

Volunteer Guide for the Learning Center

The Boys & Girls Club of Worcester
Created April 2018 by WPI Student Team
Includes STEAM Activity Plans

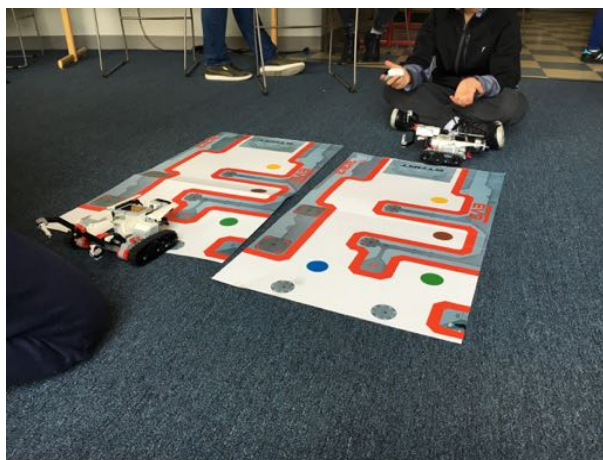
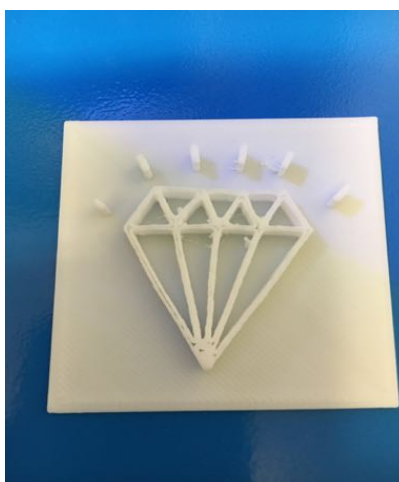


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Overview

The Boys & Girls Club of Worcester provides a safe after-school environment for children around Worcester to participate in various activities that interest them. The Club has several program areas including the Learning Center, gym, boxing room, dance room, game room, and teen room. The purpose of this guide is to assist volunteers in determining the various tasks they can do while in the Learning Center. It was developed in April 2018 by a group of WPI students working to integrate STEAM (Science, Technology, Engineering, Art, and Math) activities into the Boys and Girls Club. Power Hour runs from 2pm to 4pm, which is when members should be working on their homework. Members will often be reluctant to ask for help, so try to offer members help with their homework if they are struggling. After 4pm the Learning Center should become a dedicated space for STEAM activities. Provided is a daily guide for running the Learning Center, key concepts to consider when running activities, and several activity plans that can be used. Please ask Bolaji, the Education Coordinator, if you have any questions about the tasks.

Managing the Learning Center

During Power Hour (Monday-Thursday, 2pm-4pm):

- Power Hour is a time members can work on homework and get help with it if needed.
- Ask members if they have any homework and if they need help with it.
- If members do not have homework, ask if they would like to do a quiet activity (i.e. drawing) in the Learning Center. If members do not have homework, ask them to go to the gym, game room, or teen room until 4pm when Power Hour ends.
- Be sure to keep the room as quiet as possible, so that those doing homework have no trouble staying focused.
- Members should not be in the supply closet for any reason at this time.

After 4pm (Monday-Thursday):

- Power Hour ends at 4pm so often times members come into the Learning Center to sit and talk with one another after 4pm.
- Ask members if they would like to do an activity. i.e. playing a board game from the closet, drawing, practicing typing, using TinkerCAD, and using the Lego Mindstorms kits (there are directions for using TinkerCAD, the 3D printer, and the Lego Mindstorms kits if the members would like to do these activities)
- Members should not be playing games on the computers during this time unless Bolaji gives special permission.
- Members can enter the supply closet only to pick out board games, and only after asking a volunteer.

Fridays (No Power Hour):

- There is no Power Hour on Fridays since many of the members do not have weekend homework.
- Friday is a game day and many members come into the Learning Center to play games.
- A lot of members like to play computer games on Fridays and the computer area should be monitored to make sure they are playing appropriate games (i.e. no games with guns). If more members want to play games than there are computers available, facilitate them taking turns. They should switch about every 20 minutes so everyone gets a turn to play.
- Many members enjoy spending time watching Youtube videos. Similar rules apply, make sure that the content is appropriate for the Learning Center.
- Other members like to play board games or draw.
- Putting on a movie on Bolaji's Xbox is also a great Friday activity.

STEAM Program Overview

The Boys and Girls Club of Worcester wanted to focus its STEAM program around their Lego Mindstorms kits and 3D printer. The Club has six Lego Mindstorms kits located in the back closet of the Learning Center. The Lego Mindstorms computer program is downloaded on the computers in the Mac Lab; here you can find step by step directions for building and programming the robots. For the 3D printer activities, you will be using the free online program called TinkerCAD. The WPI student team has created some basic TinkerCAD tutorial videos that can be accessed on the BGCW Learning Center or Worcester Community Project Center YouTube pages.

This guide provides a few High Yield Learning Activities that aim to improve STEAM education for members. All volunteers should be capable of running one of these activities. There will always be challenges when introducing STEAM concepts to members for the first time, including self-esteem issues and the overall stigma against STEAM subjects. These activity plans are designed to avoid these challenges by following three important key concepts.

There are three key concepts that should be considered when STEAM topics are introduced to members. They include the Activity Before Content (ABC) approach, encouraging divergent thinking, and utilizing cooperative learning. ABC emphasizes the importance of running an activity before introducing the content; this will get the members more excited to learn. Divergent thinking is the concept of allowing members to look at a problem from multiple angles and think of novel solutions. Cooperative learning promotes education by placing students in groups to accomplish a task as a team. Be sure to keep these key concepts in mind when running activities; they should all be included in the following set of activities.

3D Printer Instructions

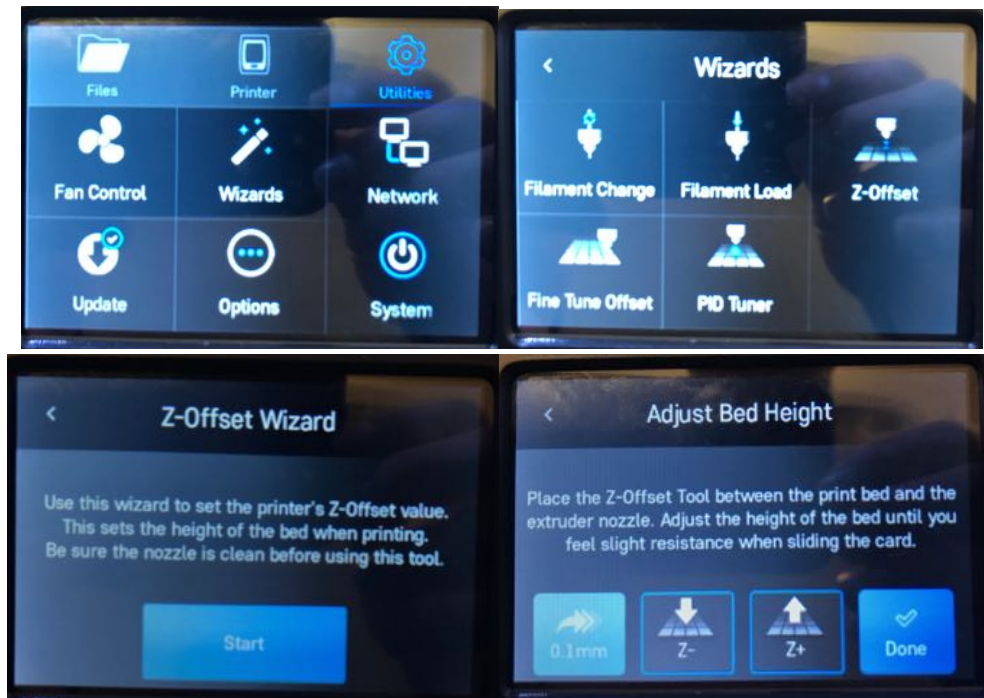
The 3D printer is located in the back closet of the Learning Center. It should only be operated by staff or volunteers. Members should not be near the printer when it is running; they could injure themselves or cause the print to be altered if the printer get moved. The following steps teach you how to set up the printer and load a file on it to be printed.

1. Turn On (allow the printer to set itself up for ~ 2 minutes)



2. Set Z-Offset

- a. Utilities => Wizards => Z-Offset => Start => -Z or +Z



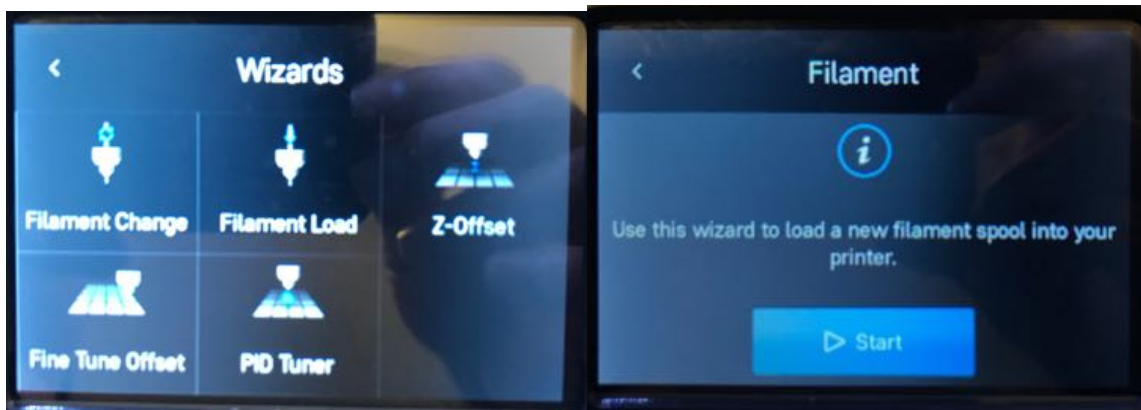
- b. Grab Z-offset paper or any regular piece of paper
- c. When moving along the Z axis, adjust so that the nozzle barely rubs against paper



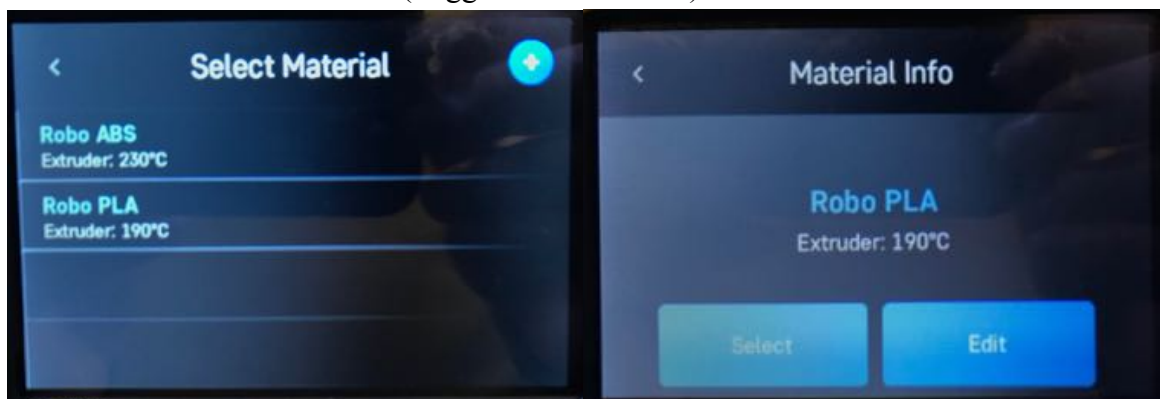
d. => Done

3. Load filament

- a. Load filament (if filament is already loaded)
- b. Utilities => Wizards => Filament Load => Start =>



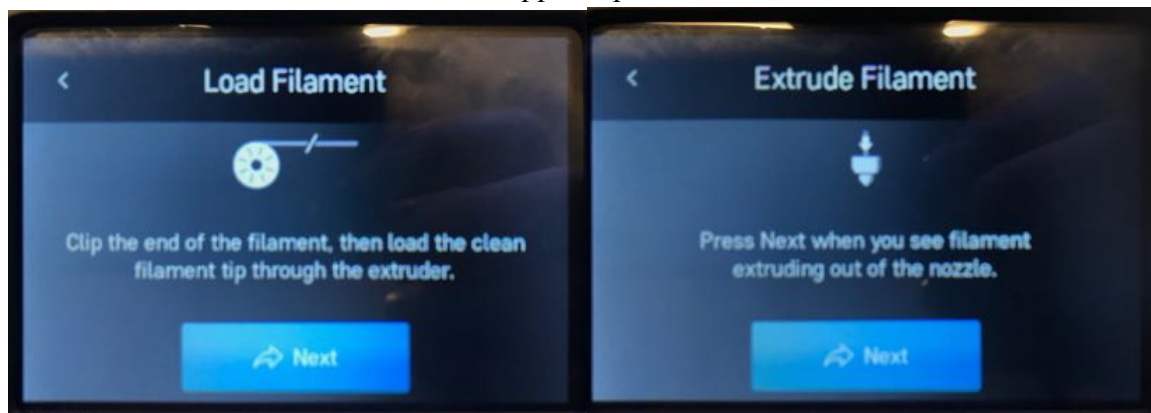
c. Select Material (Suggested Robo PLA) => Select



- d. Allow printer to heat up



- e. => Next => When filament appears press next



- f. => Ok



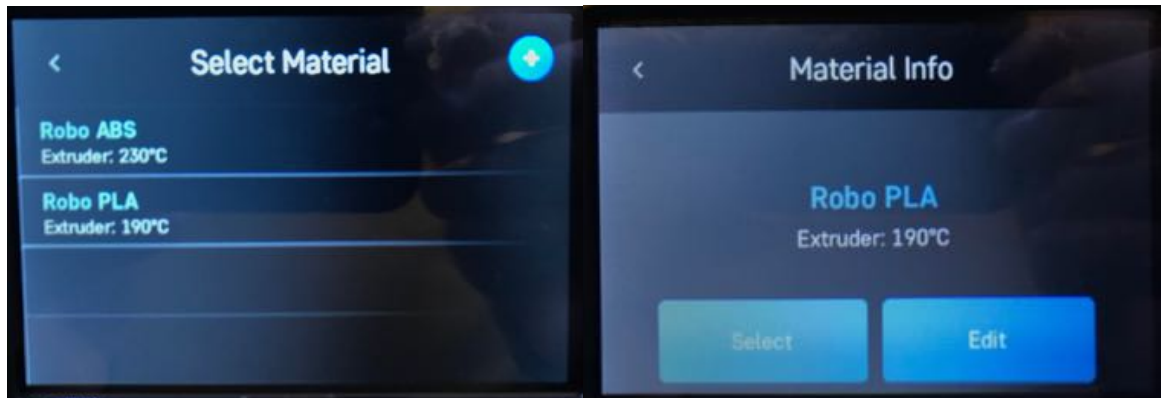
- g. Remove filament from nozzle

4. Change filament (if filament is not loaded or color needs to change)

a. Utilities => Wizards => Filament Change => Start =>



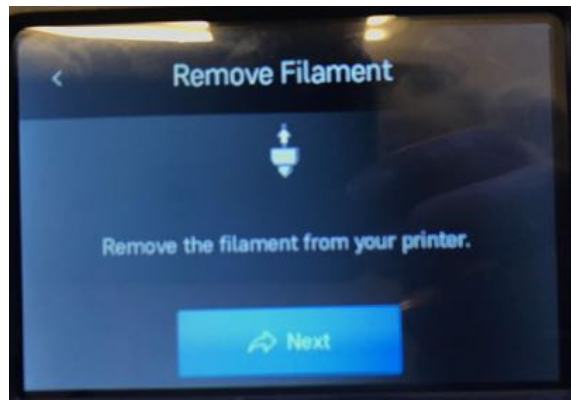
b. Select Material (Suggested Robo PLA) => Select



c. Allow printer to heat up

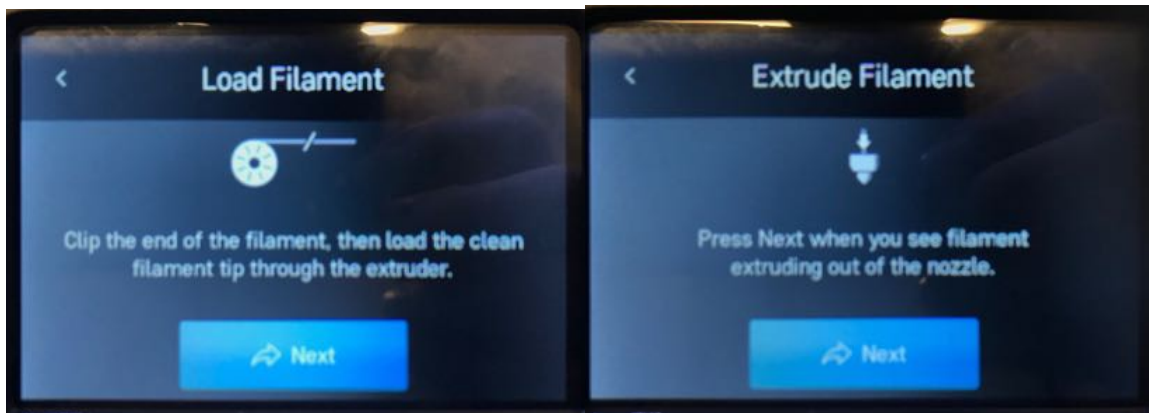


d. Remove filament => Next



e. Choose new filament => Cut off until tip of filament is clean =>

f. Load filament into extruder=> Next=>



g. When filament appears press next=> Ok



h. Remove filament from nozzle

5. Load file onto flash drive from computer as a .stl file

6. Load file onto 3D printer (plug in flash drive)

7. Convert file into a .gcode file

a. Files => USB Storage



i.

b. Select the file => Start



i.

c. Select Supports (Suggested Print Bed) => Small arrow top right



i.

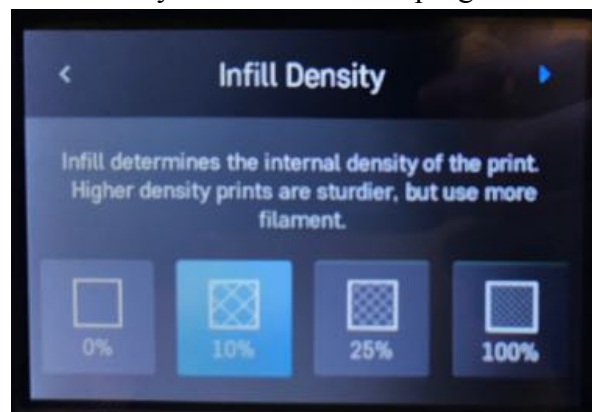
- d. Select Bed Adhesion => Small arrow top right



- i.
e. Select Print Quality => Small arrow top right

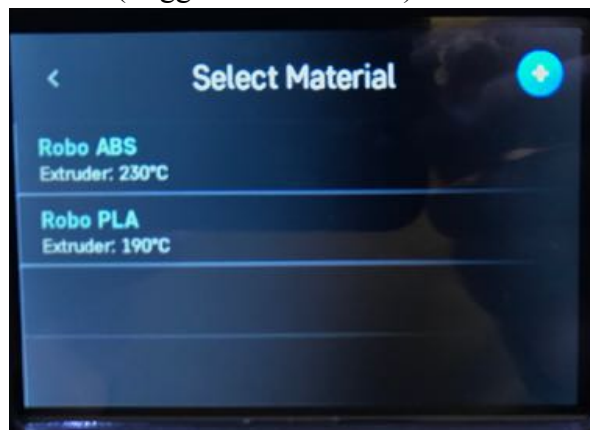


- i.
f. Select Infill Density => Small arrow top right



i.

- g. Select Material (Suggested Robo PLA) => Select

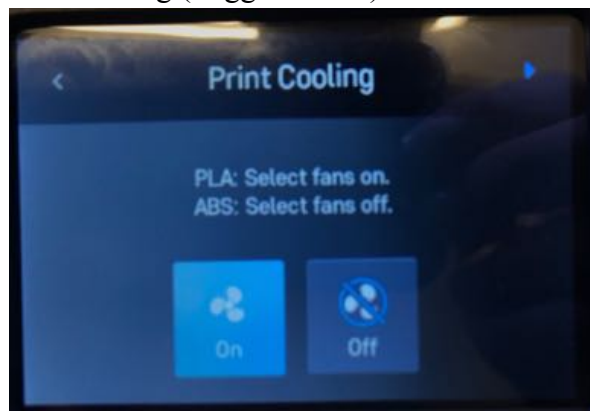


i.



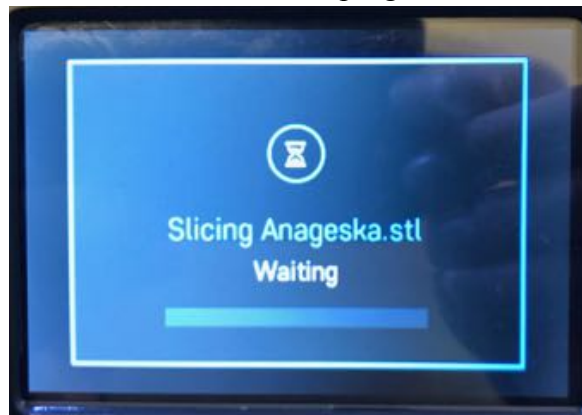
ii.

- h. Select Print Cooling (Suggested On) => Small arrow top right

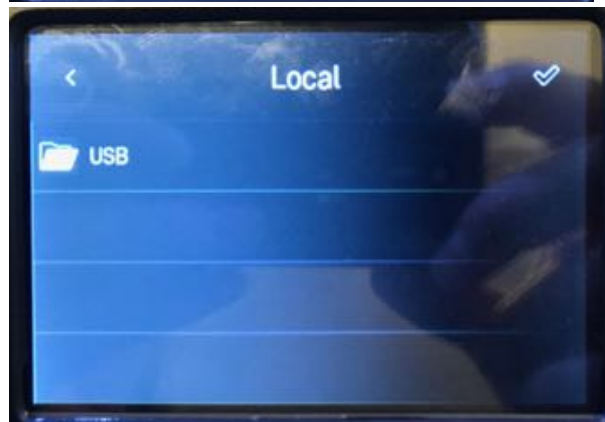


i.

- i. Allow to Load => Check mark top right

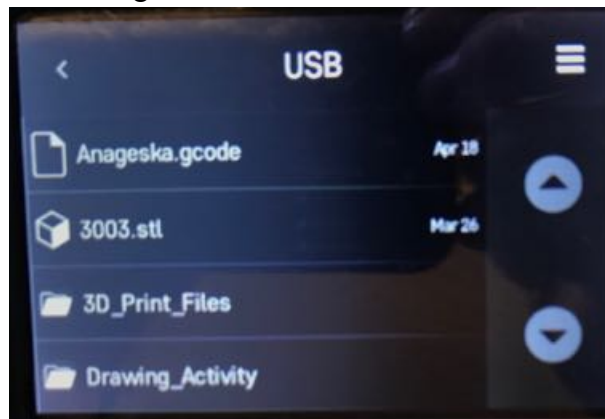


i.



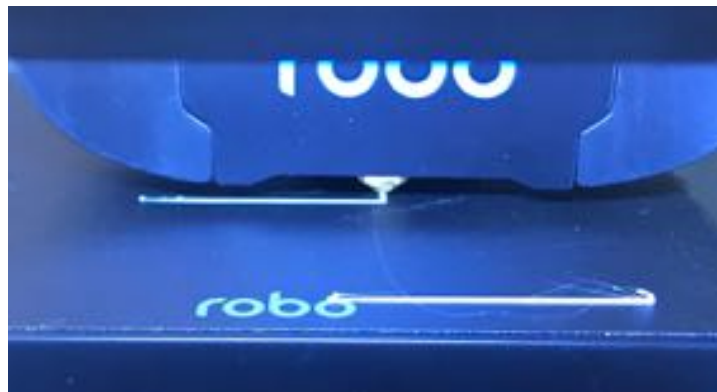
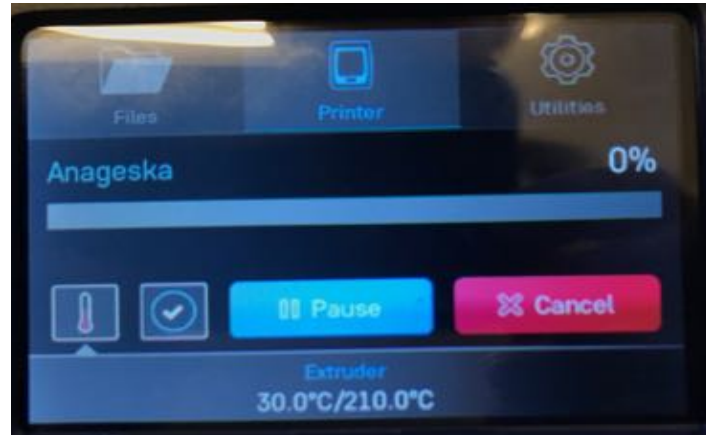
ii.

- j. Select "filename.gcode" file



i.

8. Run program (Check every now and then to make sure the program does not crash)



3D Printer Drawing Activity

Introduction

This activity is meant to spark the creative part of the participants' thinking. With almost almost full range on the topic of their drawings, participants are allowed to use their imagination to bring their 2D drawing into 3D space. In this activity, the instructor is conducting a majority of the work. If participants want to be challenged, the instructor may allow the participant to conduct the instructor portion of this activity.

Activity Objectives

- Have Fun
- Explore creativity/imagination
- (Advanced Portion) Challenge TinkerCAD ability
- (Advanced Portion) Challenge knowledge of computer operations

Materials

- Pencil and Dark Marker
- Paper (4 in x 5.5 in)
- TinkerCAD account
- Computer
- Image file converter
 - This link works well (<https://image.online-convert.com/convert-to-svg>)
- 3D Printer
- USB Drive

Instructions

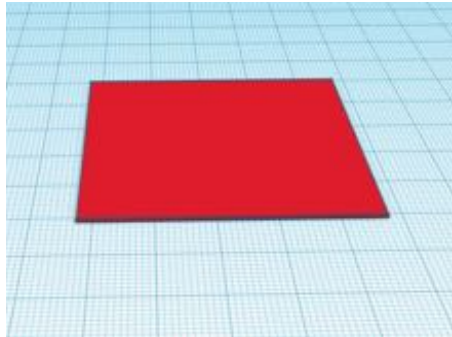
1. Decide on a criteria for all drawings to be based on (large, less detailed images work best) (anime character, logo, diamond, etc.)
2. Have all participants sit at a table with a piece of paper and pencil
3. Give participants 30 minutes to draw a picture that relates to the criteria
 - a. On the back of the drawings have students write their names
 - b. Most participants will not use the entire time allotted so have another quiet activity planned

Instructor's Job

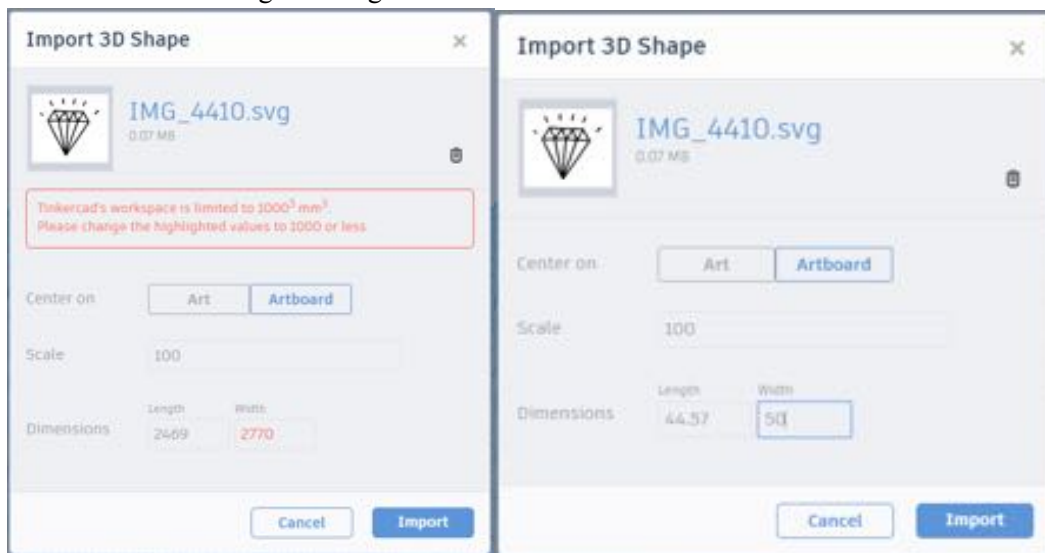
1. Outline the drawing in dark marker
2. Capture a picture of drawing
 - a. Upload the image onto a computer



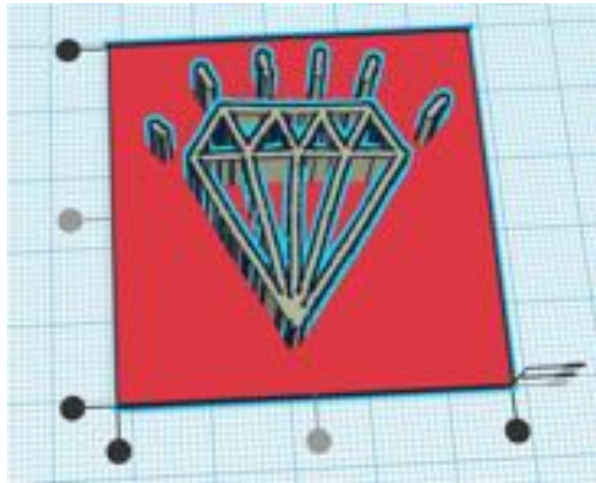
3. Convert the image to a .svg file using the link in the materials section
4. Open TinkerCAD
5. Create a box shape with dimensions 50 x 50 x .5



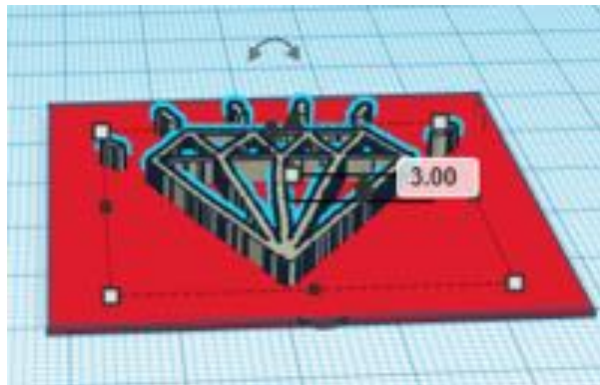
6. Import the file to TinkerCAD
 - a. Transfer image to correct dimensions
 - i. Change the larger dimension to 50



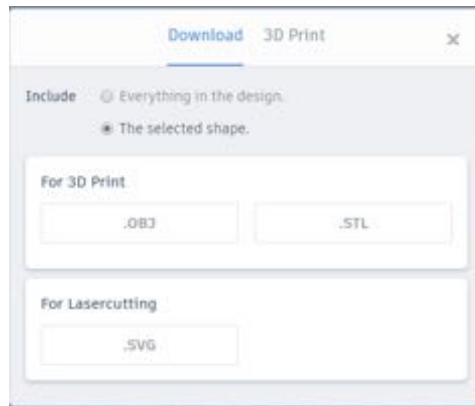
7. Align the two parts at the center on the length and width parameter



8. Change the height of the image part to about 3
- a. Depending on the amount of participants, printing drawings may take a long time so making the print smaller will save time and get drawings printed faster



9. Export the file and download as .stl file on a USB drive



10. Transfer to 3D Printer
- a. Refer to the 3D Instruction Guide to complete activity

TinkerCAD Cup Activity

Introduction

This activity is used to challenge participants' abilities in regards to TinkerCAD. The activity is not meant for someone has never used TinkerCAD before. TinkerCAD is a simple online CAD software meant for people of all ages. The software is user friendly and has tutorials within the software itself.

Activity Objectives

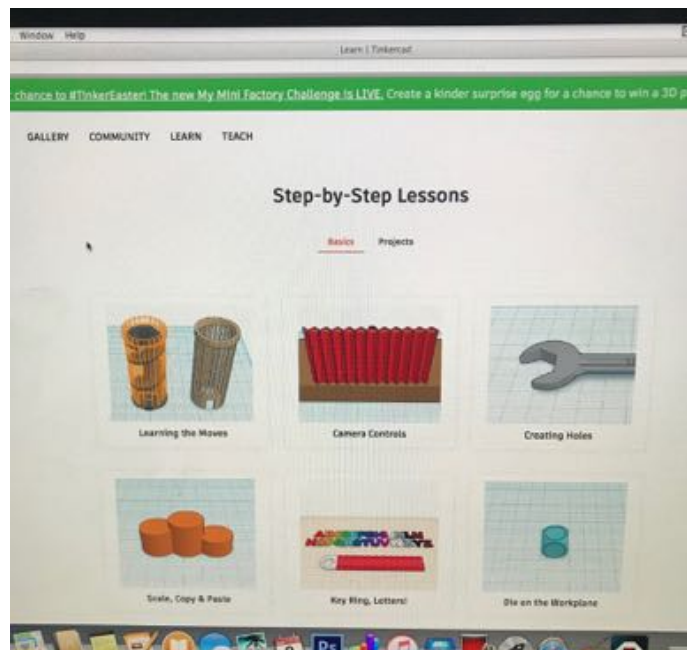
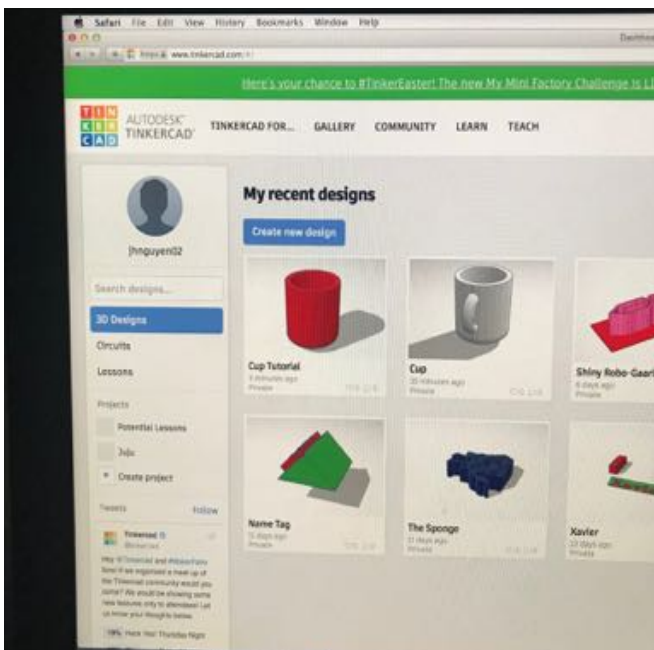
- Challenge user's TinkerCAD Ability
- Create a fun and intricate part that is 3D printable

Materials

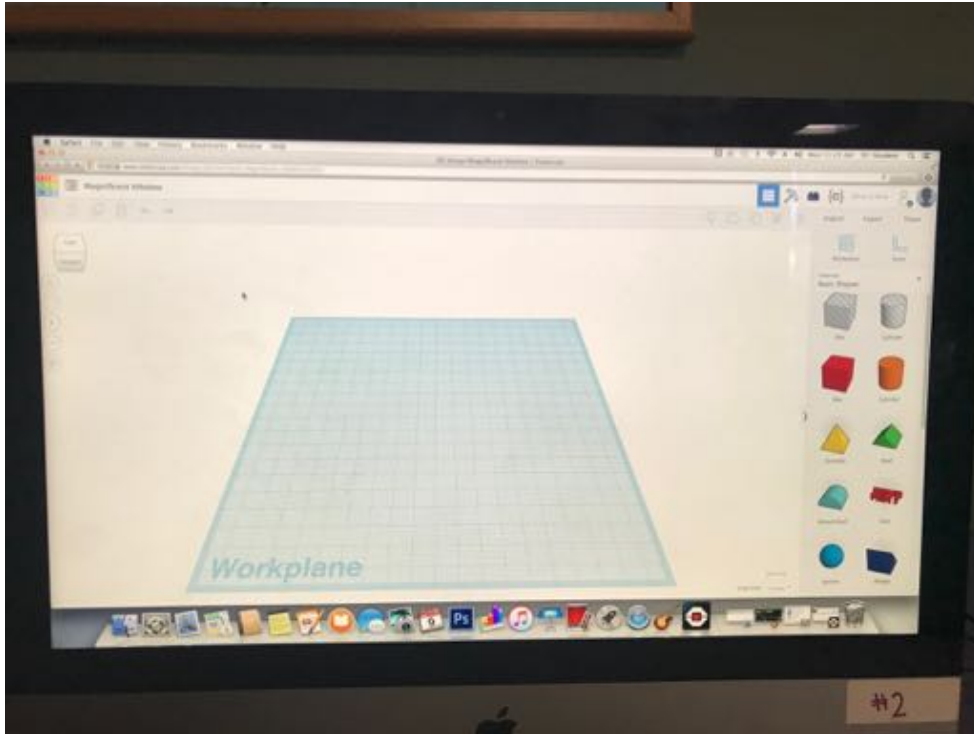
- Computer with Keyboard and Mouse
- TinkerCAD Account

Instructions

1. Open TinkerCAD (Log in or Create an account)
2. Go through tutorial if you have not already
 - a. On the home page click on the learn tab on the top of the screen
 - b. Be sure go through the "Learning the Moves", "Camera Controls", "Creating Hole", and "Scale, Copy & Paste" sections



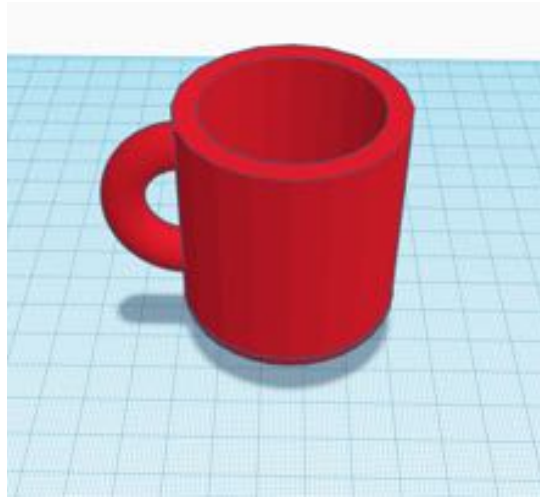
3. Create a New Design (Screen should look similar to the image below)



Activity

1. Rename your design
 - a. Click on the “My Designs” button on the top left hand side of the screen
 - b. Click on the gear
 - c. Enter in the name of your design and save changes
2. Create a half sphere shape
 - a. Rotate the shape so that the flat side is facing upwards
 - b. Resize the shape to make it larger (50x50x10)
3. Move the work plane to the flat surface of the half sphere
4. Create a cylinder shape
 - a. Adjust the size so it is the same length and width as the half sphere
 - i. The height is up to the creators discretion (50x50x50)
5. Align the shapes at the midpoints
 - a. Select both shapes and click on the align button on the top right hand side of the screen
 - b. Click on the midpoint of the length and width side of the shapes
6. Group the shapes so it is one whole shape
7. Create a cylinder shape on the same work plane
 - a. Make the length and width dimensions slightly smaller the previous cylinder but the height the same (40x40x50)
 - b. Make the second cylinder a hole (not solid)
8. Align the shapes at the midpoints
9. Group the shapes (the center of the first cylinder should be hollowed out)
10. Change the work plane back to the original

11. Create a donut slice shape
 - a. Rotate the shape so it is upright
 - b. Make the dimensions about (10x20x40)
12. Align the two shapes so that the donut slice is at the midpoint of the cylinder
13. Move the donut shape into the cylinder so the flat surfaces of the donut shape are just inside the cylinder surface but do not extrude into the inner surface
14. Group the shapes
15. The final shape should look similar to the image below



TinkerCAD Castle Activity

Introduction

This activity is used to challenge participants' abilities in regards to TinkerCAD. The activity is not meant for someone has never used TinkerCAD before. TinkerCAD is a simple online CAD software meant for people of all ages. The software is user friendly and has tutorials within the software itself.

Activity Objectives

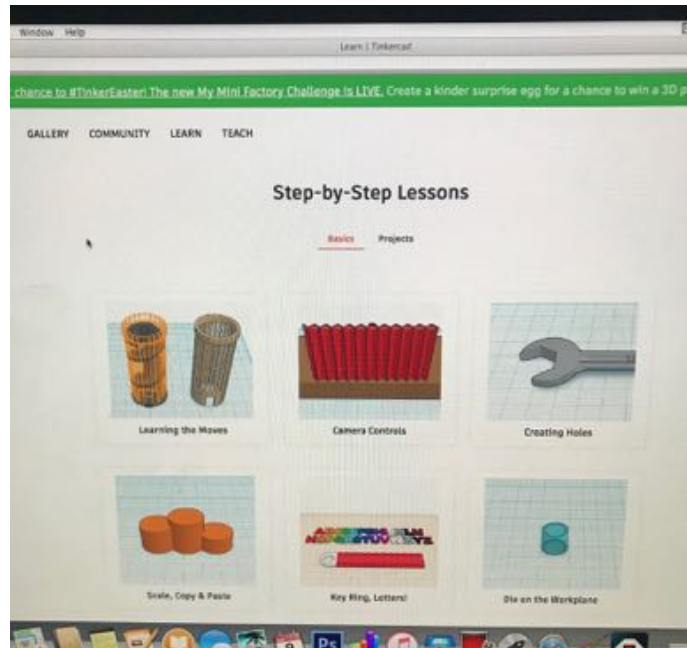
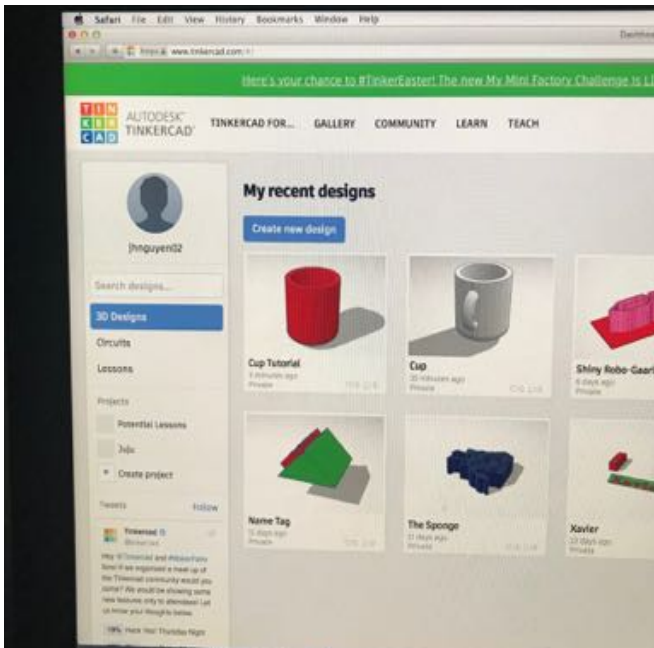
- Challenge user's TinkerCAD Ability
- Create a fun and intricate part that is 3D printable

Materials

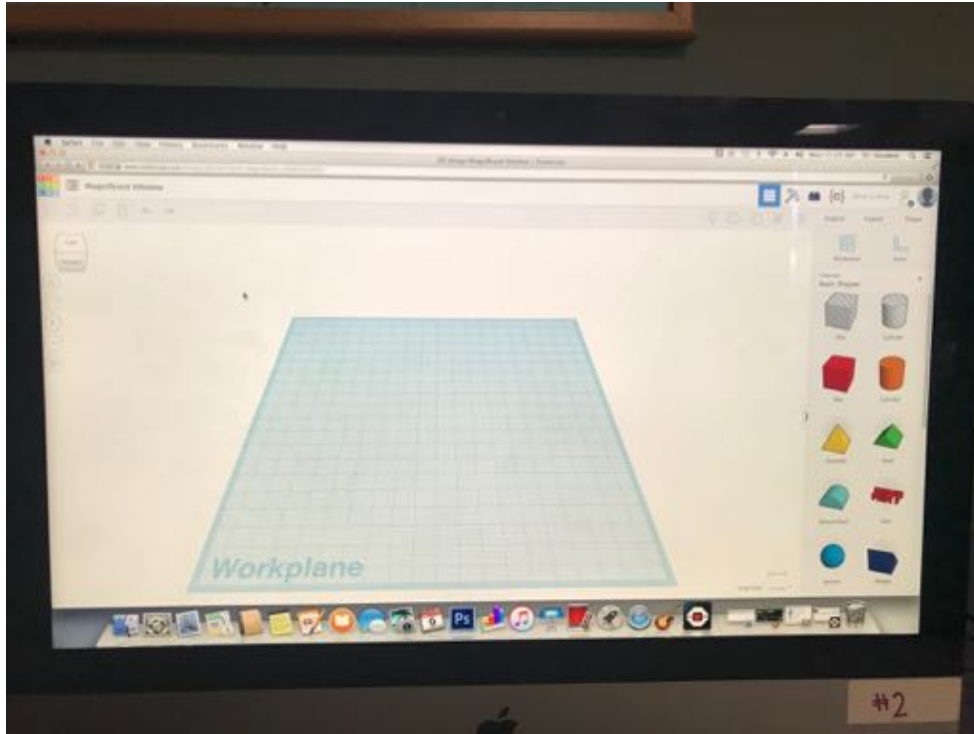
- Computer with Keyboard and Mouse
- TinkerCAD Account

Instructions

1. Open TinkerCAD (Log in or Create an account)
2. Go through tutorial if you have not already
 - a. On the home page click on the learn tab on the top of the screen
 - b. Be sure go through the "Learning the Moves", "Camera Controls", "Creating Hole", and "Scale, Copy & Paste" sections



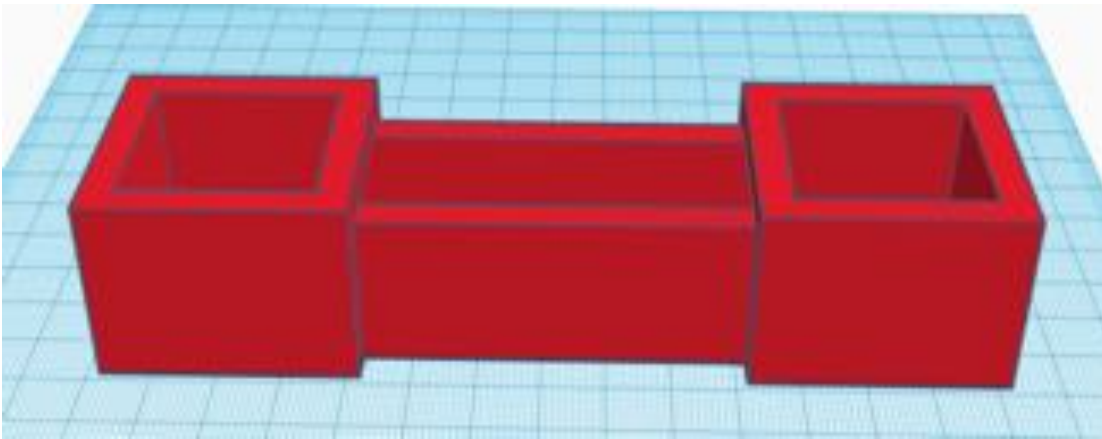
3. Create a New Design (Screen should look similar to the image below)



Activity

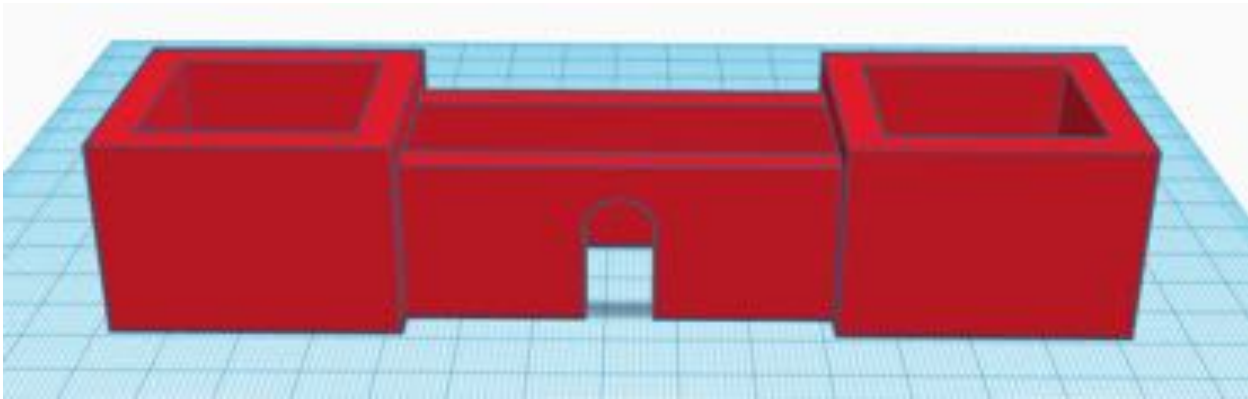
1. Rename your design
 - a. Click on the “My Designs” button on the top left hand side of the screen
 - b. Click on the gear
 - c. Enter in the name of your design and save changes
2. Create a box shape
 - a. Place it on the left hand (or right hand) side of the work plane
 - b. Make dimensions about (40x40)
3. Create a box shape
 - a. Place it in the middle of the the previous box
 - b. Make the box a hole (30x30)
 - c. Align the boxes so they are centered at the same point
 - d. Group the boxes
4. Duplicate the shape
 - a. Copy and paste the grouped boxes from step 3
 - b. Move the second figure to the opposite side of the work plane
 - i. Align the figures so the front is on one line
 - c. The figures should be about 60 units apart
 - d. Group the figures

5. Create a box shape
 - a. Make the dimensions large enough that it connects the two figures in the previous step (61x30x25)
 - b. Align the box so it is at the center of the previous figures
 - c. Group the figures
6. Create a box shape
 - a. Make the box shape a hole
 - b. Make the dimensions larger in length but smaller in width than the previous box in step 5 (70x20x25)
 - c. Align the box so it is at the center of the previous figures
 - d. Group the figures
 - e. The figure should look similar to the image below

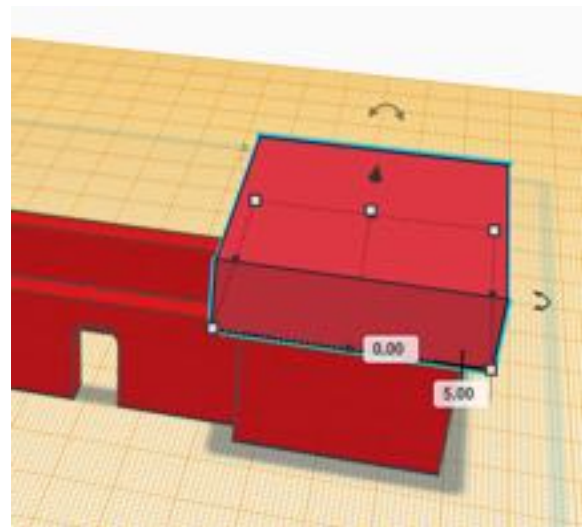


7. Raise the height of the figure to a desired height (30)
8. Create a box shape
 - a. Place it in front of the figure
 - b. Make dimensions about door sized (10x20x15)
9. Change work plane to the top of the box shape in step 8
10. Create a round roof shape
 - a. Make dimensions (10x20x5)
 - b. Align the base of the round roof and top surface of the box in step 8
 - c. Group with box shape in step 8
 - d. Make the figure a hole

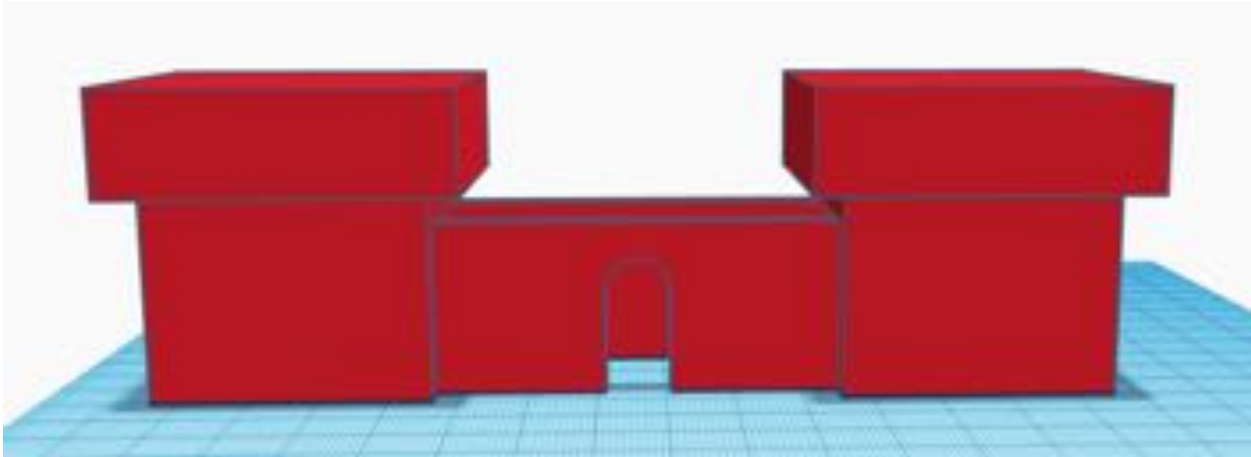
11. Align the two figure so it is center horizontally and at the front
- a. Group the figures
 - b. May look similar to the image below



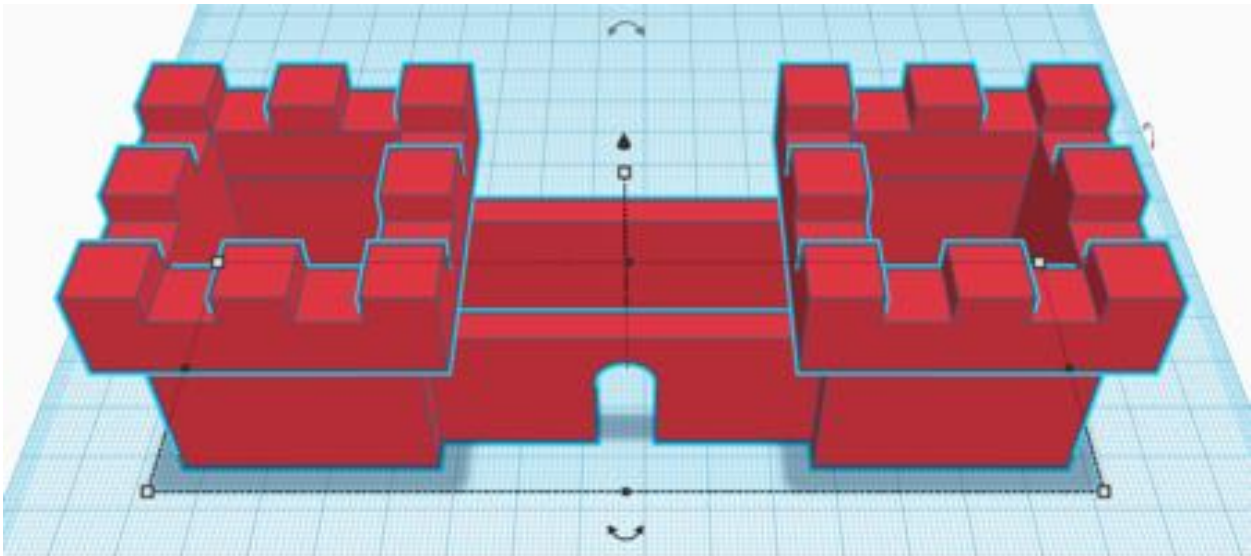
12. Change the workplane to be at the highest point on the figure (left or right side pillars)
13. Create a box shape
- a. Make the dimensions 50x50x15
 - b. Align the middle (width side) of the two shapes and right (or left) most side of both shapes
 - c. Move the box shape so that the box has an offset of 5 from the outer edge of the base figure (like the image on the right)
 - d. Copy and paste the box shape
 - e. Select the original box shape and the base figure and group them



14. Move the pasted box shape to the opposite side of the figure and complete the same actions as in step 13 part b, c and e. (Should look similar to the image below)



15. More advanced steps can include adding ridges to the tops of the pillars, adding a roof to the connecting box, adding windows to the towers, and adding more towers (making the castle have four pillars)
- a. May look similar to the image below



Lego Mindstorms Race

Introduction

This activity focuses on captivating participants through competition. As they make their way through the track, they must work together to beat the opposing team. In addition, they must also solve any issue/obstacles that may come up during the race.

Activity Objectives

- Encourage collaboration between participants
- Encourage communication
- Teach divergent thinking
- Teach persistence
- Assist in problem solving

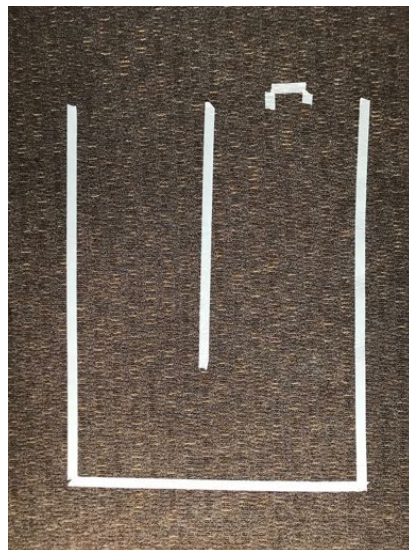
Materials

- Masking tape
- Lego Mindstorms Robot (preferably already built)(tracker)
- IR Controller (Disclaimer: Only works with two robots at one time)
- Space on the ground

Instructions

Making a track

1. Use painters tape to mark a basic tracks on the floor.
2. The track should be a U-shape roughly 3-4 ft long and about 2 ft wide
3. Mark a line as a start point
4. Mark off a small area at the end to place an object that must be moved by the robot's secondary function



5. Repeat steps 1-4 for as many tracks as necessary

Racing

1. Line the robots up at the starting line
2. Make sure the members understand that the race only starts on your word
3. After starting, the robots cannot cross the tape line.
 - a. If a robot crosses a line badly, grab the robot and set it back straight but further back
4. After traveling the U-shaped track, they must move an object with the secondary function, usually a spinner or a claw.
 - a. Set up a tire from the Lego set and have them move it with the spinner or the grab it with the claw
5. Once they have moved the object, they must return to the start line, again avoiding the lines

Controllers

1. Bluetooth
2. IR Controller
 - a. Should be able to control robot with no setup as long as you are on the right channel
 - b. To set channel, press the right arrow button on the robot, to get to the third tab
 - c. Find IR Control, and press the center button to click on it
 - d. Pick Channel 1-2 or 3-4
 - e. On the controller, there is a slider near the bottom center of the controls
 - f. This slider has 4 positions, one position for each channel.
 - g. Click it into 1 if you chose channel 1-2 earlier or 3 if you chose 3-4, and press the buttons to move the robot.

Lego Mindstorms Programming

Introduction

Throughout this activity participants will explore the capabilities of the programming side of the Lego Mindstorms. Lego Mindstorms are robots that can be assembled and operated using a remote, a cell phone, or computer. The goal is to have the participants work through problems that arise when trying to navigate their robot through a premade course. After going through the tutorial, participants will be challenged with adapting their program so that their robot can complete the challenge.

Activity Objectives

- Teach Basic Programming Skills
- Teach Problem Solving Skills
- Have Fun

Materials

- Lego Mindstorms EV3
 - Preferable if robot is built
 - This activity was done with the Tracker robot
- Computer/Laptop with Lego Mindstorms Program downloaded
 - Program is downloaded on computers #1, #2, #5
- Track is the cover of Lego Mindstorms box

Instructions

1. Wirelessly connect computer with the Lego Mindstorms brick using bluetooth
 - a. Make sure bluetooth on the block is on and iPod/iPhone is off



2. Open Lego Mindstorms Program on computer
 - a. Select the robot you built
 - b. Move to the top right hand side of the screen and click on the book button on the top right hand side of the screen and select the version you build
 - c. Click the programming tab (image below)



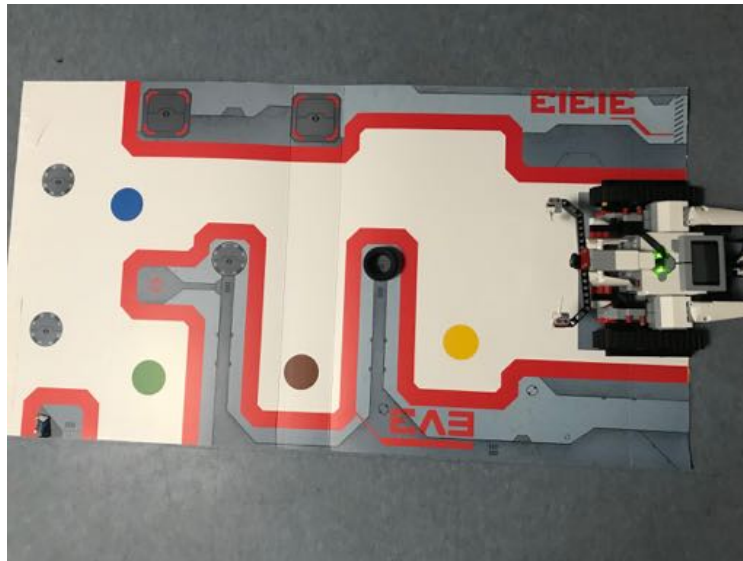
3. On the bottom right hand side of the screen refresh the device and connect the program with the block (image below)



4. Click on the “Follow step-by-step programming instructions”
 - a. Complete the directions
 - b. The final program should look like the image below

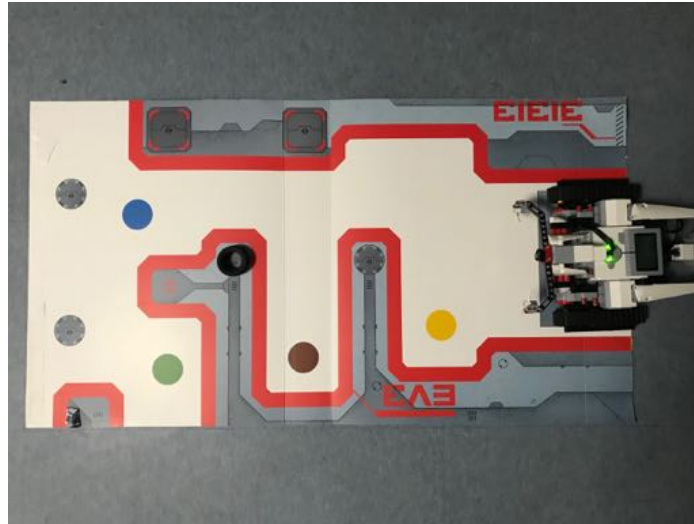


6. Run the program so that the robot hits the tire out of the spot and returns to the start area
7. If the program is run correctly move onto the following activities below



Tracker vs Tire Mission 1

1. Position the tire on the track so that it is in the second circle in front of the robot like below

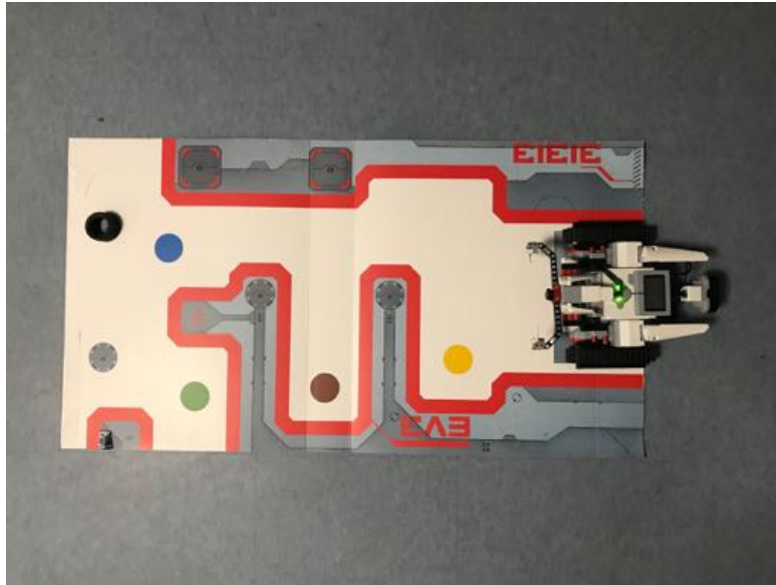


2. Adapt the program so that the robot moves to the tire, hits the tire, and returns to its original position
3. The program can look similar to the following
 - a. In the second and fourth blocks, the number of rotations was changed from 2 to 4



Tracker vs Tire Mission 2

1. Position the tire on the track so that it is in the farthest right side circle in front of the robot like below

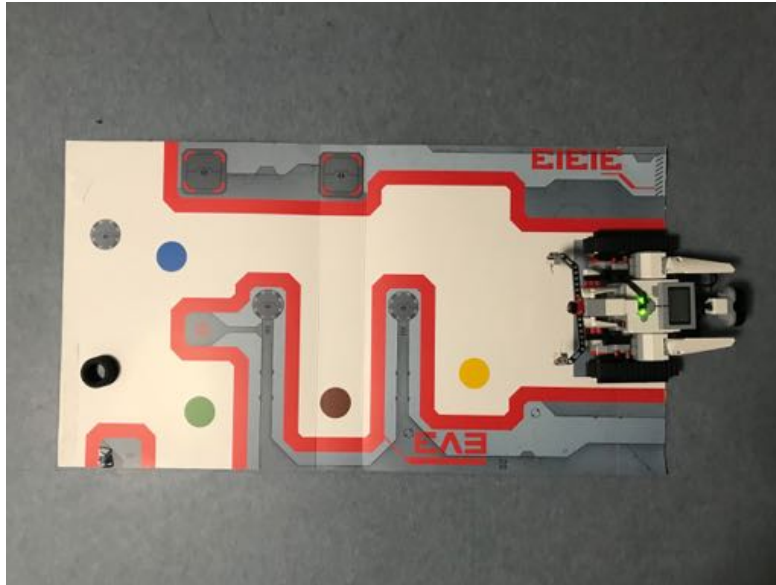


2. Adapt the program so that the robot moves to the tire, hits the tire, and returns to its original position
3. The program can look similar to the following
 - a. In the second and fourth blocks, the number of rotations was changed from 4 to 7
 - b. In the second and fourth blocks the directional number is changed from a 0 to 5



Tracker vs Tire Mission 3

1. Position the tire on the track so that it is in the farthest left side circle in front of the robot like below

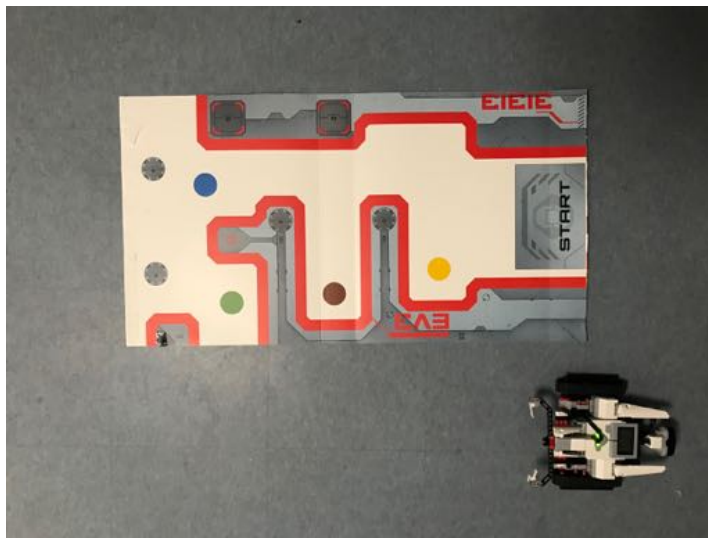


2. Adapt the program so that the robot moves to the tire, hits the tire, and returns to its original position
3. The program can look similar to the following
 - a. In the second and fourth blocks the directional number is changed from a 5 to -5



Victory Lap

1. Position the robot on the left hand (or right hand) side of the track like below



2. Create a program that allows the robot to complete one lap around the track
3. The program can look similar to the one below



4. Have the members edit the program to have the robot make unlimited laps around the track (the program will almost look the same with the added command as seen below)



Make Your Own Track

1. Have the members create their own track
2. Have the members then drive through the track using the remote
3. Have the members create a program to make the robot automatically go through the track