Combining 3D Printing & the Arduino Board

Standards:

Measurement:	CCSS.MATH.CONTENT.2.MD.A.1
	CCSS.MATH.CONTENT.3.MD.B.4
	CCSS.MATH.CONTENT.4.MD.A.1
	CCSS.MATH.CONTENT.4.MD.A.3
	CCSS.MATH.CONTENT.5.MD.A.1
NGSS: 4-PS3-4.	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another

Standards for Mathematical Practice:

CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them.

CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively.

CCSS.MATH.PRACTICE.MP4 Model with mathematics

CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically

CCSS.MATH.PRACTICE.MP6 Attend to precision.

CCSS.MATH.PRACTICE.MP7 Look for and make use of structure

Learning Objectives:

Students will design and produce a container for an Arduino Board

Students will design and produce a lid for an Arduino Board box with holes for a push-button and LED light

Students will use the Arduino board and push-button switch to power an LED light

Recommendations:

Group Size: 2 to 4 students, depending on how many variations you would like students to compare within the class setting. For a smaller class, groups of 2 would be ideal.

Class Size: up to 36 students

Materials Required:

At least one computer per group, loaded with Google Sketchup or Tinkercad
Paper and pencil for drafting
Arduino Board
Arduino button
Arduino LED light
Airwolf 3D Printer
Video for creating the container and lid in Sketchup: http://www.youtube.com/watch?v=wIsGfP059Tk
Video for creating the container and lid in TinkerCad: http://www.youtube.com/watch?v=9UIXPIHAzr8

Introduction:

Assumptions being made:
-- Students have a good understanding of 3D modeling. Prior to incorporating this lesson into a unit, it is recommended that students have had training on Google Sketchup or Tinkercad.
-- Students have a good understanding of SAE (Imperial) and/or Metric units.
-- Students have a good understanding of an Arduino board

For an introduction video on creating a 3D model, go to http://youtu.be/gsfH_cyXa1o

To begin the lesson, show the students an Arduino board. If there are enough for the entire class to get their hands on one, this would be even better. Following this, have students measure the dimensions of the board and note their findings on the board.

Next, present students with their challenge:

Create a container that will hold an Arduino Adafruit Uno R3 board and allow an opening for a push button and LED light.

Give students time to work in their small groups to design potential containers with the determined dimensions. Depending on the time permitted and resources (Airwolf 3D printers, Arduino kits, etc.) available, having students get right to the basic box design would be the most efficient use of time. All dimensions need to be included on the draft before showing the instructor.

The Meat:

Students work with Google Sketchup or Tinkercad to create their draft, attending to the precision of the dimensions that have been noted by the class. Prior to printing, have students seek the approval of at least one group to check for accuracy.

When printing, it is advisable to print at least 2 perimeter layers thick, so take this into consideration during the design. Each perimeter layer is 0.3 mm thick. Following the check by the instructor, students will print their container.

To ensure that everything lines up accurately, groups will check their classmates' designs prior to showing the instructor. The instructor will need to confirm the students' drawings as best as possible before sending it to print.

Once the design of the container has been printed, students will clean it up and verify all measurements for accuracy. The next challenge is to create an appropriate lid that will fit perfectly onto the box for the Arduino board. This lid will have a hole for the push-button and another for the LED light that needs to be included in the final product.

For this portion of the project, students will need to measure the push button and LED light and account for the space that each will consume within the lid. Have students follow the same procedural steps as the container prior to printing their design.

To confirm accuracy, have students assemble the lid with the board inside the container. Depending on the ability of the students, setting up a tongue & groove design for the interlocking of the lid may be beneficial.

After having created the container, students will work in groups through the user's guide of the Arduino kit to set up the appropriate circuit for lighting the LED bulb. Depending on the level of students involved in the project, introducing Ohm's Law and/or tolerance of a circuit would be a great extension of the project.

For the Arduino user's guide, there are plenty of tutorials online, and this link may give a better reference. Using the Arduino board can be an extensive project in itself, so allocating time for students to learn the programming and electronics of it would be beneficial.

Discussion:

What were some of the challenges in designing the container and lid?

What did you learn during the project?

Just like in a Research and Design lab for major companies, the feedback and reflection on these projects will be the best part. Give students an opportunity to talk within their group and amongst their classmates to seek advice on improvements or modifications to obtain the ideal design.

Desired Outcomes:

A desired outcome is a container that will perfectly fit an Arduino Uno R3 board, along with a push-button and LED light that both fit flush with the lid and are operational.

Some Possible Extensions/Modifications:

To limit the amount of time spent printing, have the perimeter layers set at 1 or 2, but know that this will make for a much weaker container.

To bring this down a level, provide students with the dimensions or even a template for them to work off of.

To step up a small amount, have students create a unique design that will host the Arduino board. Whether it is a turtle, a car, or a flower, students can get creative with their container as long as it hosts the Arduino board appropriately.

To extend the project even further, and with more accessories for the Arduino board, give students a mission based on the additional parts that are available and grade-level appropriate. Feel free to peruse a list of additional products available. (https://www.adafruit.com/products/50)

Resources:
For an introduction video on creating a 3D model, go to http://youtu.be/gsfH_cyXa1o
Arduino kit with necessary components: http://www.adafruit.com/products/170