**Lesson 3: Prototyping and Manufacturing**

**Problem statement:** How do engineers construct a prototype using their designs?

**Learning objectives:** I can construct a prototype of a package, by using technical drawings to create a preliminary example of our package.

**Lesson standards (NGSS, CCSS, CTE):**

**NGSS**

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

**Soft skills:**

**Collaboration:** Students are working as a team to use their technical drawing to generate a prototype of their package

**Creativity:** Students are challenged to consider how realistic their technical model is to create a 3-d prototype and to modify their design as needed.

**Connections to career and educational pathways:**

Students are mimicking the process of taking technical language and using it to generate a prototype, just like an engineer might.

**Materials:**

-Groups technical drawings

-Light-colored construction paper

-Scissors, tape

-Plastic eggs (at least 1 for each group)

-Shape drawings from Lesson 2 (*Appendix A)*

**Lesson preparation:** Collect materials for prototypes (consider sending home a paper grocery bag for students to collect clean recycled materials **1 MONTH PRIOR** to starting unit as well as asking for supplies in the teacher's lounge or other community space).

**Time required:** 60-90 minutes

**Grouping of students for instruction:** Students will be in design groups from Lesson 1

**What is the instruction?**

* Students will meet in design teams with technical drawings
* Teacher will model how to use a technical drawing to generate a prototype to better explain the process of their invention.
* Students will then work to make a prototype of their package that meets the specifications

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| **Teacher** | **Student** |
| **Review and model: 10 minutes**  Review with students about the speculations for their package invention and about the technical drawings they completed in the class prior. | Students share out what are the requirements for their inventions, as discussed in the first two lessons. |
| Demonstrate to students with sample technical drawing of box how to use that to measure on construction paper and cut outline of box for prototype.  Reiterate to students that it is important to measure multiple times before cutting the paper and that it may take multiple prototypes before creating a successful design that meets the specifications.  Remind students that their highly valuable egg must sit comfortably inside their package.  **Provide students with plastic eggs to help design their prototype** | Students observe modeling process and ask follow-up questions about process. |
| **Work time: 45-70 minutes**  Teacher checks in with groups during the prototyping process.  Teacher decides whether each group is expected to work on one prototype together or whether each student will make one prototype each and then identify one prototype to move forward with or to check-in as a group to create a prototype that uses everyone’s ideas. | Groups work together to measure out and create prototypes with the goal of having one design that they will be moving forward with. |
| **Check in:** 5-10 minutes  Teacher checks in with each group about their prototype, questioning what are they all agreeing about, what are they disagreeing about as a design team, what possible problems do they foresee with their package. | Students clean up work spaces and have dedicated spots to place their prototype in the classroom. |

**Accommodations:**

Teacher decides whether students will make one prototype per group **or**  each student in the group makes one prototype and then the group decides which design to move forward with.

**Extensions:** Each group member makes their own prototype using the same technical drawings.

*Appendix A*

