

# VIRTUAL STEM CAMP

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## OVERVIEW

In the summer of 2020, in response to the Covid-19 pandemic, FRC Team 980 ThunderBots adapted our in-person LEGO RoboCamp as a Virtual STEM Camp.

Virtual STEM Camp remains a one-week program aimed at early Middle School students (rising 5<sup>th</sup> and 6<sup>th</sup> graders). In order to open Virtual STEM Camp to the widest possible audience, we have designed this program to be no-charge to the participants. All that is required is a computer on a reliable internet connection. There are no subscription fees and no purchases required.

The decision to keep the camp affordable for everyone prompted some changes in our previous curriculum. At our in-person camps, we provided computers and LEGO Mindstorms sets, and the week was devoted to building, programming and competing. Avoiding the necessity of campers purchasing their own Mindstorms kits, we modified the Mindstorms coding to a two-day curriculum, allowing us to add OnShape CAD and (a super fun) Basics of Engineering. All these curricula are available, below.

Virtual STEM Camp is designed as a 5-day program, run for 4 hours each day. This timeline can be adjusted.

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# ABOUT THE CAMP

Virtual STEM Camp was created by the student members of FRC Team 980 ThunderBots and is designed to be run by the students with oversight by adult Mentors.

Camp sessions are run on Zoom. Each day will include several whole group activities, but the main teaching will take place in Breakout Rooms of 6-10 students.

Students are encouraged to participate fully (cameras on!) and to follow the same type of Code of Conduct set by their schools. Camp staff is friendly and knowledgeable and wants every camper to feel that they have mastered a new technical skill – while having lots of fun.

## SCHEDULE

	<b>Monday</b>	<b>Tuesday</b>	<b>Wednesday</b>	<b>Thursday</b>	<b>Friday</b>
<b>9-10am</b>	Staff prep	Staff prep	Staff prep	Staff prep	Staff prep
<b>10-11am</b>	OnShape CAD	OnShape CAD	Mindstorms coding	Mindstorms coding	Basics of Engineering
<b>11am – 12pm</b>	Break/One-on-One help	Break/One-on-One help	Break/One-on-One help	Break/One-on-One help	Break/One-on-One help
<b>12-12:30pm</b>	Group Activity	Group Activity	Group Activity	Group Activity	Group Activity
<b>12:30-1pm</b>	Guest Speaker	Guest Speaker	Guest Speaker	Guest Speaker	Guest Speaker
<b>1-2pm</b>	Team Demos	Team Demos	Team Demos	Team Demos	Team Demos
<b>2-3pm</b>	Staff debrief	Staff debrief	Staff debrief	Staff debrief	Staff debrief

## STAFF

### Student Leadership:

1-2 students

Responsible for overall preparation and running of the Camp, including recruiting staff, verifying curriculum and documentation, training staff, running registration/supplying information and Zoom links to campers, recruiting guest speakers, troubleshooting during camp, sending out awards, debrief to staff and mentors.

### Instruction Lead:

1-2 students

Responsible for preparation and documentation of one of the three curricula: OnShape CAD, Mindstorms coding, Basics of Engineering. Trains all instructors to teach their curriculum and is available on teaching days to assist in Zoom Rooms as needed.

**Instructors:**

TBD

Assigned to one Zoom Breakout Room and responsible for teaching that Room throughout the week. They are the Virtual STEM Camp “teachers.” Ideally each instructor will have 6-10 students in their Breakout Room.

**IT:**

1-2 students

Help with all technical issues, from signing up students for online accounts to guest speaker shared presentations.

**Group Activity Coordinator:**

1-2 students

Create and run the daily Group Activity (game, cool engineering thing, etc.)

**REQUIREMENTS****Internet**

Campers must have to have access to a reliable internet connection to participate. Meetings take place on Zoom and the technical skills are taught using online sites.

**Computer**

Campers should be using a “professional” device, like a computer – laptop or desktop – or a higher end tablet running MacOS or Windows. Mobile phones, e-readers, and older tablets will not allow the students fully access the online technical sites.

**Account sign-ups**

Prior to the first meeting, all campers should sign up for FREE accounts for OnShape CAD and LEGO Mindstorms. See below for instructions.

**Other materials (recommended)**

We will be teaching the Basics of Engineering using easy to find items that you might already have at home. These are: uncooked spaghetti (not angel hair or thin) and marshmallows (not mini).

# PREPARATIONS

## **Registration:**

We use Google Forms for registration. Registered students are divided up into groups of 6-10 and assigned to their Breakout Rooms prior to beginning of camp. We recommend keeping Mac and PC users together as there are some differences between the platforms for Mindstorms coding.

Along with the registration form, campers are asked to complete (sign) and return a “Minor Child Photo Release Form” and a Code of Conduct form.

## **Training:**

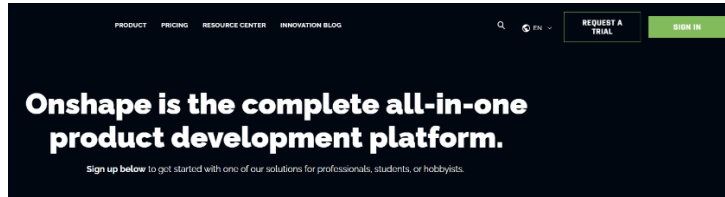
Training is done on Day 0, with all instructors going through the program as campers. This ensures that instructors are familiar with the curriculum and also debugs any problems with the online sites, curriculum, etc.

# SIGN-UPS

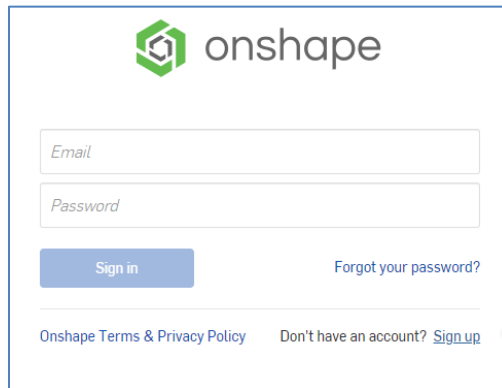
## OnShape CAD

Sign up at <https://www.onshape.com/signup>

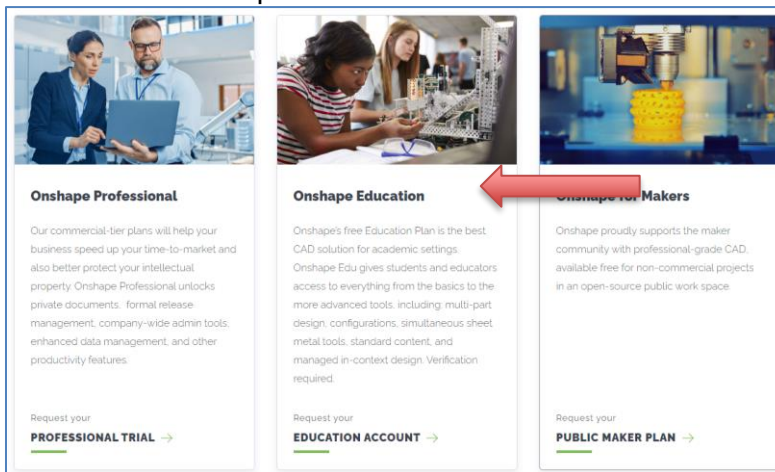
- Click “SIGN IN” (Green and White button in top right corner)



- On the login window, click on “Don’t have an account? Sign up” (bottom right; underlined)



- Scroll down and select Onshape Education



- Click Create Free Account (Green Box to the left)

# Onshape for Education

Onshape is a professional-grade, cloud-based CAD platform that students and educators can access for FREE on any device, anywhere, anytime.



CREATE FREE ACCOUNT

EDUCATION ENTERPRISE

- Fill out basic info (select student)

Get started with Onshape for Students & Educators

First Name \*  
Happy

Last Name \*  
Camper

Email \*  
happycamper@gmail.com

Are you a student or educator? \*  
Student

School level \*  
Grade School (K-12)

By checking this box, I agree to be contacted by Onshape in relation to Onshape's products and services which may be of interest to me and I acknowledge that I can withdraw my consent at any time, as outlined in Onshape's Privacy Policy.

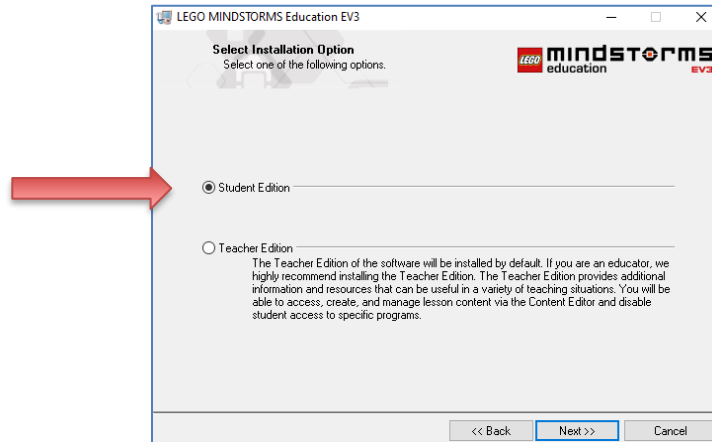
CREATE EDU ACCOUNT



- Once you reach the signup page, complete the registration. If there are any issues, contact us at [stemcamp@team980.com](mailto:stemcamp@team980.com).
  - You can use Team980 and Team980.com as school and website.

## LEGO Mindstorms

- Download for Mindstorms Mac/PC version: <https://education.lego.com/en-us/downloads/mindstorms-ev3/software#downloads>
- Download for Mindstorms only PC version: <https://education.lego.com/en-us/downloads/retiredproducts/mindstorms-ev3-lab/software>
- Introduction video for Mac/PC (newer version): [https://www.youtube.com/watch?v=jVKt693Jei0&ab\\_channel=MitchellDaigle](https://www.youtube.com/watch?v=jVKt693Jei0&ab_channel=MitchellDaigle)
- Introduction video for only PC: [https://www.youtube.com/watch?v=5r38eT07Hf0&ab\\_channel=TechwithMike](https://www.youtube.com/watch?v=5r38eT07Hf0&ab_channel=TechwithMike)
- Download and select Student Edition.





# CURRICULUM

## OnShape CAD

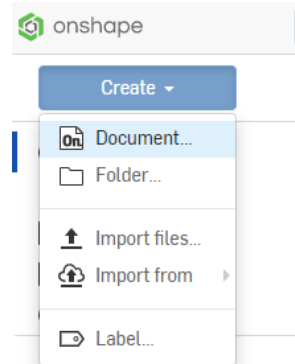
We introduce campers to the world of Computer-Aided Design (CAD) through the OnShape ([www.onshape.com](http://www.onshape.com)) platform. This is an in-browser CAD software; there are no downloads required! The ThunderBots curriculum covers all the basic aspects of CAD software, establishing a baseline knowledge that can be translated across multiple software suites common in the industry today.

### Step 0: Sign-up and browser check

- Make sure all students are signed up to OnShape and are using **Chrome**
- if OnShape gives WebGL error:
  - Reload page
  - Navigate to Chrome settings > Advanced > System
  - Check the box saying “Use Hardware Acceleration”

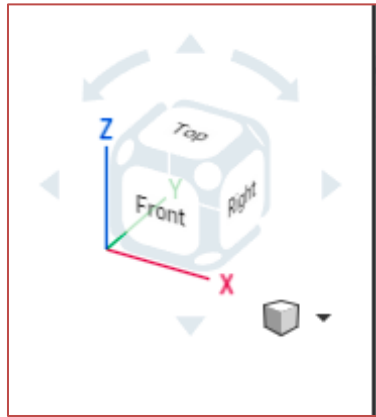
### Step 1: New Project/ 2D Sketching

1: Create > Document > “demo”

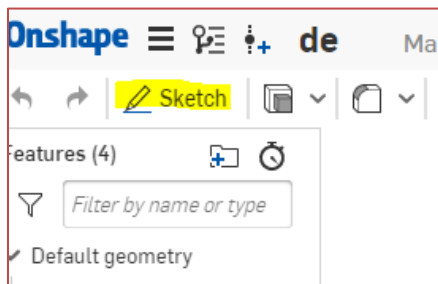


## 2: Main parts of onshape:

- 3 Planes (surfaces) Front, Right, Top
- Origin point (center)
- Right Click + drag to rotate view
- Left Click to select, click on white space to deselect
- Escape button to get out of the menus
- To reset view, use the cube ( should look like this)

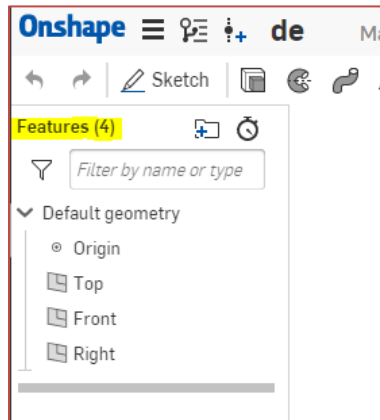


## 3: Click on Sketch button > window opens that needs sketch plane



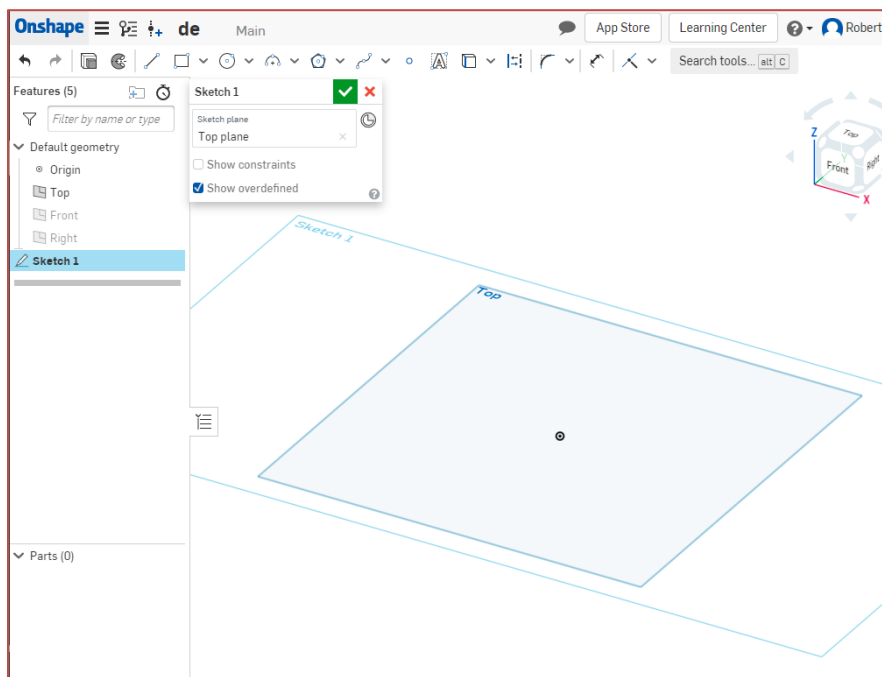
#### 4: Select TOP PLANE

- Below sketch button is the Features list

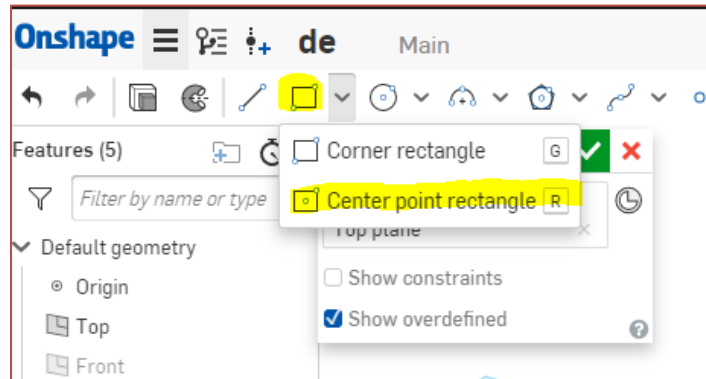


#### 5: Hover mouse over Front plane and Right plane, click on the eyeball to hide them for now

- NOTE: at this point it should look like this

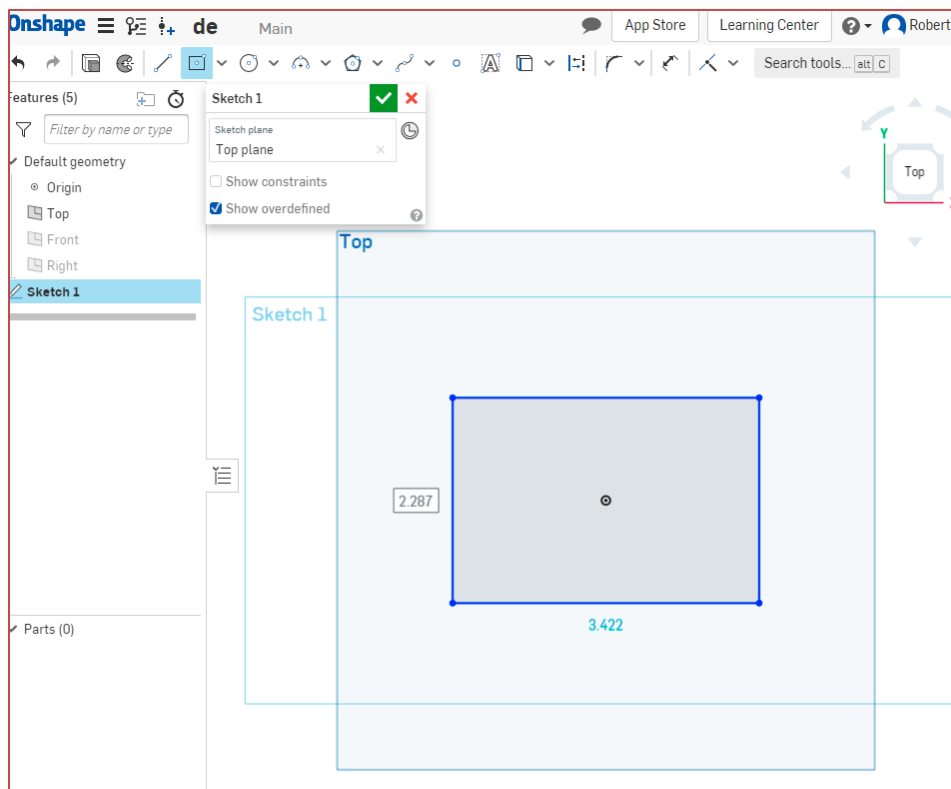


6: Select Rectangle tool > Center Point Rectangle

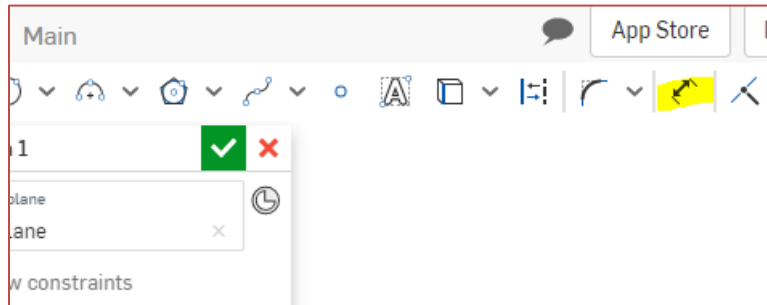


7: Click TOP of the view cube to zoom in on top plane

8: Click on ORIGIN and drag to make a rectangle (no set measurements yet)

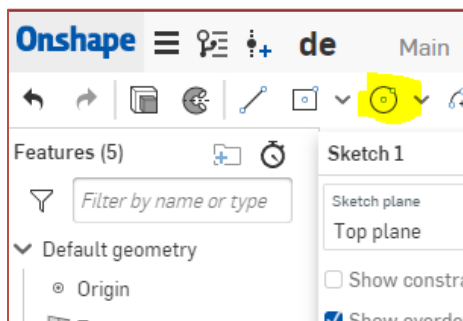


9: Select Dimension button, used to specify length etc.

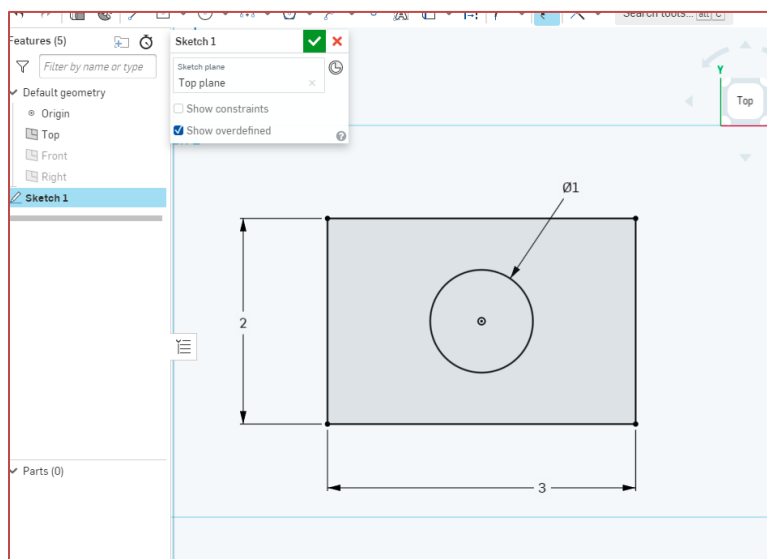


10: click on height (vertical) and type in 2, repeat for width (horizontal) and make it 3. Measurements are in inches. by default

11: Select Circle tool



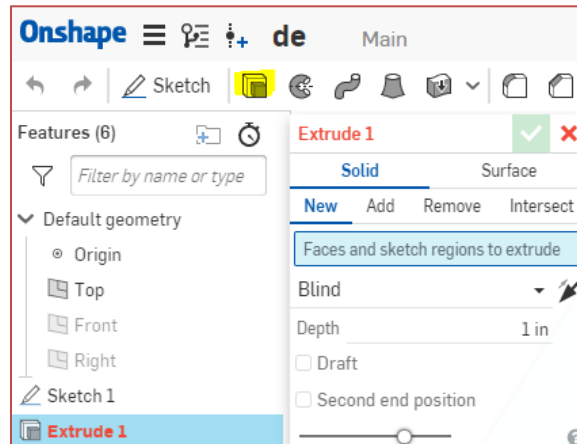
12: Click on ORIGIN and draw a circle, Dimension it for 1 inch



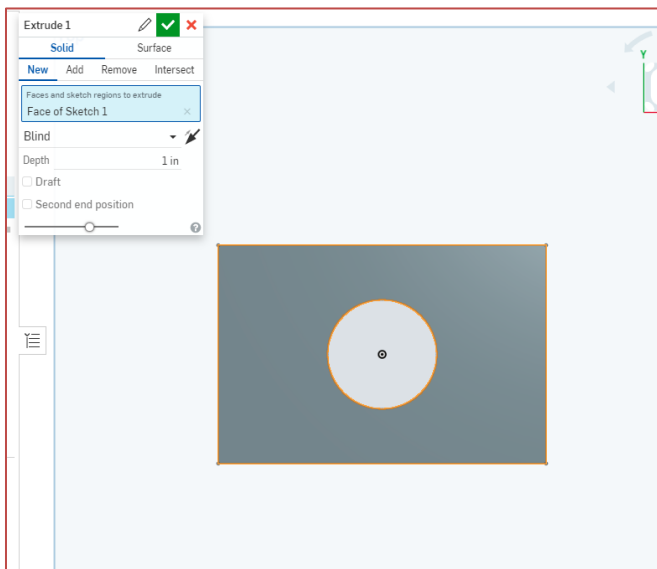
## Step 2: Extruding Sketch

Now we'll turn our 2D sketch into a 3D shape

13: Select Extrude button, then select only the rectangle



14: After selecting, it should look like this:

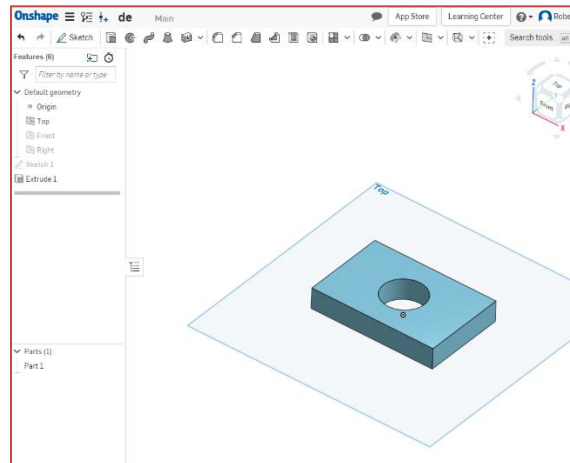


IF yours is solid/no hole, go back to sketch and make sure all of your lines are solid!

15: Set DEPTH to half an inch. (either 0.5 or 1/2)

16: Accept extrusion (green check mark)

17: Right click to rotate camera, you should have a block with a circle in it



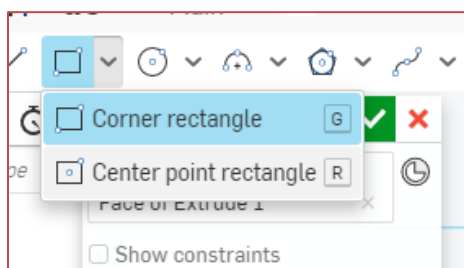
### Step 3: Adding Features

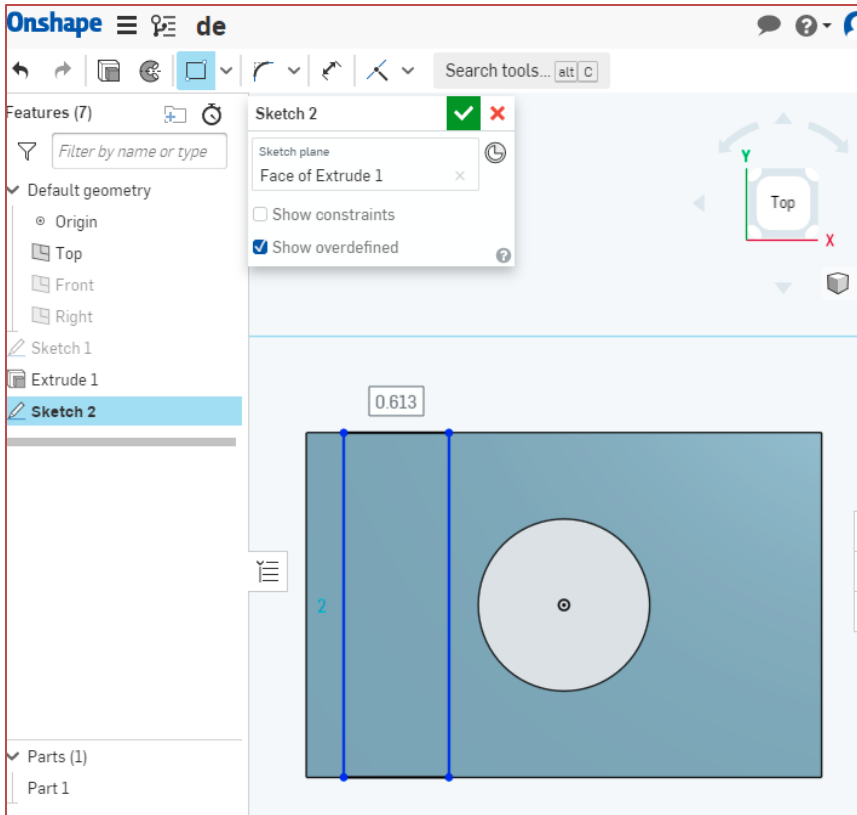
We are going to add a slot into the rectangle by cutting some material away from it

18: Make a new sketch, this time select the top surface of your block to sketch on

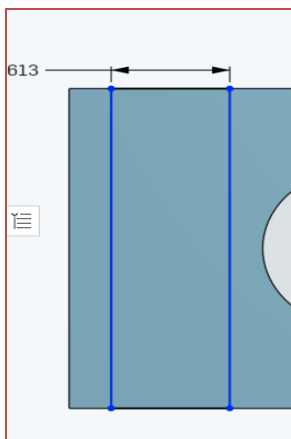
19: Click on TOP of viewcube

20: Select Rectangle tool (this time just CORNER) and drag a rectangle from top of one edge to the bottom of the other





21: To set width of rectangle, L. click on Dimension tool, then L. click on the two sides of the rectangle



22: Make width 0.25 in

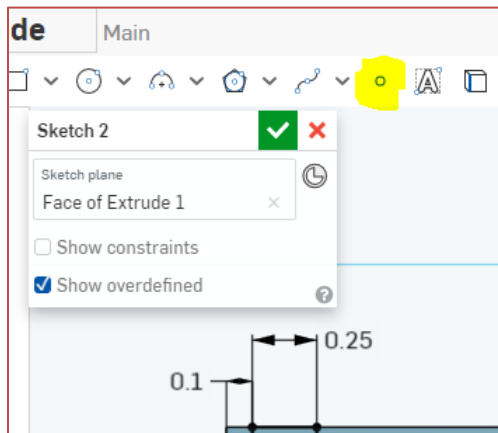
23: We also need to set the distance from left edge, so select edge of your block and the left edge of the new rectangle, make width 0.1 in



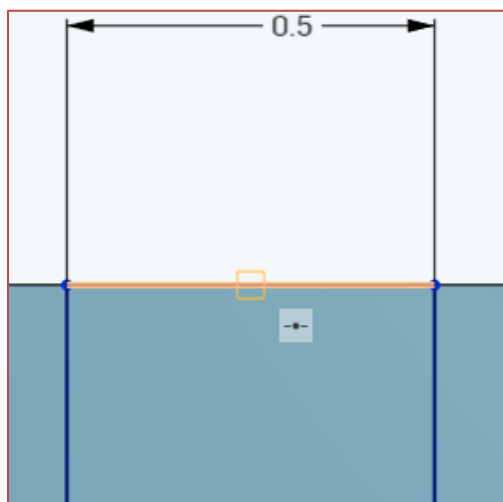
Now we're going to add another slot that runs through the circle

24: Sketch another rectangle using Rectangle tool somewhere near the center, set its width to 0.5

25: Select POINT tool



26: Hover over the top edge of the rectangle you made until it looks like this:

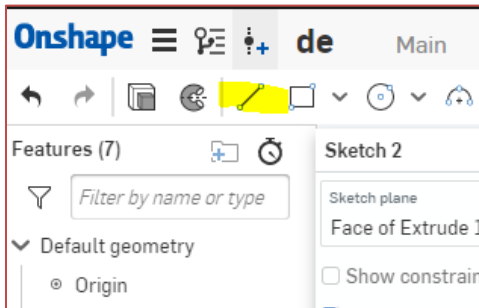


The symbol means that you're hovering over the midpoint or the center of the rectangle

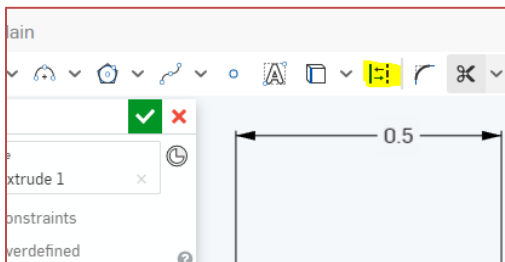
27: Place your point there

We are going to draw the centerline of our rectangle next

28: Select LINE tool



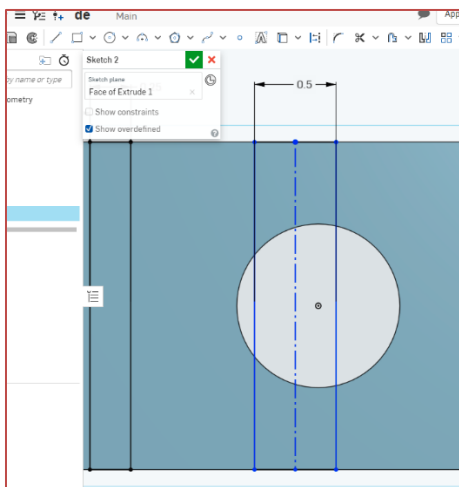
29: Before you draw the line, also click CONSTRUCTION tool



This is going to make it a “helper” line rather than part of our actual sketch

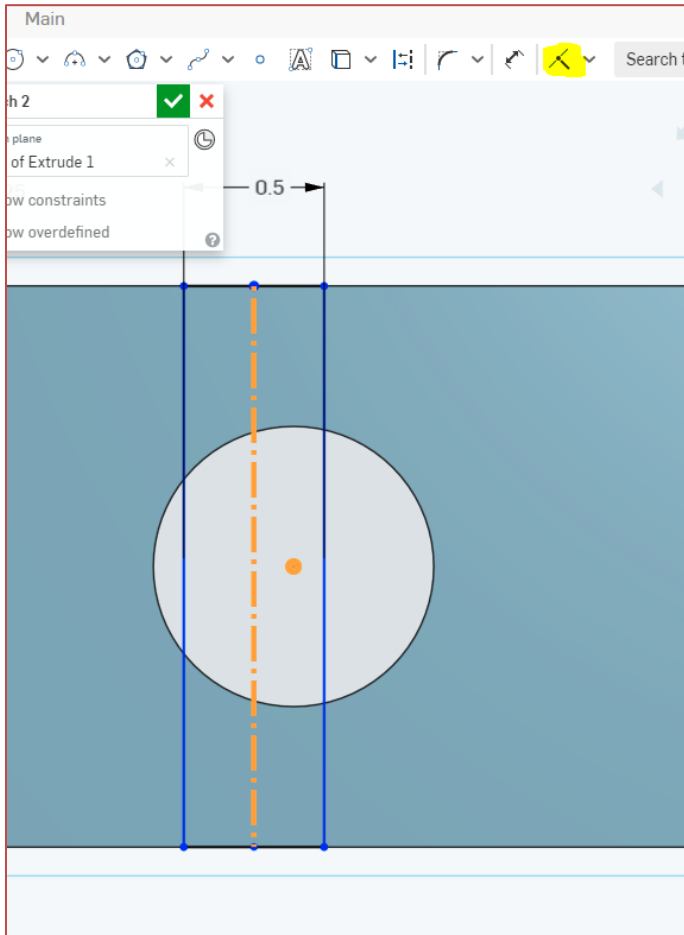
30: Left Click on the point we made and draw the line straight down, clicking on the bottom edge to finish it

Line should be dotted, if it's not you can select the line and click the CONSTRUCTION tool again

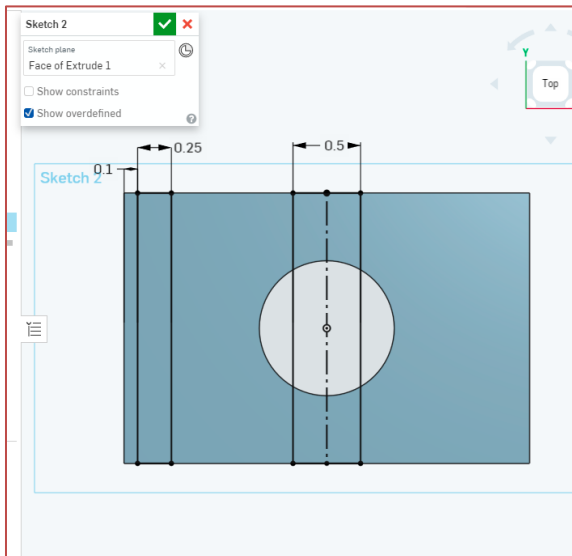


31: Now to align our rectangle, select (Left click) the line and then the origin

32: When both are highlighted orange, select COINCIDENT tool

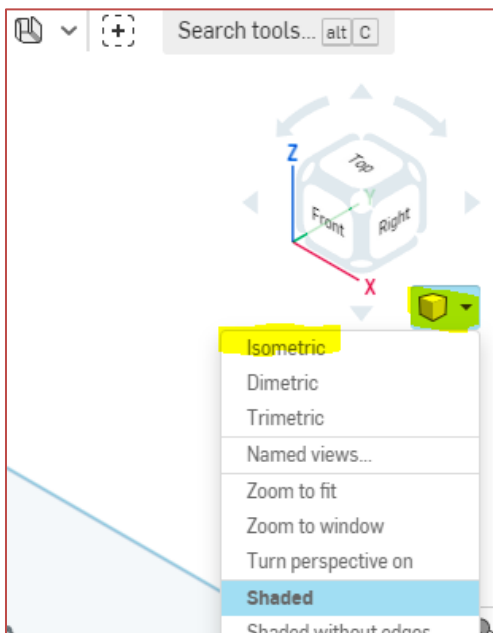


33: Final result should look like this (ALL lines are black, meaning all dimensions are defined)



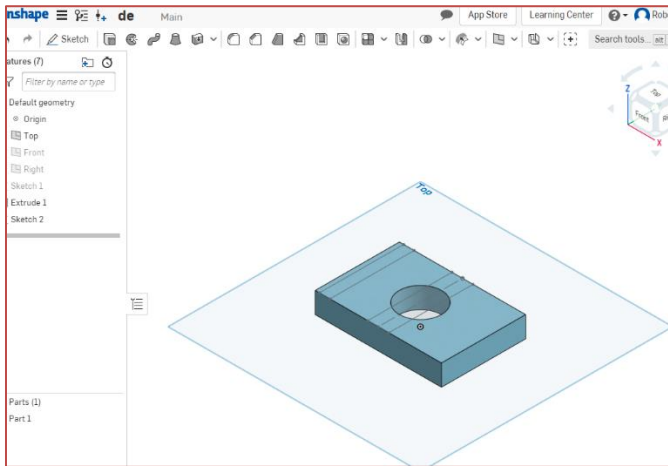
34: Accept the sketch (green check mark)

35: Select small cube under the view cube, click on ISOMETRIC

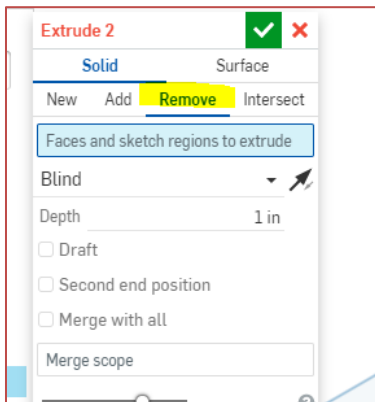


## Step 4: Making the Slots

36: Model should look like this

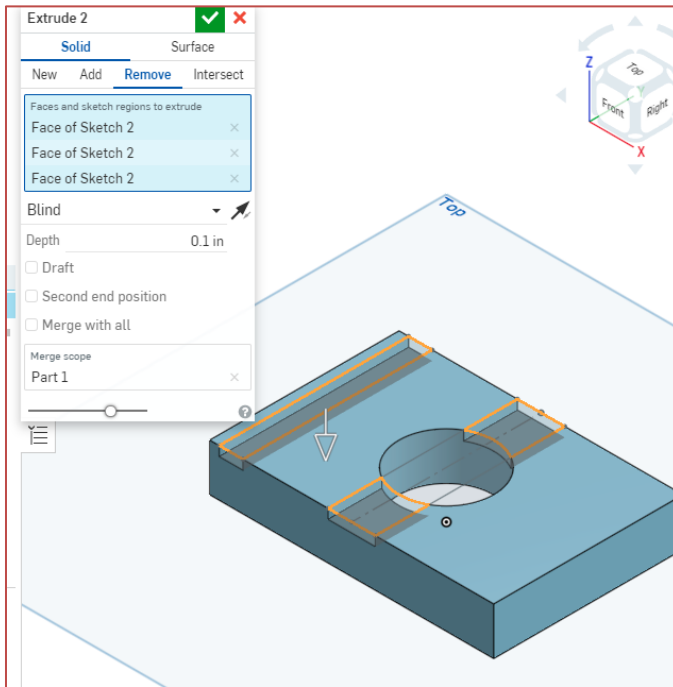


37: Select Extrude tool again, this time we want it to remove stuff so select REMOVE in the menu



38: Set DEPTH to 0.1

39: Now select the sketches we made (for the center slot you will need to make two selections on either side of the hole)



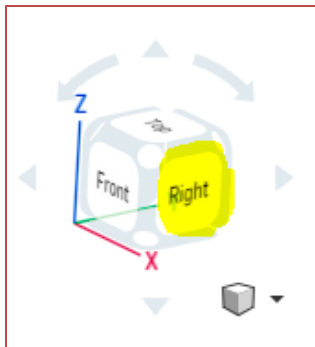
40: Hit Accept (green check mark)

### Step 5: Extruding a Handle

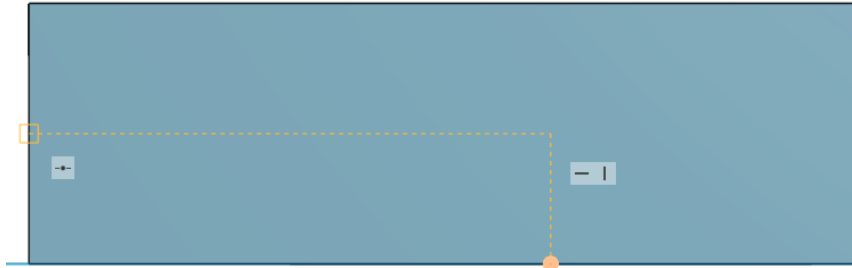
Lastly we're going to give this weird thing a handle

41: Click on RIGHT face of view cube

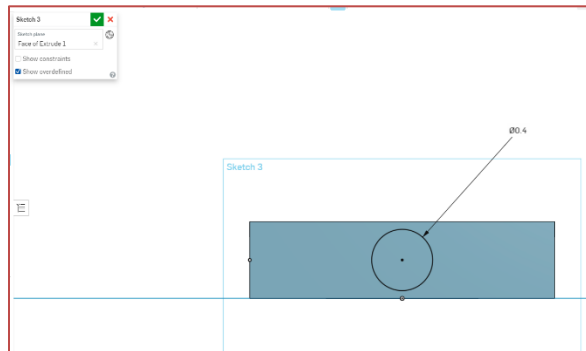
42: Create new sketch on side of block



43: Now use the CIRCLE tool and hover over midpoint of the shorter edge until orange dotted line appears, then continue hovering cursor towards middle until second orange dotted line appears

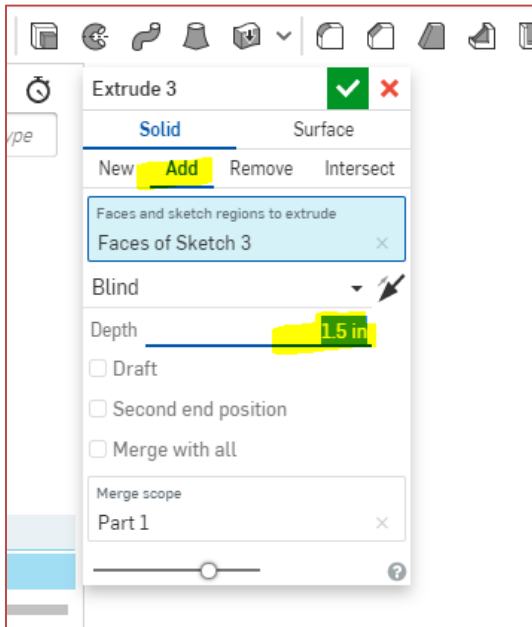


44: set diameter to 0.4 using DIMENSION tool



45: Accept Sketch, now we'll use the EXTRUDE tool to finish it.

46: Make sure you have “Add” selected, set depth to 1.5



DONE!

### Step 6: Day 2 Challenge

The Day 2 Challenge is to recreate a LEGO brick in OnShape. Campers can look for references and examples within the “Online” section of OnShape as well as on Google. Be prepared to help them if they can’t find a reference or get stuck.

To find existing LEGO brick designs: go to the list of options at the top left of the page, just under the “Create” button. Search for “Public” next to the globe icon, and select it. Just to the right of the OnShape logo in the top left corner you will see a search bar. Type “Lego Brick” into the search bar.



## LEGO Mindstorms Coding

Students are taught the basics of coding using LEGO Mindstorms software to develop block-based code to program a LEGO EV3 robot through an obstacle course. No purchase is required! The code is sent to an instructor who will upload and test the code over Zoom.

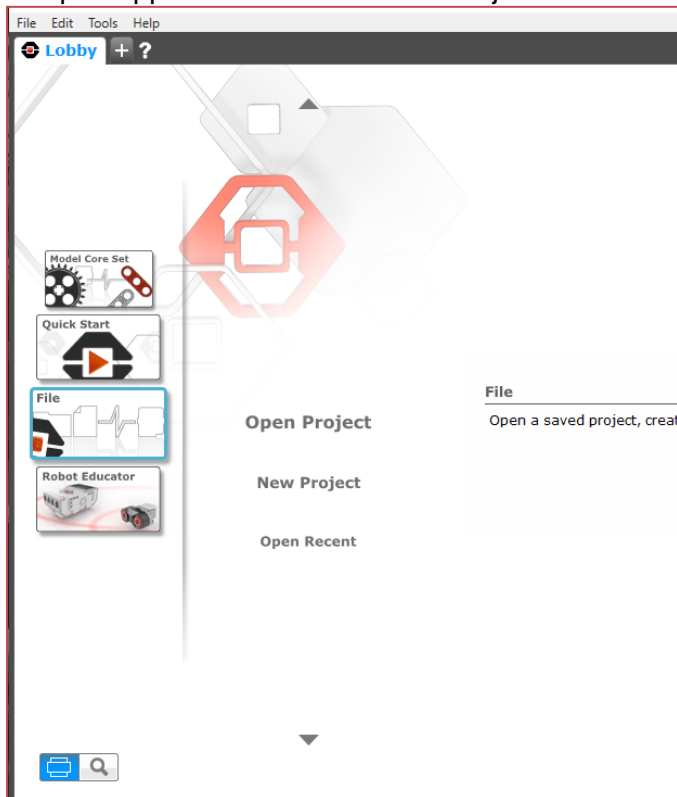
Note: All block instructions are under blocks. All installation and navigating instructions are above pictures.

Scroll Down for Mac version

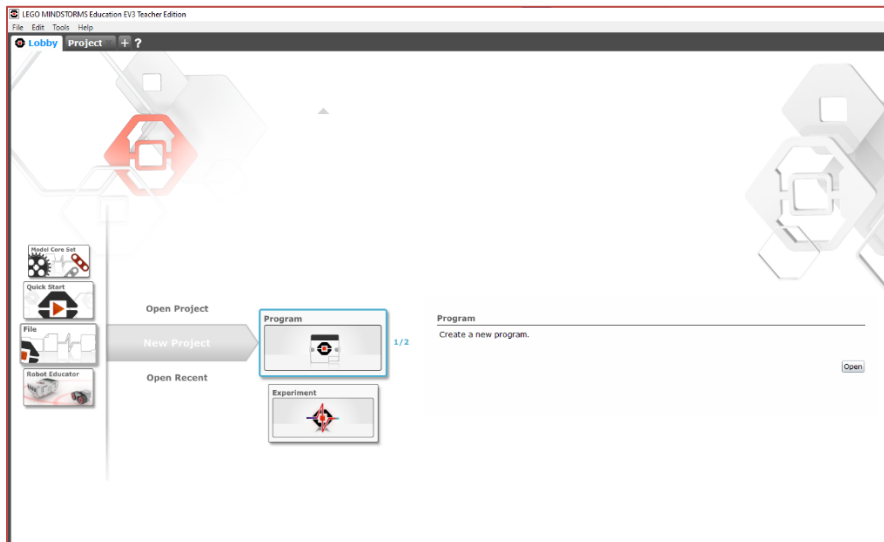
### For PC:

#### Zig Zag Program (PC)

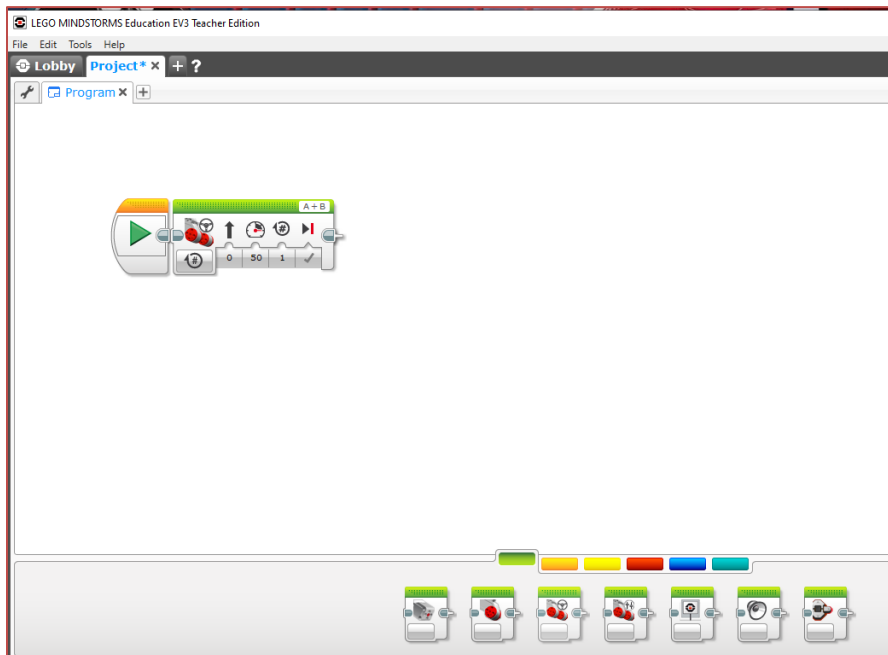
1: Open app and select File>New Project

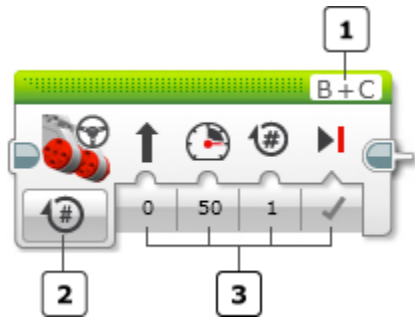


## 2: Select Program

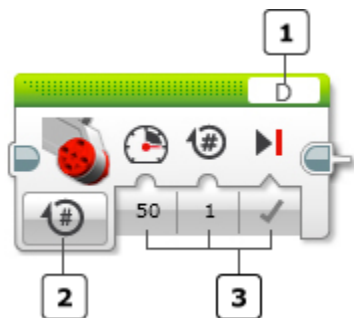


3: Go to the green tab (at the bottom) and drag out the move steering block.





- 4:
- Set the first button to rotations (2 in the picture)
  - Set the speed to 50 (the second button in 3)
  - Set the rotations to 1 (The third button in 3)
  - Set the ports to A+B (1 in the picture)



- 5:
- Then go to the green tab and drag out the large motor block
  - Then set (number 2 in the picture) to rotations
  - Set the first button (on 3 in the picture) to 50
  - Set the second button (on 3 in the picture) to .5 rotations
  - Set the port to B. (1 in the picture)



- 6: Then put in another of the first blocks.



- 7: Then put in another of the second block except instead of Port B put Port A.



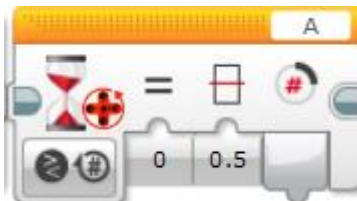
8: Put the move steering block on the line but set it to on. Put it to ports A and B.



9: Go to the orange tab and pull out a wait block.  
Set it to Motor Rotation>Compare>Rotations.  
Set the port to A.  
Set the second button to equal and then set the third button to 1.



10: Then go back to the green tab and pull out another large motor.  
Set it to On and then to 50 speed. Set it to port B.



11: Go back to the orange tab and pull out a wait block.  
Go to Motor Rotation>Compare>Rotations.  
Put the second button to equal then put the third button to 0.5. Set the port to A.



12: Go back to the green tab and pull out the tank steering block.  
Set it to rotations and set both speeds to 50. Set the fourth button to 1. Set the ports to A+B.

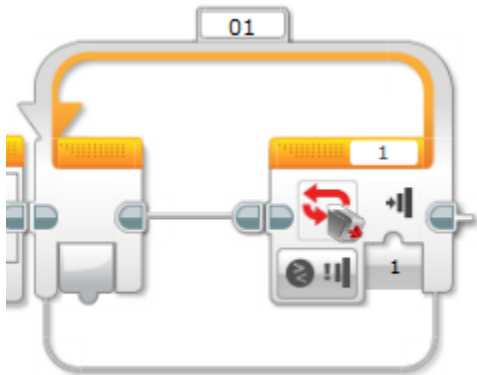


13: Pull out a tank steering block and set it to rotations.  
Set the second button to -50 and set the third button to 50. Set the fourth button to .5.  
Set the ports to A and B.

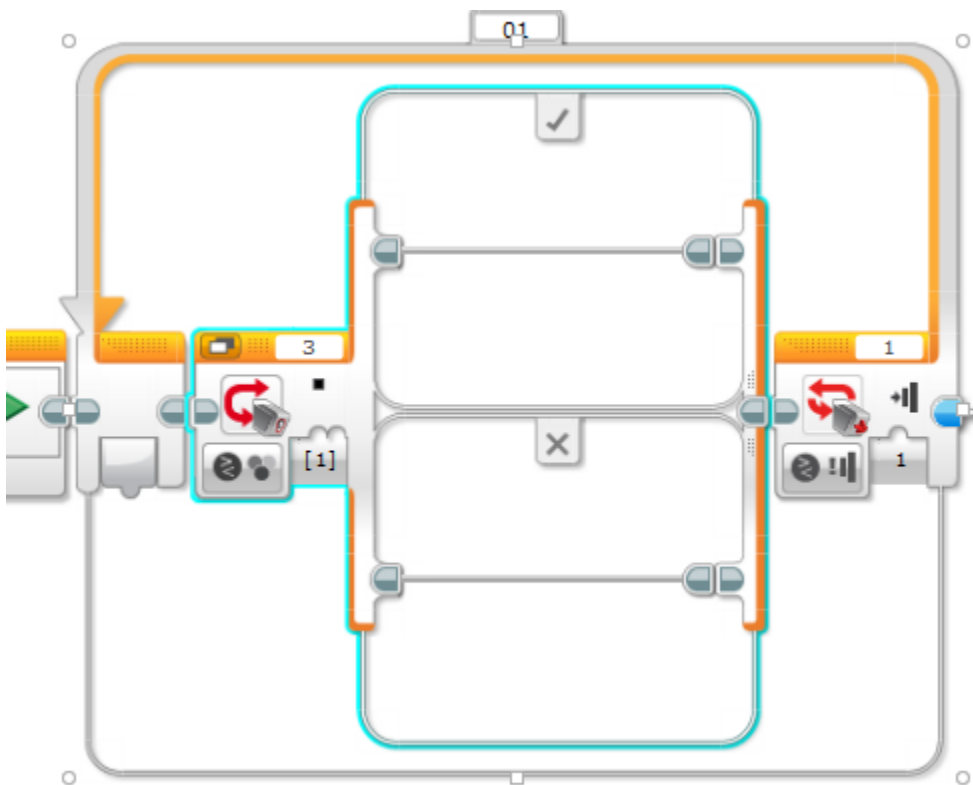
14: Finished Product



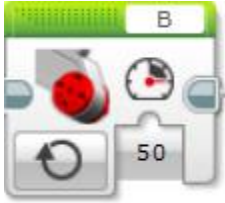
## Line following program (PC)



1: Got to the orange tab and drag out the Loop block  
Click the infinity button and click on Touch Sensor>State.  
Set it to number 1 and set it to port 1.



2: Then pull out the switch block. Put it inside the loop and set it to port 3. Set it to Color Sensor and then compare and then color. Set it to number 1 (black). Deselect all other colors selected.

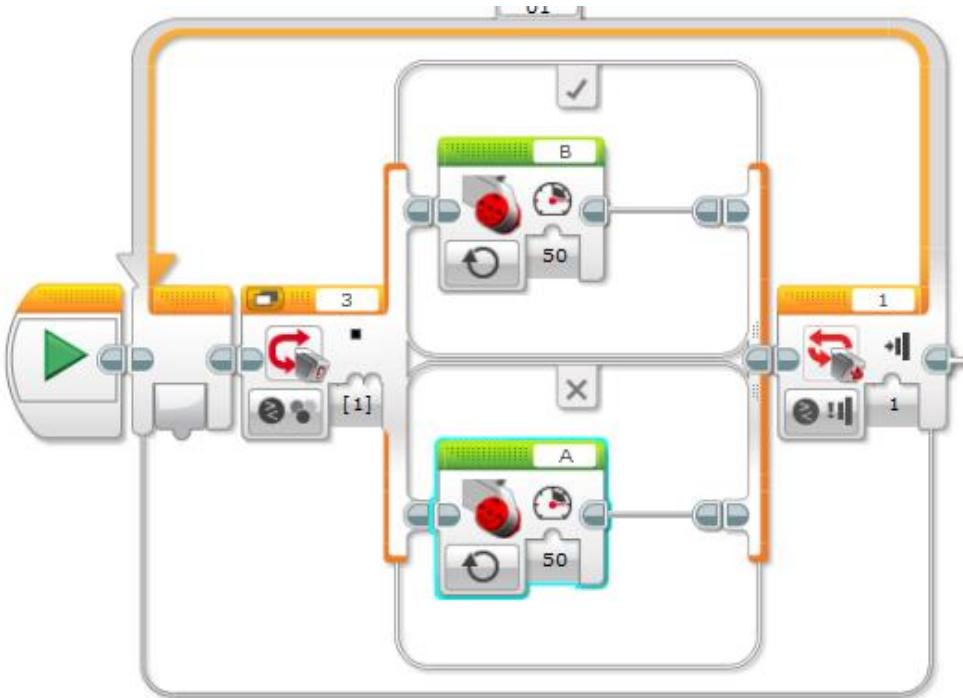


3: Pull out the large motor block in the green tab and drag it into the box with a check mark. Set it to on and set the speed to 50 and put the port to B.



4: Pull out another large motor block and set it to On and at 50 speed. Put it on port A and drag it into the box on the switch that has a x on it.

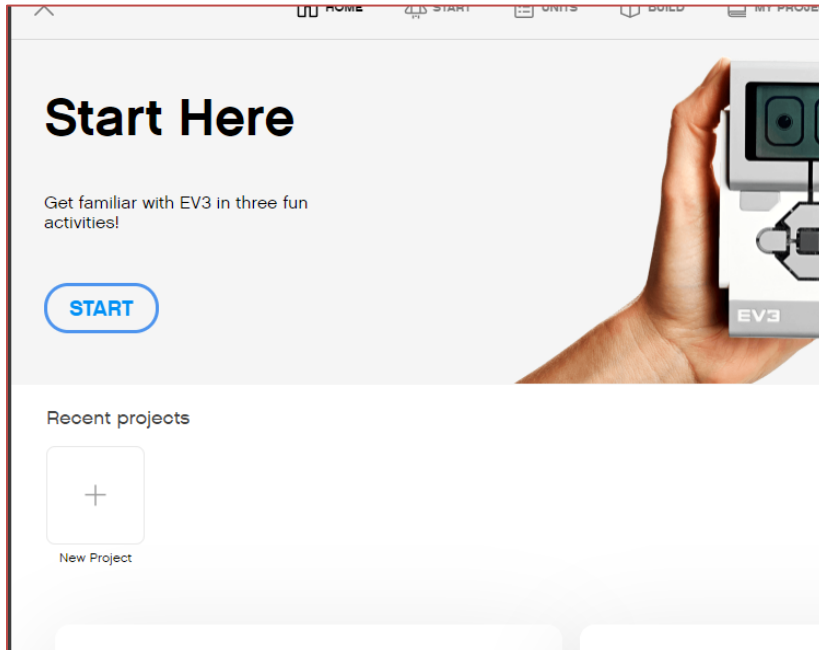
5: Finished Product:



For Mac

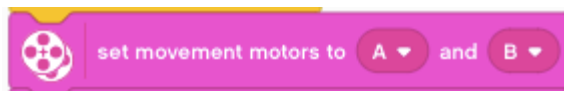
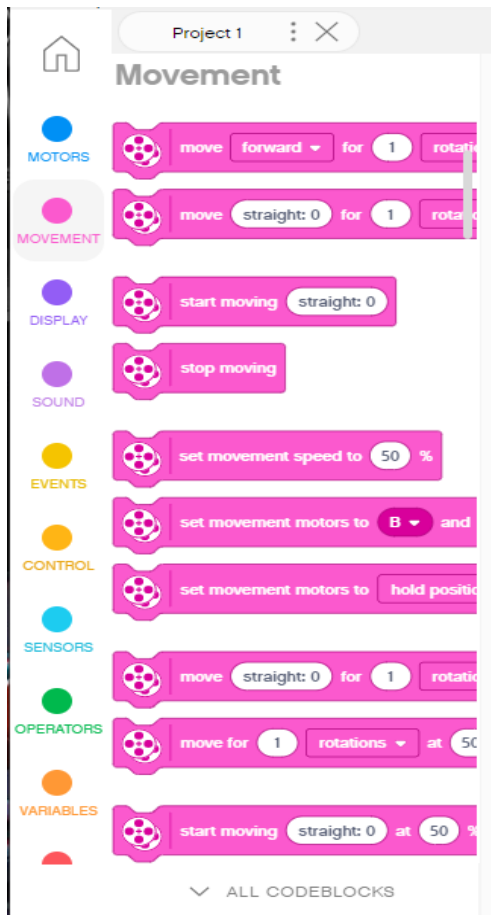
## Zig Zag Program (Mac)

1: Open up the app and click on new project





Movement tab:

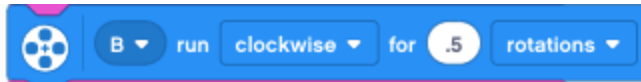
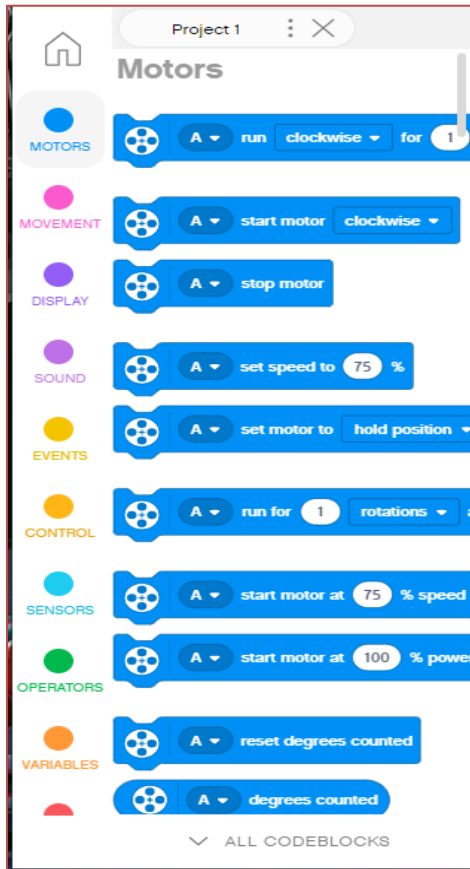


2: Go to the Movement tab (Pink) and drag the “set movement motors to () and ()” block. Unlike the Pc version, the Mac version you build vertically so place the block under the start block. Set the ports to A and B.

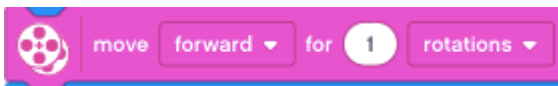


3: Drag the move () for () and put it under the other block. Set it to forward and rotations. Set the number to 1.

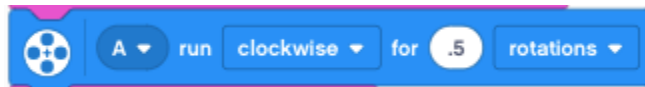
## Motors Tab:



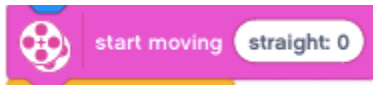
4: Next go to the blue tab (Motors). Drag out the () run () for () () block. Set the first button to B, set the second one to clockwise and set the third to .5. Set the fourth to rotations.



5: Then do exactly as you did for the second block.

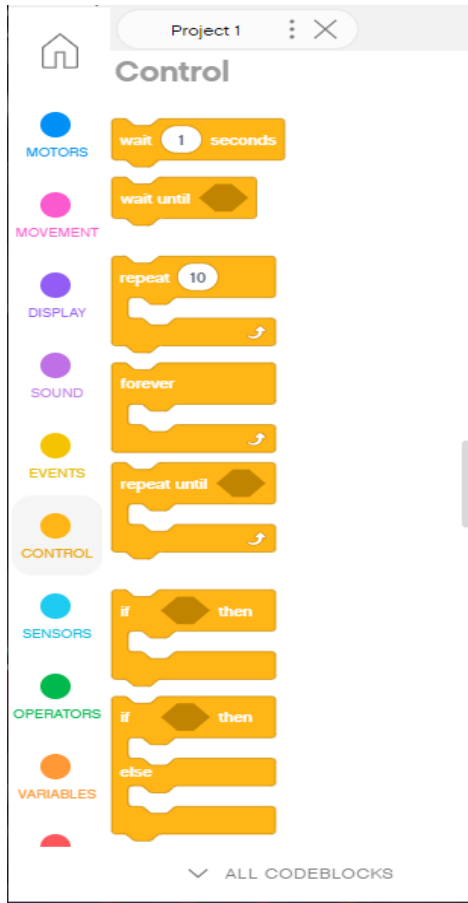


6: Then do exactly as you did for the third block except for it should be Port A instead of Port B.

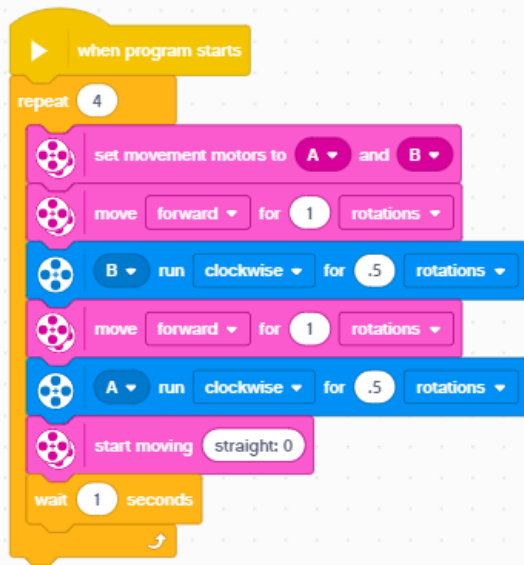


7: Go to the pink tab Movement and drag out the start moving block.

Control tab:



8: Go to the Yellow tab Control and drag out the Wait () seconds. Set the number to 1.



9: Go to the Control tab again and drag out the repeat block. Set the number to 4.



10: Go to the sound tab and drag out the play sound () until done. Scroll down to Communication/ Good job and select it.



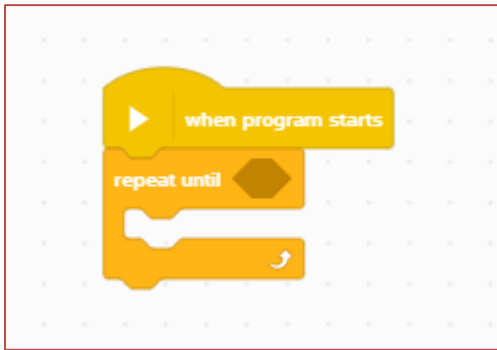
11: Go to the Control tab and pull out the stop () block. Set it to all stacks.

12: Finished Product:

```
when program starts
repeat 4
  set movement motors to A and B
  move forward for 1 rotations
  B run clockwise for .5 rotations
  move forward for 1 rotations
  A run clockwise for .5 rotations
  start moving straight: 0
wait 1 seconds
```

The image shows a Scratch script on a grid background. It begins with a yellow 'when program starts' block. This is followed by a 'repeat' loop block set to 4 iterations. Inside the loop, there are six blocks: a pink 'set movement motors to A and B' block, a pink 'move forward for 1 rotations' block, a blue 'B run clockwise for .5 rotations' block, a pink 'move forward for 1 rotations' block, a blue 'A run clockwise for .5 rotations' block, and a pink 'start moving straight: 0' block. The loop ends with a yellow 'wait 1 seconds' block.

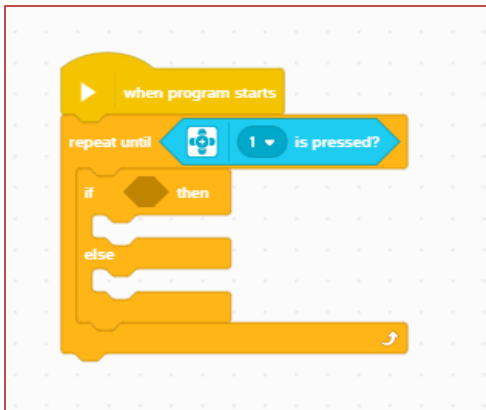
## Line Following Program (Mac)



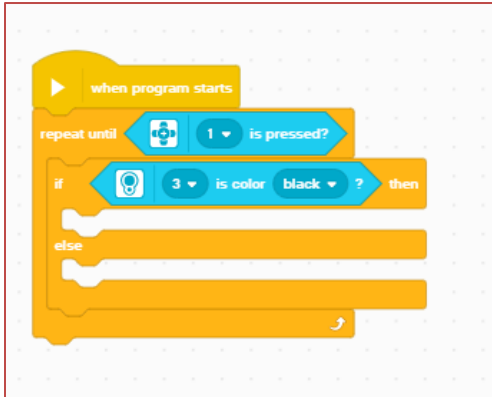
1: Go to the Control tab and drag out the repeat until block



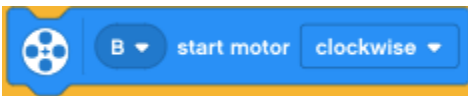
2: Go to the Sensors block and go to the Touch sensor section and drag out the “() is pressed” block and place it in the hexagon shape. Set it to 1.



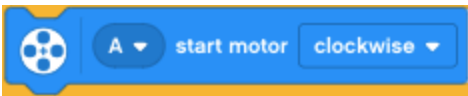
3: Go to the Control tab and drag out the If, then else block and put it inside the repeat until block.



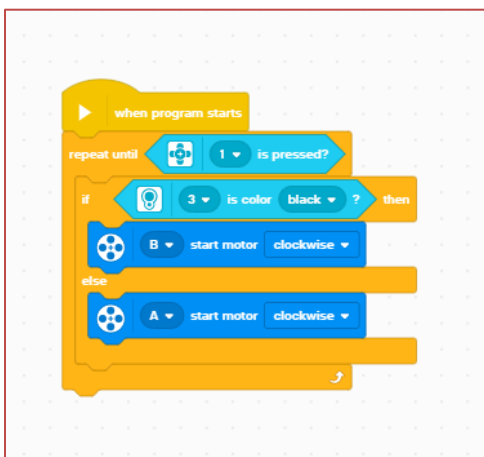
4: Go to the Sensors tab and pull out the color sensor block that is “() is color ()” and set the port to 3 and the color to black. Drag that block in between the *If/then* words.



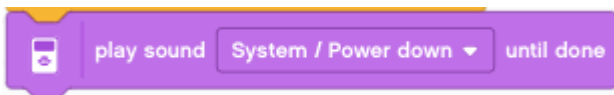
5: Go to the motors tab and drag the “() start motor ()” block out. Set the port to B and the other setting to clockwise. Drag that block in the first slot of the *If, then, else* block.



6: Do the same as above except put it for the A port and drag it into the second slot of the *if, then, else* block.



7: **needs a label**

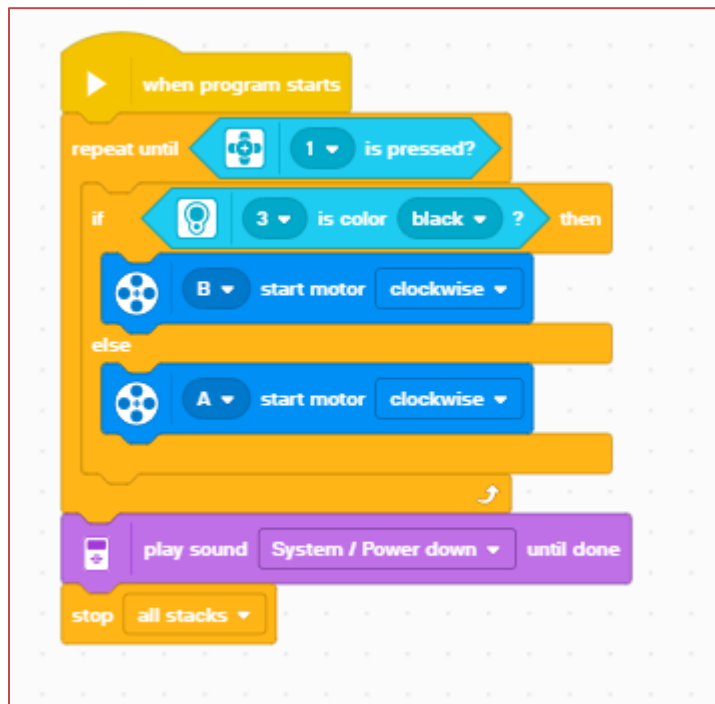


8: Go to the sound tab and drag out the play sound until done block. Scroll and select System/Power down.



9: Go to the Control tab and drag out the “stop ()” block. Set it to all stacks.

10: Finished Product:

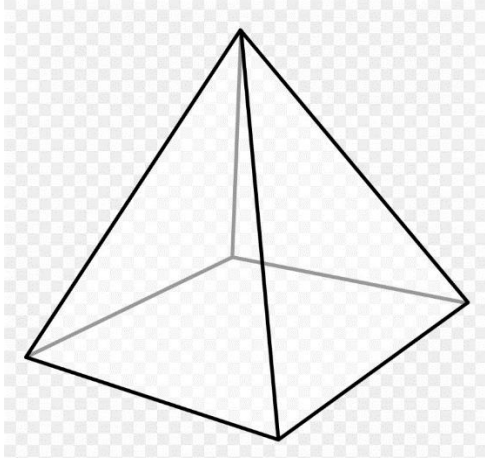




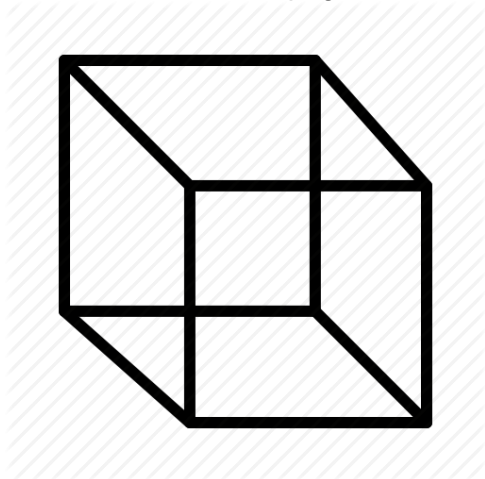
## Basics of Engineering

Students construct spaghetti and marshmallow structures to apply lessons about structural engineering. The students will learn about bracing and the structural importance of angles through this process, creating a solid (and yummy) foundation for practical mechanical design.

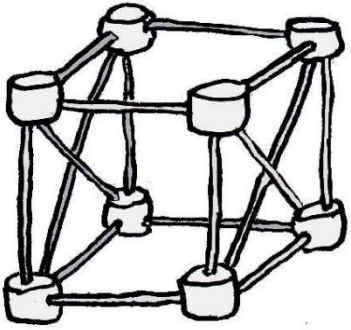
1: Make a pyramid with spaghetti and marshmallows.



2: Make a cube with spaghetti and marshmallows.



Tap the side of each and show the kids that the cube fails and the pyramid is a stronger shape so it won't collapse.



3: Now build a cube with cross braces and tap it. It should be stronger than the cube with no braces. Note: The image has two braces on each side, only one on each side is required.

Challenge: Whoever can build the tallest tower before the end of the Instruction period wins!

## **Group Activity**

In addition to a game, group activities could include finding one '*Cool Engineering Thing of the Day.*' This could be anything from a bridge to a car to a skyscraper to a robot to a rocket. Instructors will then lead a discussion.

Game ideas: Cahoots  
Jeopardy