**Engineering Design Process**

After our class session in which others shared their comparative design analysis, I was inspired to spend some more time looking at the analysis I had originally created. After our class, I felt encouraged to think a little bit more out of the box and reflect on what *inspired me* when working on engineering design in the classroom. Two processes immediately came to mind: NASA's Engineering Design Process and Stanford's Design Thinking. As a result, I made some adjustments to the engineering design process I wanted to include in my classroom.
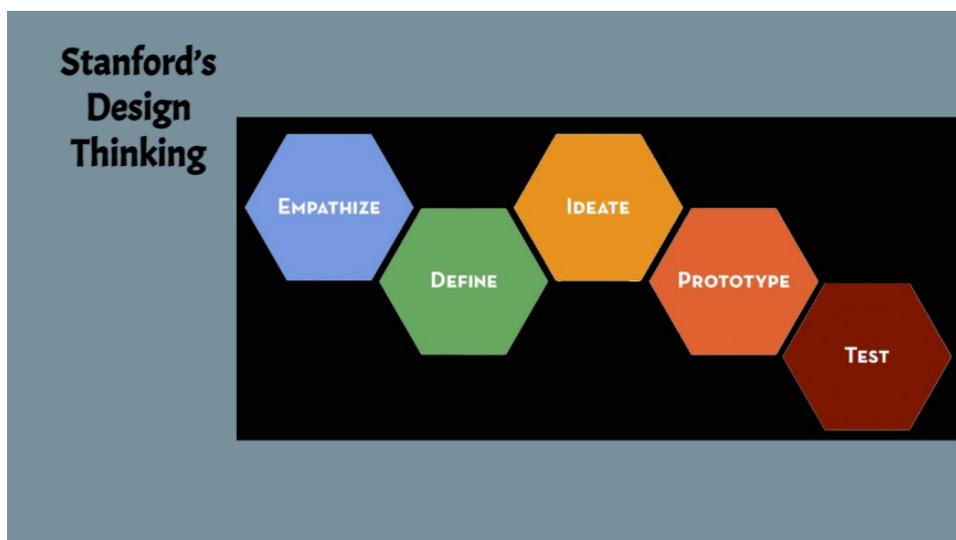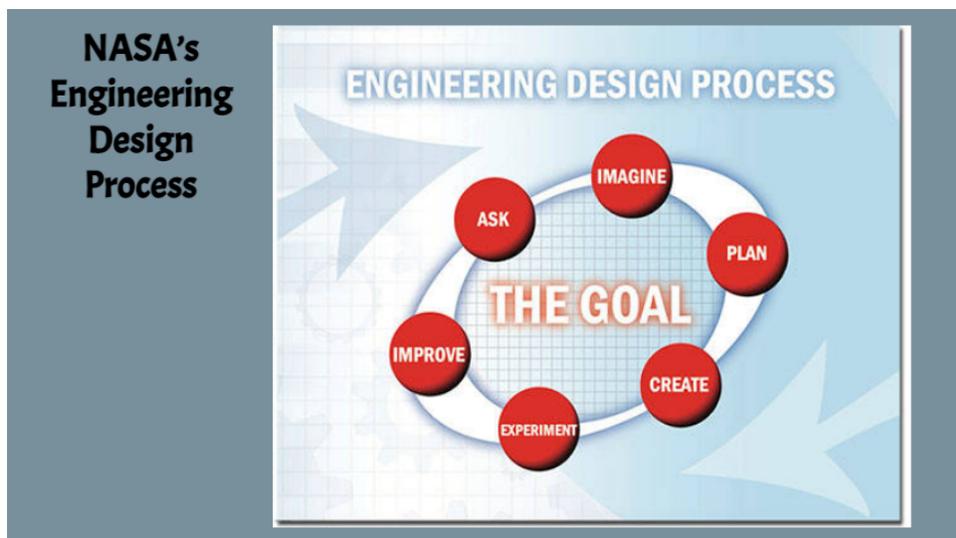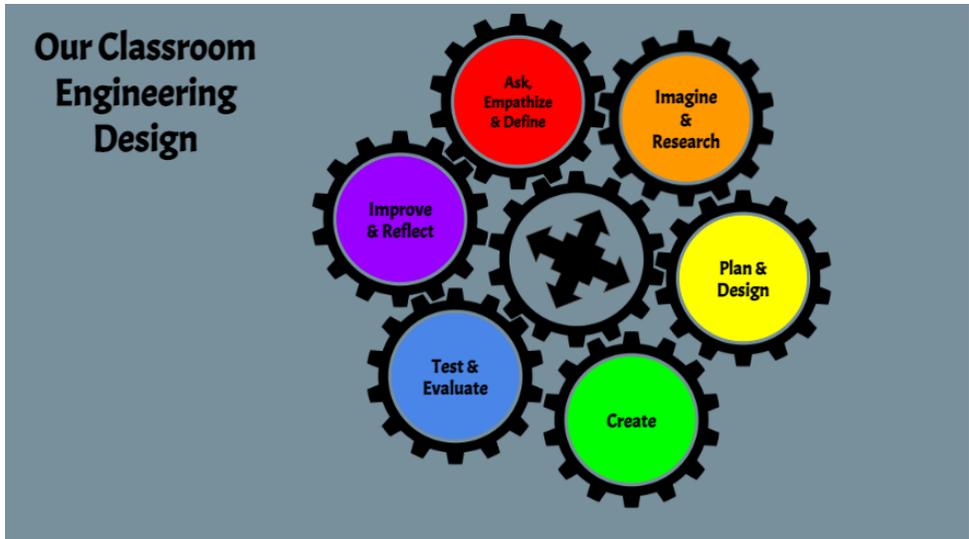
Before beginning the project, I introduced NASA's and Stanford's models with my students. We discussed similarities and differences between the two both in content and in layout. I then introduced my model and discussed how I found inspiration from both NASA and Stanford to create a model I wanted us to try out this year. I was happy that students noticed the gears and arrows in my model and we talked about the significance behind those symbols.

Implementation Timeline

Day	Activity	Engineering Design Process Step
Day 1	Engineering Design Process ● NASA vs. Stanford ● Our Classroom Model	N/A
Day 2	Read Aloud ● *Don't Think About Purple Elephants* (Susanne Merritt) ● Discuss strategies for dealing with anxiety/stress	Ask, Empathize, Define
Day 3	Introduction of SEL STEM Challenge ● Answer initial questions	Ask, Empathize, Define
Day 4	Review Goal, Criteria, Constraints ● Address new questions Brainstorm and Discuss with Support Team	Ask, Empathize, Define Imagine & Research
Day 5	Inspiration Research	Imagine & Research

Day 6	Develop a Plan ● Detailed sketch with labels ● Materials list ● Steps for building	Plan & Design
Day 7-9	Build Products ● Test products as building and make adjustments, as needed ● Meet with Support Team for collaboration and help	Create Test & Evaluate Improve & Reflect
Day 10	Reflection ● Student reflection	Improve & Reflect
Day 11	Design Expo	Improve & Reflect

Engineering Notebook

Please see this link for my Engineering Design Notebook.

Reflection

Overall, I think the project had some successes. First and foremost, it gave me the opportunity to really dive deep into the engineering design process with my students. Since the project has already taken about three weeks and we haven't quite finished yet, we have been able to talk about the engineering design process multiple times and at multiple stages. I think this has helped some students to internalize the concept and process of engineering.

For that reason, I'm glad we had the project towards the beginning of the year. However, due to the very open-ended nature of the engineering design challenge, I think it may have worked better later in the year. The challenge was *really* difficult for some students and, as a result, a handful of students went with a very simple solution - they made a stress ball. Since they went with such a simple solution, they had a lot of time on their hands, which meant they didn't always make the best behavior choices. On the other hand, there were some students who really rose to the challenge and found creative and unique solutions to the challenge. I can't help but wonder...If I had done this project in March, when students have had more experience with open-ended projects and finding solutions and working on STEM Challenges in teams, would a higher percentage of students have met this challenge head on?

Reflecting on how long it took me to finally make a decision on my project, I'm so glad I went with a SEL-themed challenge. Recently, we had an MTSS meeting and, during that meeting, I brought up six of my twenty-five students - all for social and emotional concerns, not academic. This is in addition to the behavior and bullying problems I'm trying to work out. I've never had a group of students that are struggling so much with their social-emotional needs. For that reason, I'm glad the foundation of this

STEM Challenge was SEL and reminded students about the importance of their own mental health, as well as the needs of others.

As expected, student engagement was very high throughout the project for most students. The other day, one of my students said, "I love days like this when it's like we're not just students, we're real engineers. But then it also means there is so much to clean up to do!" I chuckled at the accuracy of his statement. During this project, our room has been messy and loud and chaotic. It hasn't looked like a classroom but more like a studio or workshop and, to be honest, that's what I'm hoping to achieve in my classroom most of the time. I wanted this to be a truly authentic learning experience for my students and I think it has been. I've worked diligently to consistently refer to my students as engineers throughout this project. I hope calling them engineers helps to make this process even more real for them.

The content this project covered included:
- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 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.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Through class conversations, we were also able to discuss:
- 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

We used our STEM Challenge criteria (device must be made of 50% recycled materials) to talk about how organizations might use recycled materials in their business. For example, we talked about how different shoe companies make their products out of recycled materials and one student brought in their smencils to show, which are smelly pencils made of entirely recycled products. Once again, our conversation came back to Ford and GM and their decision to move towards building more eco-friendly vehicles.

I had initially intended to use the STEM Challenge criteria:
- Device must be made of 50% recycled materials

to explore the relationship between percents, fractions and decimals. However, due to time constraints, I had to abandon covering this standard.

Using the engineering design process helped support the NGSS Engineering standards we covered. For example, as we moved through the "Imagine & Research" stage of the process, we specifically addressed how to develop *multiple* possible solutions and then choose the one that best met the goals and criteria. Overall, the engineering design process I ended up with was appropriate for my fifth grade learners but I would definitely make some tweaks in the future. I felt some frustration with the significant overlap between the "Create" and "Test and Evaluate" stages. Looking back, perhaps this wasn't the best project to introduce our engineering design process. In the future, I'd consider developing a simpler, more

streamlined project that would isolate the stages of the engineering design process so we could walk through them together. I think this would help students have a more thorough understanding of each step in the process so that, later in the year, when we had a larger, more open-ended project they would already have a solid understanding of the engineering design process.

My students are so excited to share their products at our Design Expo next week. They are so proud of their creations and I'm really proud that they persevered through this challenging engineering project. From my perspective, working through this project helped me to feel a bit more inspired after a challenging two years and also helped remind me of my "why."