Lesson Plan for Activity: <u>CAD for 3D printing</u>

Subject: Basics of CAD and 3D printing   **Length of Lesson**: 120 minutes

Concept or Skill Focus: 2D sketches and basic 3D operations (additive and subtractive extrusion and revolution).

Goal: The students should develop a basic understanding of how to use CAD software with 3D printing in mind.

Objectives/Outcomes:
- Students will improve their understanding of geometric and special concepts
- Students will learn the basics of CAD modeling
- Students will learn about the strengths and restrictions of 3D printing

Materials
- Computers with software installed (see list below)
- CAD Principals Worksheets (Play Dough Activity – below)
- Warmup Exercises (below)
- 3D Printers (optional)

Software (depending on age group and/or experience level):
- Tinkercad: https://www.tinkercad.com/
- Onshape: https://www.onshape.com/
- SketchUp: https://www.sketchup.com/
- Solidworks: https://www.solidworks.com/ (not free)
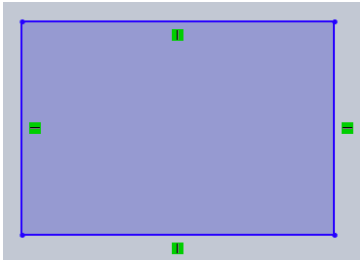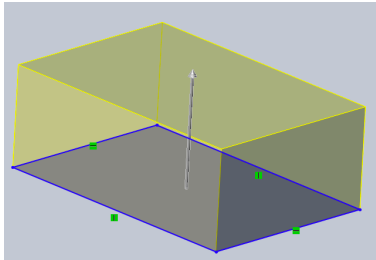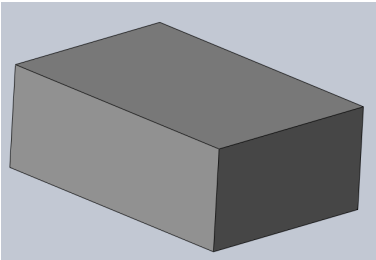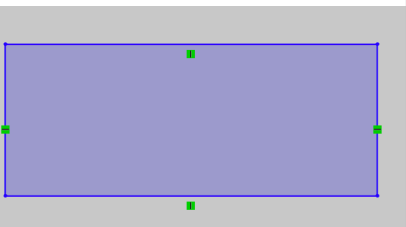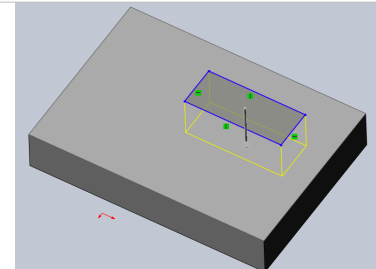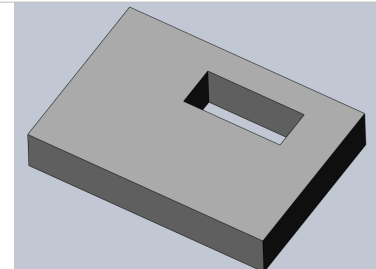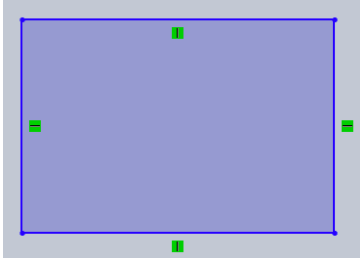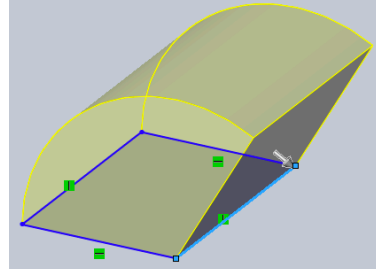
Activities and Time Line (Introduction, Middle, Conclusion)

1. *Work on CAD Principles Worksheet – Play Dough Activity in groups with guidance from counselors. Discuss answers with entire class afte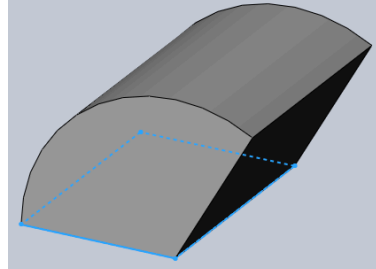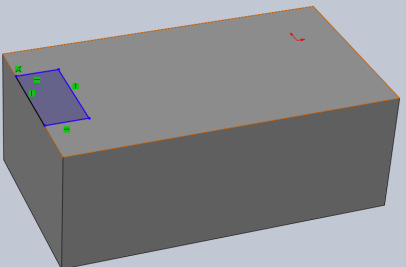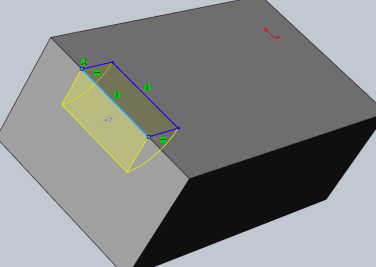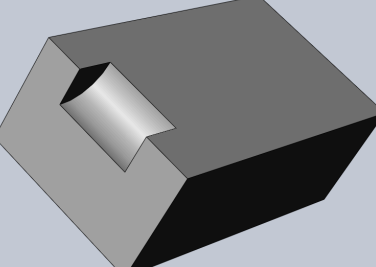r each question. Should take around 30 min. Some of the questions are more challenging and it is not necessary that we get to all of them.*

2. *Warmup exercises in groups of two. Perform the operations on a computer hooked up to the projector and the students will follow along.*

3. *Free CAD time. A few suggestions of simple things for students to CAD will be provided: Pacman, Minecraft Characters, etc.*

4. *Students will submit their CAD files to be 3D printed. If there is time, I will show them how to use the slicer themselves.*

This worksheet presents a series of exercises/mind-games that introduce the type of three dimensional thinking required when designing an object using CAD software. It also provides an excuse to play with play-doh.

For the following exercises, you should be familiar with four basic operations that can be performed on a 2D figure to transform it into a 3D object:

|	2D Figure	Operation	Product
Extrusion **(Features -> Extruded Boss/Base)**			
Subtractive Extrusion **(Features -> Extruded Cut)**			
Revolution **(Features -> Revolved Boss/Base)**			
Subtractive Revolution **(Features -> Revolved Cut)**			

1. What would it look like if you extruded the following figure upwards a few inches?
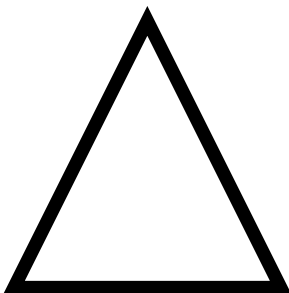
2. What would it look like if you extruded the following figure upwards a few inches?
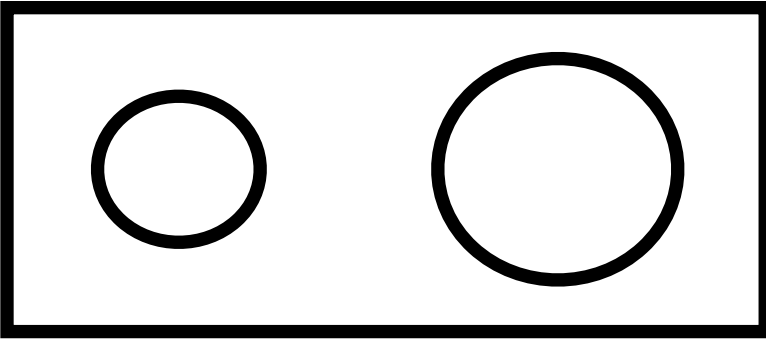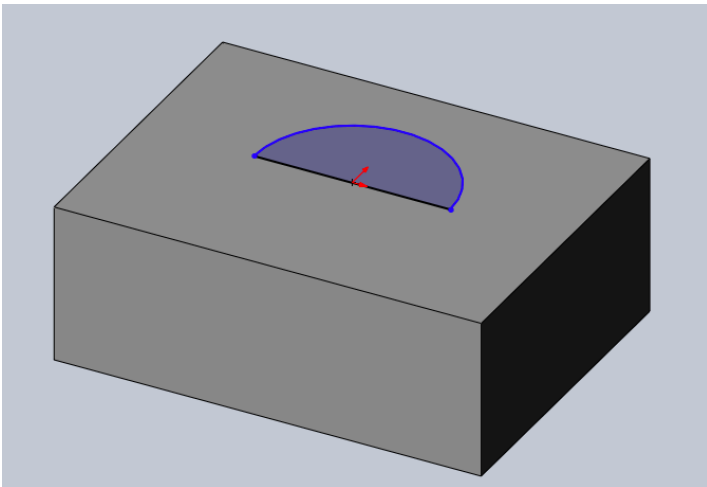

3. What would it look like if you extruded the following figure upwards?
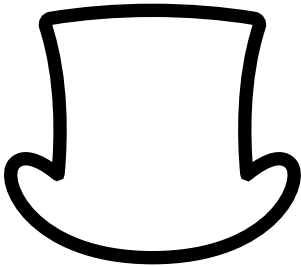
4. Could you wear the 3D object you just made like a top-hat? Which operation could you perform on the figure above to turn it into something closer to a top-hat?

5. Make a block out of play-doh. Then trace a semicircle in the top of it so you have something like this:

Then perform the subtractive revolve operation on the semi-circle, rotating around the black line with the red marker on it.

6. Take a look at the weird hut thing on your table. Look directly down on it. Draw a 2D image of what you see. Can you think of any operation listed in the table above that could be performed on this drawing or parts of this drawing to produce a part or parts of the physical 3D object.
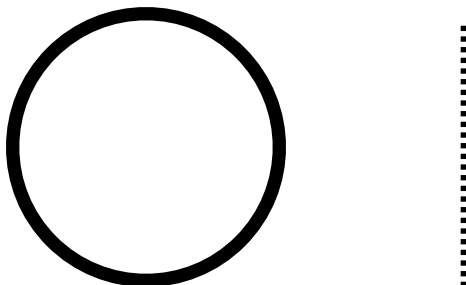
Now look at the hut thing from one side as indicated in the picture below and perform the same exercise.
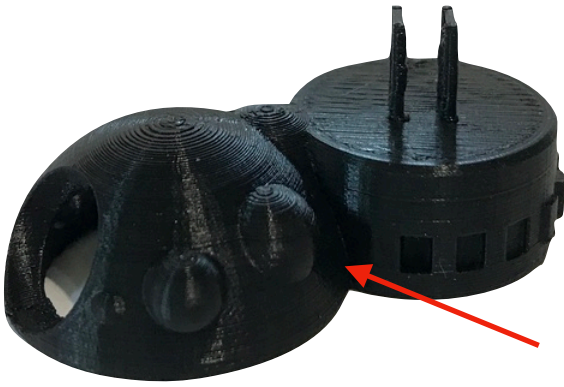
7. What would this 3D object look like in two dimensions if you were to look at it from the indicated direction (What outline would you see)?
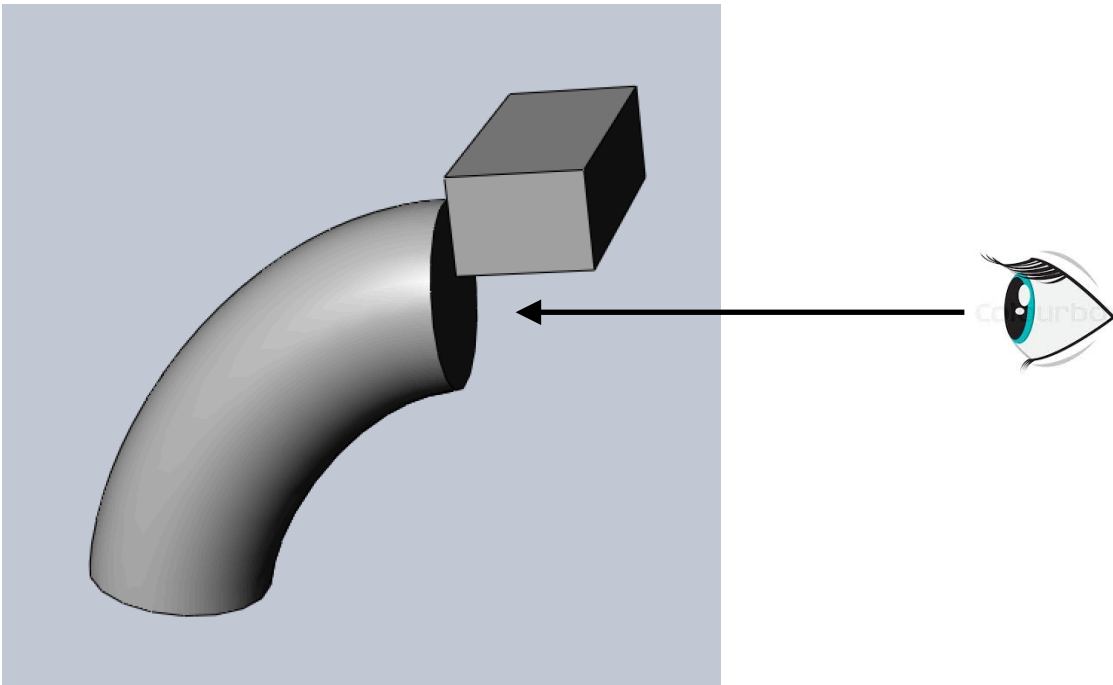

8. What would it look like if you revolved given figure about the given axis for 360 degrees.

9. Try to perform the following operations: Draw a rectangle. Extrude it. Draw a new rectangle on the top face of the resulting figure with one side on one of the edges of this top face. Perform the subtractive revolve operation on this rectangle about this same edge of the top face of the original figure. Stop revolving after 90 degrees.

10. What series of operations could you perform on basic 2D figures to get these things:
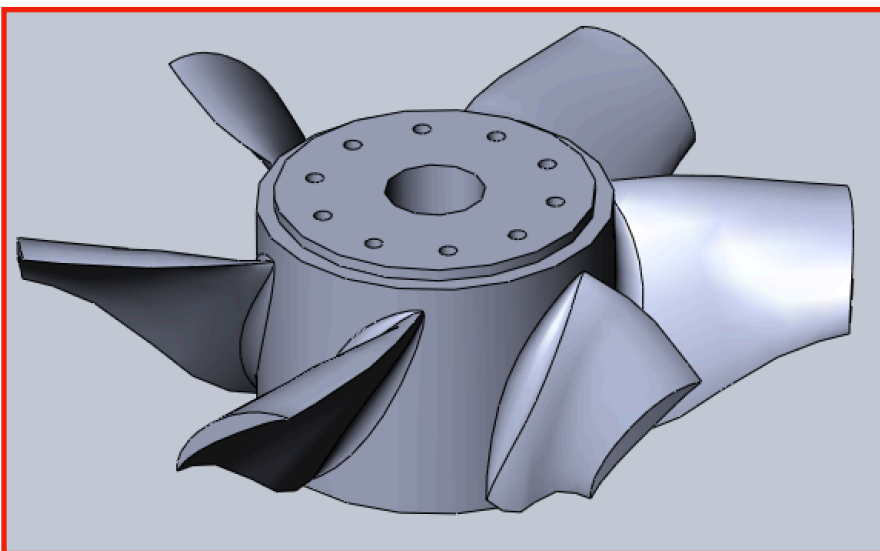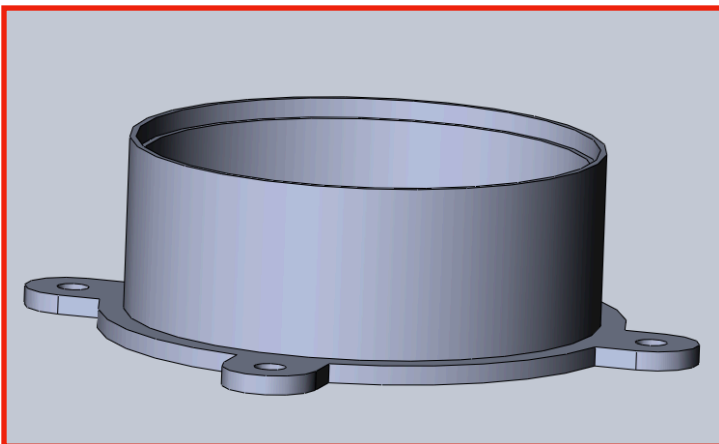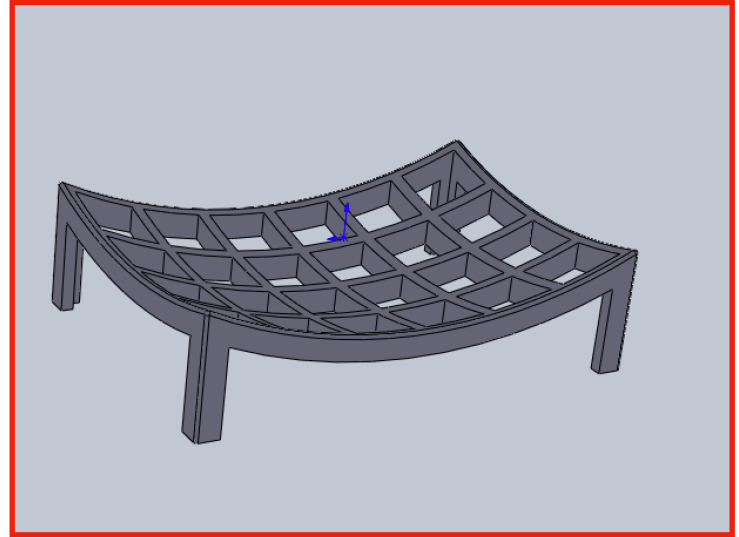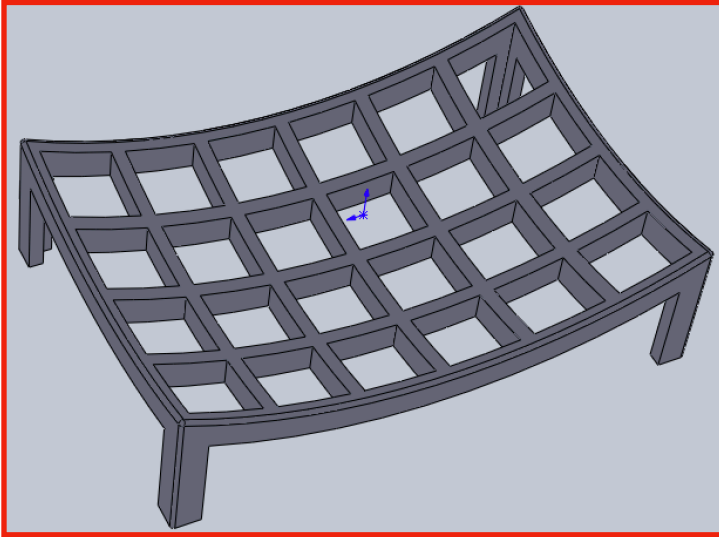
Warmup Exercises

- Sketch corner rectangle
- sketch center rectangle
- Extrude rectangle

- sketch circle
- extrude circle
- delete extrusion
- draw line through the middle of circle
- revolve half of the circle 360º

- sketch random thing with lines
- extrude it
- draw circle on top of this thing and put line through it.
- revolved cut a hemisphere out of the solid.
- draw a rectangle on top of the solid
- extruded cut with the rectangle.

- Edit rectangle sketch and dimension it.

- Make triangle sketch
- Dimension it to make it equilateral
- Use constraints instead.

- Show Coincident and Vertical/Horizontal contraints