

# Lending a Hand Activity – Reflecting on the Engineering Design Process Worksheet – Example Answers

1. **Do Now:** Complete Newton's laws of motion by filling in the blanks.

The First Law of Inertia

An object at rest stays at rest, unless acted upon by an unbalanced force.

An object in motion stays in motion, unless acted upon by an unbalanced force.

The Third Law

For every action, there is an equal and opposite reaction.

2. **List of Criteria:** Next to each box, provide the expectations of your design. These are the requirements as set by the client (the doctor).

Your design must:

Be able to grip a cup that increases in weight.

Be able to grip at least 200 ml of sand.

Look somewhat like a hand.

Stay within a \$50.00 budget.

Be completed in 5 days.

Be able to be manipulated with user's hand.

3. **Choose a Solution:** Describe how your group decided upon the first design idea.

In your answer, circle (shown as underlined text in this example) your use of the vocabulary: *criteria*  
*constraint* *prototype*

**For our prototype we chose to focus more on the hand's structure and build from there since one of the criteria is to look like a hand, we chose to make it as one of our main priorities. The constraint of the materials did hurt our sketches and plans a little though.**

4. **Constraints – Approved Materials:** Explain how the construction of your prototype was affected by the types of materials available to you.

**Due to the limited type of materials that were approved, it did affect our prototype. We had to redesign a prototype that would use approved materials.**

5. **Constraints – Budget:** Explain how the construction of your prototype was affected by the cost of the materials. Discuss the challenges created by a set budget (\$50).

**The budget was a constraint that we carefully looked over and checked many times. This constraint affected us because a lot of the materials were a little bit over priced and it made it difficult to buy all of our materials at once. The challenges created by a set budget were to not waste all your money and to make sure you buy enough materials and not extras because it's wasting money.**

6. **Building & Testing:** Explain how designing, building, and testing of your prototype was an iterative process. In your answer, circle (shown as underlined text in this example) your use of the vocabulary: *iterative* *communicate* *redesign*

**Designing, building and testing our prototype was an iterative process because we had to continue adjusting the hand so it can fit the criteria. After each testing we would communicate to each other about what would help make it better. Our group didn't redesign the entire hand, but we redesigned by adding on to it. The process continued and repeated until we decided on the final product.**

7. **Record Data:** In the table provided record qualitative data on how the different types of forces affected the performance of your prototype. *Full sentences are not required.*

Type of Force	Description of how the force acted on the prototype during final test
Gravity	<b>Gravity pulls the prototype downwards.</b>
Normal	<b>The cup rests on the palm, preventing it from falling.</b>
Tension	<b>The weight of the strings.</b>
Compression	<b>The sand is weight pushed down the cup. The hand pulls up due to the strips.</b>
Shear	<b>I didn't see any shear force (not direct)</b>
Bending	<b>The fingers bend up as we lift the strings up</b>
Applied	<b>Someone poured sand into the cup while someone else was holding the strings.</b>
Friction	<b>Friction force kept the cup on the hand.</b>
Air Resistance	<b>Same thing as friction.</b>

8. **Applying Newton's Laws:** Describe how Newton's first law of inertia was observed in the final test of your prototype.

**Newton's first law of inertia was observed in the final test of our prototype because at first it was at rest, but as the sand got poured in, the hand started to tilt to one side due to the unbalanced force and weight of the sand.**

9. **Applying Newton's Laws:** Describe how Newton's third law was observed in the final test of your prototype.

**Newton's third law was observed in the final test of our prototype because when we poured in the sand, the weight increased, as the hand was weighing down. But a person is still holding the string which keeps it up right.**

10. **Redesign:** Explain how you would change your design. If you could redesign, what would you do differently?

**If I could redesign the prototype, I would do many things differently. First, I would use different materials because our group saw a video where a person used straws and we wanted to try that idea. Second, I would probably make the hand larger because our design was slightly smaller compared to our classmates. Lastly, I would make the palm of the hand sturdier because on our design it was not very strong and if weight were to be over 200 ml, I think it would**