with internet connection.	Laptop with internet connection.

Lesson Activities:

Instructors	Students	Time Allotted
<u>Introduction</u> Coding is the method of communicating between humans and computers, and you can see coding in real life every day. While coding has created many cool and sophisticated things, it is accessible to anyone who wants to learn.		10 minutes
<u>Body</u> Using website https://scratch.mit.edu/ , students will accomplish a given task. Tasks could include:	Using website https://scratch.mit.edu/ , students will accomplish the first 15 levels of the course.	45 minutes

1. Creating a scene where there is dialogue and movement. 2. Make an interesting and functional game. Create enough stipulations for the students that they are challenged but not overwhelmed. Go to Tutorials and they already have a lot of ideas documented that are relatively easy to learn once you watch their videos.		
<u>Closure</u> While a cool game, this website has taught you important foundations of coding!		5 minutes

Four Week Session: Learning To Code!

Lesson Title: Learning to Code

Created By: WPI Student Team

Length of Session: 1 hour

Subject: Arduino Programming

Number of Instructors: at least 1

Lesson Number: 4

Intended Age: 15-17

Last Updated: March 3, 2023

Purpose of Session:

This session will provide students with additional hands-on engineering experience with Arduino programming.

Prescribed Learning Outcomes:

Students will develop a basic understanding of how to code. They will develop practice using Arduino with a motor and a button

Instructional Objectives:

- Students further their understanding of applications of engineering.
- Students will understand how to set up a program in Arduino
- Students will learn how to declare variables.
- Students will learn how to add code in the main loop to move a servo motor.
- Students will learn how to take inputs from a sensor
- Students will learn how to use an if statement.

Prerequisite Concepts and Skills:

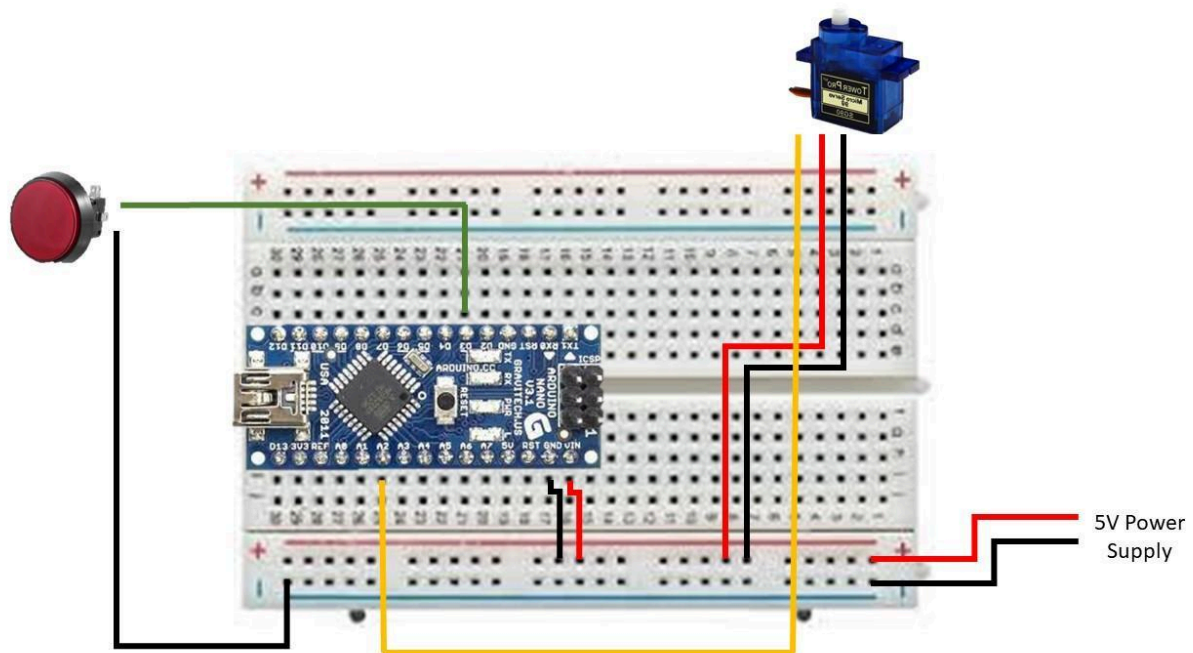
Ideally students would have attended the prior sessions, but this is not required.

Materials and Resources:

Instructor	Students
Laptops with Arduino IDE & CH340 Driver Wires Breadboards Servo motors Arduino Nano Upload wire for Arduino	-----

Set Up:

Prior to the session the instructor should set up the electrical boards as shown below. The number of electrical boards depends on the number of students and available resources. Students can work in groups on each board.



Lesson Activities:

Instructor	Students	Time Allotted
<u>Introduction</u> Instructor introduces themselves and welcomes everyone. Instructor reminds students of the introduction to programming from the previous session. Preferably ask student what they remembered to engage them and review the core concepts from that lesson. Students are then told they will be working on learning to Arduino and move a servo motor. Students are shown the pinball machine.	Students arrive.	5 minutes
<u>Body</u> The instructor splits students into groups and gives each group an Arduino and a laptop.		5 min

In the course of the session, the instructor will help the students to write the code given for this lesson attached to the document. Instructor begins by including the Servo library. The instructor explains the purpose of adding a library. Instructor shows the students how to declare the motor and vaguely describes what an object in code is. Instructor shows students how to declare a constant and explains the purpose of this for the servo pin. Instructor also explains how this coorelates to the wiring on the board Instructor shows students how to declare a variable in the code and set the variable flipper_timer and explains the purpose of a variable Students switch lead software engineer. Instructor explains the purpose of the set-up loop and purpose of the main loop. (Set up code happens once and loop code repeats)	Students gather their materials and group partners. They then pick a lead engineer. The lead engineer will be the one to touch the laptop. This role will switch over the course of the session. Students open the Arduino IDE in front of them. Students add the library in their code Students declare the motor in their code Students declares the servo pin and button pin in the code Students declare the variable in their code.	5 min 5 min 10 min
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Instructor explains the serial.begin line is necessary for communication and that the servo attach line declares the motor and button. Instructor also explains the use of the constant in this line. Instructor describes a print statement and its purpose in the code. Students switch lead software engineer. The instructor explains the purpose of the if statement. They also explain how the not works. In the if statement and why this is important for a pull up resistor The instructor then explains the purpose and function of servo.write(0) The instructor explains the role of a delay and the use of the variable in this code. The instructor explains how servo write (90) is different than the previous line	Students write these lines in their code as the instructor explains them Students implement the print statement. Students add this code Students add this code Students add this code Students then upload this code to their board and run. Students with the help of the instructor trouble shoot any issues. Students can modify the code and reupload to play with these commands, as time permits.	10 min 5 min
<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

Students are then showed the servos that are attached under the flipper and the electrical board on the pinball display	Students are given the opportunity to play with the pinball machine.	5+ minutes
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