

Introduction to Engineering and Manufacturing

Grades: 9 - 12

(50 minute class periods)

Lesson Plan: Injection molding Introduction and CAD application project - The Gummy Candy Mold

Standards Addressed:

- 5.2.4. Apply annotations on sketches and drawings.
- 5.2.9. Select a view to graphically communicate a design solution.
- 5.3.1. Apply manufacturing processes (e.g., casting, molding, forming, separating, conditioning, assembling, finishing, rapid prototyping).
- 5.3.2. Evaluate a sketch and generate a model utilizing three-dimensional modeling software and techniques.
- 5.3.4. Perform part manipulation during the creation of an assembly model.
- 5.3.11. Evaluate the accuracy of mass properties calculations*
- 5.5.1. Determine the production processes used to create products from categories of materials.
- 5.5.2. Measure and inspect work pieces according to product specifications.

**For higher level project variation only*

Preparation:

Materials/Equipment:

General supplies:

- Computers/3D modeling software
- White board / projector
- Paper
- Rulers

To create the mold:

- 3D printer and filament (I generally use PLA but ABS should work fine)
- Masking tape
- Cooking spray
- Drill and drill bit (drill bit size should match the outer diameter of the tubing used)**
- Plastic tubing (~6" long per mold)**
- Syringe**

***There is no strict size requirement here, but you want to make sure all three of these components (syringe, tubing, and drill bit) work together. I recommend a syringe that has at least a 20mL volume, but larger is fine. The goal is to have tubing that will attach snugly at one end to the syringe and at the other into a hole in your mold.)*

To make the edible gummy candy:

- Small bowl / jar (for mixing)
- Spoon (for mixing)
- Microwave (or any other heat source for boiling water)
- 1 box of flavored jello
- 1 Tbsp unflavored jello
- 1/3 cup water
- 1/2 tsp citric acid (optional; add if you want the gummy candy to be sour)

Setting:

Classroom

Preparatory Assignments for Students:

Students should have an understanding of ruler reading, technical sketching, and design constraints/requirements from the previous lessons prior to beginning this lesson. Students should also be familiar with 3D modeling in CAD software.

Performance Objectives: (Behavior/Condition/Standard)

By the end of this unit, students should be able to:

Create a personally designed gummy candy using a 3D printed injection molding system that reflects visibly reflects their original design intent and adheres to the project guidelines.

Presentation and Application:

Time: ~10 - 50min class periods

Scope: This lesson introduces students to Catia through a series of tutorials that they can then use to create their own first part model depicting a mold they will use to later CNC their design for use in manufacturing their own gummy candies.

Day 1: Project Introduction
Student led discussion and setting of design requirements
Technical sketching (Individual) of intended candy shape

Day 2-4: Students model their gummy candy design (that matches their previously created and collected technical sketches.
Each day should begin with a review activity to clarify common problems/challenges students are experiencing in their 3D modeling (as needed)

Day 5: Students model their gummy candy molds.
Students should save these mold files as .stl files to send to a 3D printer*
**At this point, the molds will need to be printed before the candy can be made. Depending on class size, this will likely take at least 2 days. Begin printing as soon as students turn them in to avoid unnecessary delays.*

Day 6-7: Introduce manufacturing processes, highlighting injection molding

Day 8-9: Students should prepare and create their gummy candy molds and inject the solution so they can leave the mold to cool overnight.

Day 10: Students remove their candy from the mold
Assessment on student understanding of manufacturing processes

Evaluation:

Formative Teacher observation and related review activities daily

Summative Final project will be graded for technical competency using rubric that highlights 3D modeling technical proficiency, meeting design requirements, and mastery of injection molding process as evidenced by their resulting candy.