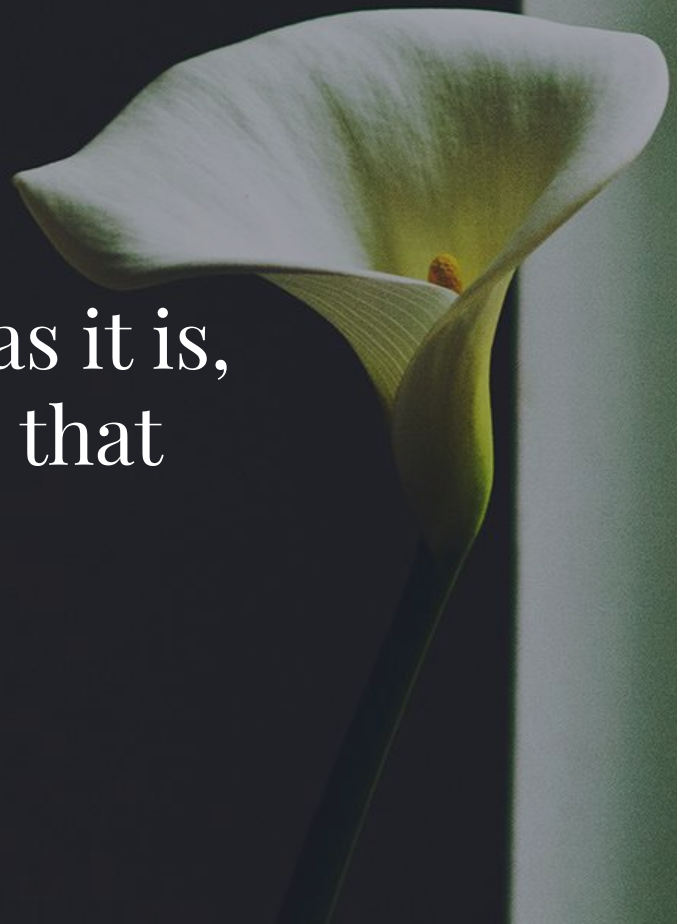
ME 127 Portfolio

Brenden Koo | ME 127 | Winter 2023

“

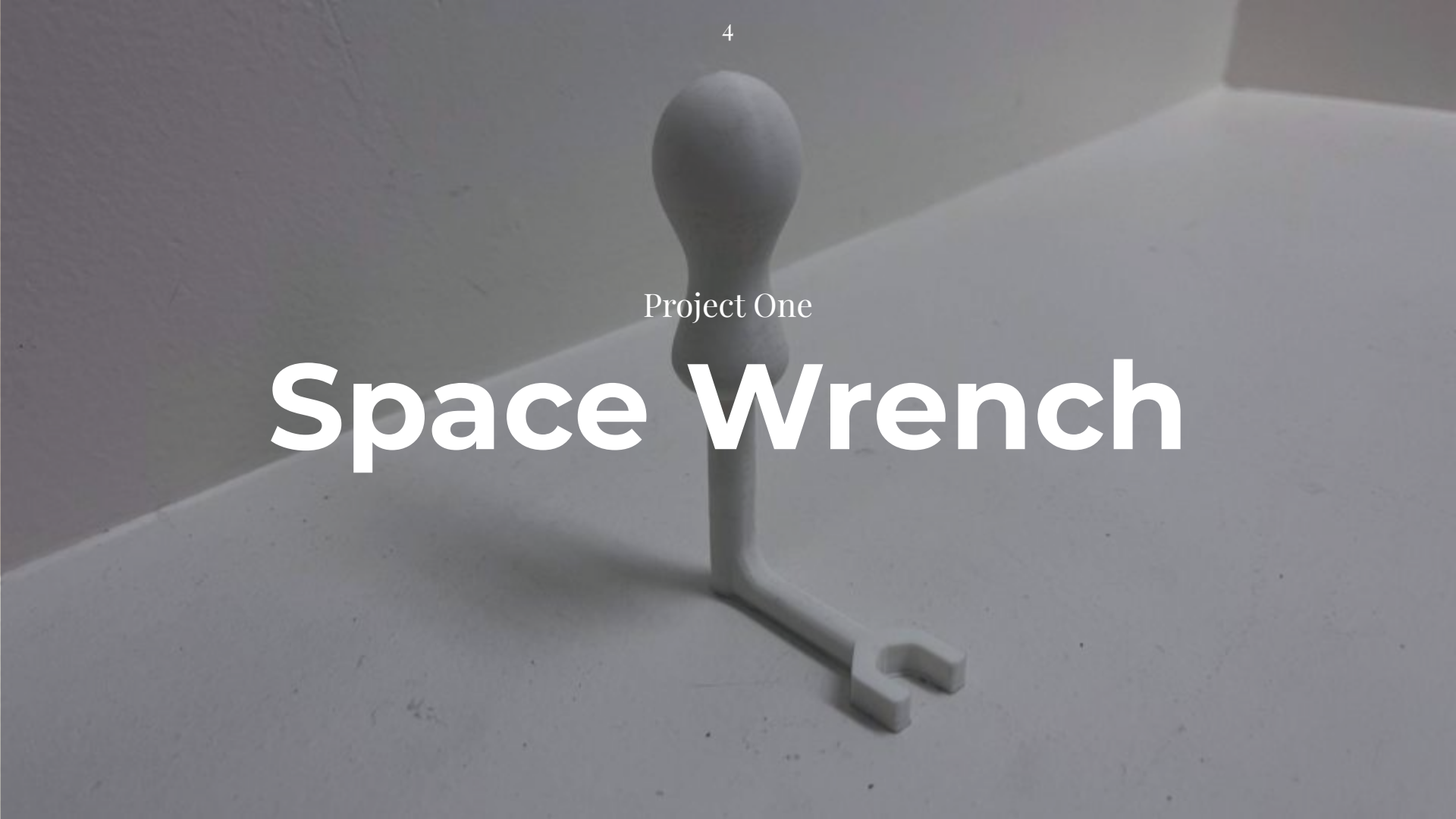
Scientists study the world as it is, engineers create the world that has never been.

Theodore von Kármán



1
Final Project Results

What did I do throughout this quarter?



Project One

Space Wrench

Space Wrench

As someone whose prior experience with CAD is primarily through SolidWorks, the Space Wrench was my introduction to Fusion 360. As the introductory project for the course, I wanted to take this opportunity to map out a clear solution from start to finish–utilizing a simple design to understand the full capabilities of Additive Manufacturing.

Although my initial design was successful, I decided to take advantage of the available time to continue improving my solution. I increased the diameter of the wrench handle to improve the ease of gripping the handle. If given the opportunity to redo the assignment, I would implement a more advanced design; the design was pretty hefty and shape optimization could prove useful in this scenario.

Project Two

Chapstick Keychain


FIND

Chapstick Keychain

The chapstick keychain project experienced a couple of bumps along the journey, but was, in hindsight, a project where I was successfully able to pivot from a less-than-ideal design.

My final design involved a print-in-place chain with mid-print keyring inserts, implementing two of the three proposed additive manufacturing assembly techniques. I exceeded my own expectations by designing a chain that would not need supports (which I did not know was previously possible).

If I had the opportunity to explore this project again, I would take the time to design a better system to secure the cap to the keychain–as opposed to the form-fit cap–so that the chapsticks are more easily interchangeable.

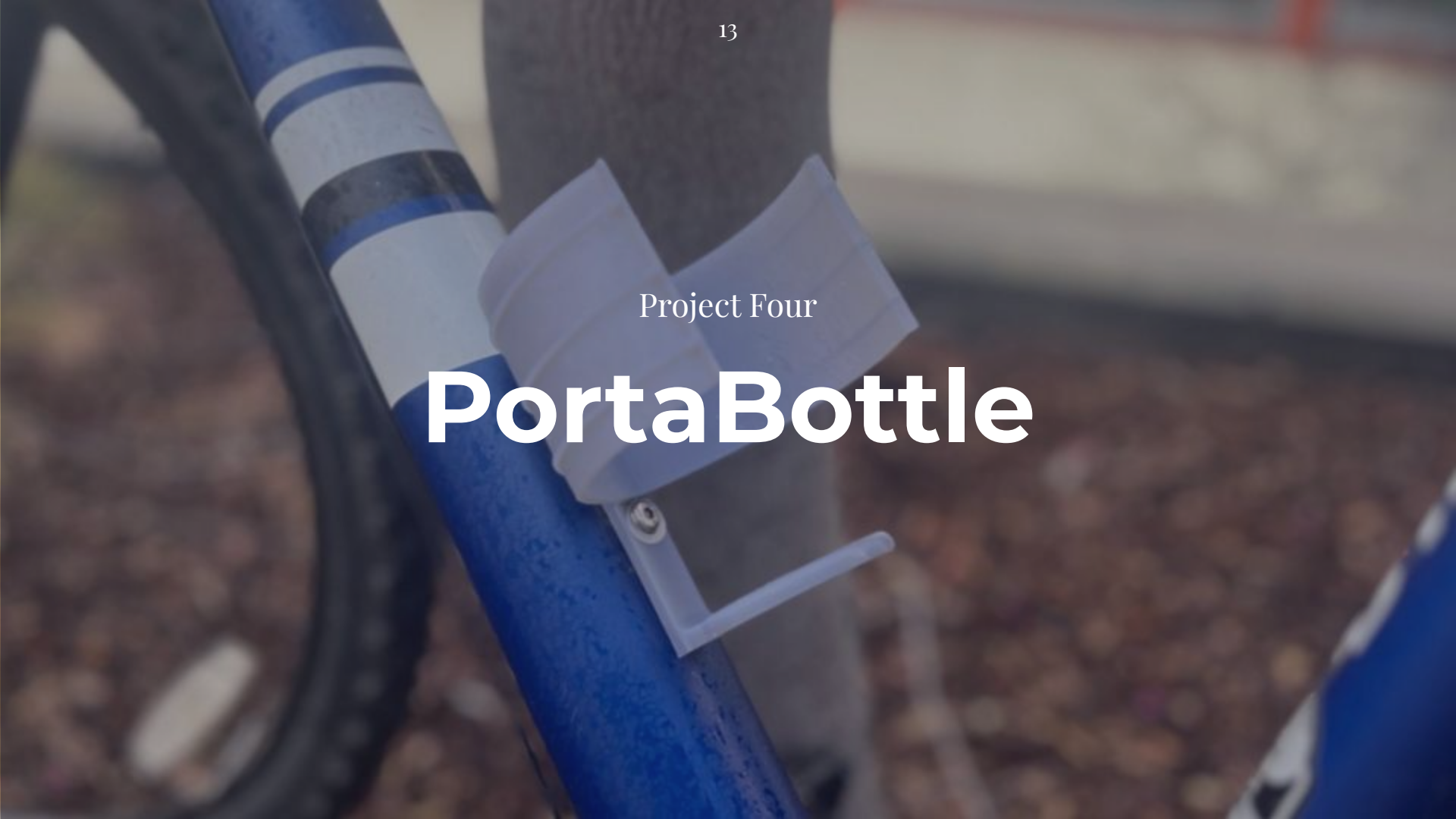
Project Three

AddiesForBaddies Phone Case

AddiesForBaddies Phone Case

As someone who has primarily used Ultimakers for Additive Manufacturing this project was my introduction to using the FormLabs SLA printers. My team–AddiesForBaddies composed of myself, Anu, and Liam R.,–designed an iPhone 13 Pro phone case from Flexible 80A with a built-in stand made of Tough 1500. This project was a fantastic introduction to material properties, as my team had to conduct research to understand the respective specifications of each materials.

Furthermore, this project taught me the value of adaptability through each step of the design process. Even so-called “failed” prototypes were opportunities to gain a tangible understanding of the materials I was working with, and setbacks were moments from which I could learn and progress, as opposed to wallowing and contemplating starting over.



Project Four

PortaBottle

PortaBottle

PortaBottle is the culmination of everything I've learned in ME 127, and I am more than satisfied with the outcome. I created a Tough 1500 bike-mounted water bottle holder designed to accommodate larger water bottles. I used a combination of prototypes, simulations, and material properties to design a spring-loaded bottle holder that securely and satisfyingly snaps back around my water bottle. This project required both mathematical planning and prototyping iterations to perfect the final dimensions of the design.

In deciding the direction of my final project, I initially went in two different directions–the current iteration, and another design that utilized algorithmic design for shape optimization. If given more time, I would take the opportunity to explore the intersection of the two directions, making my current design more mass-efficient.

takeaways

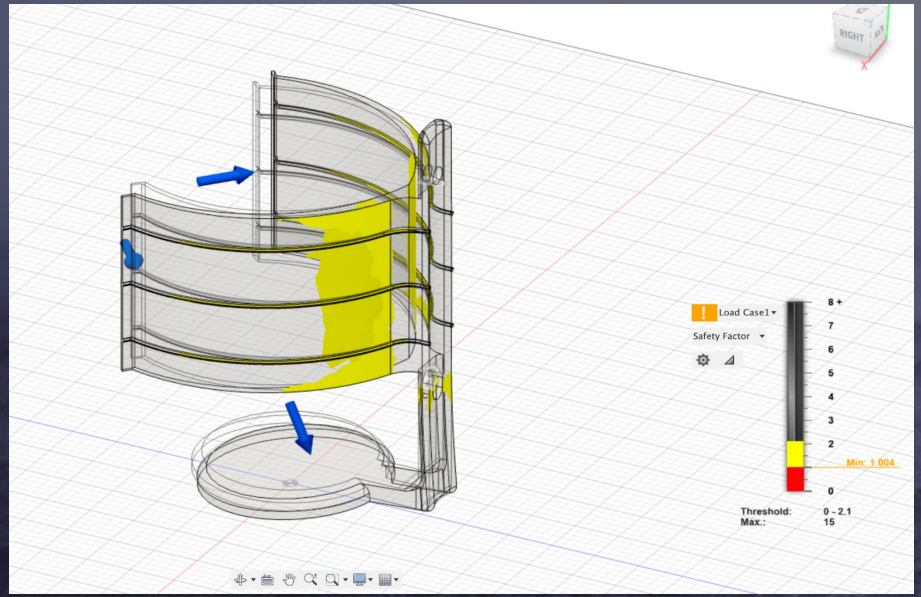
The Major Developments throughout ME 127

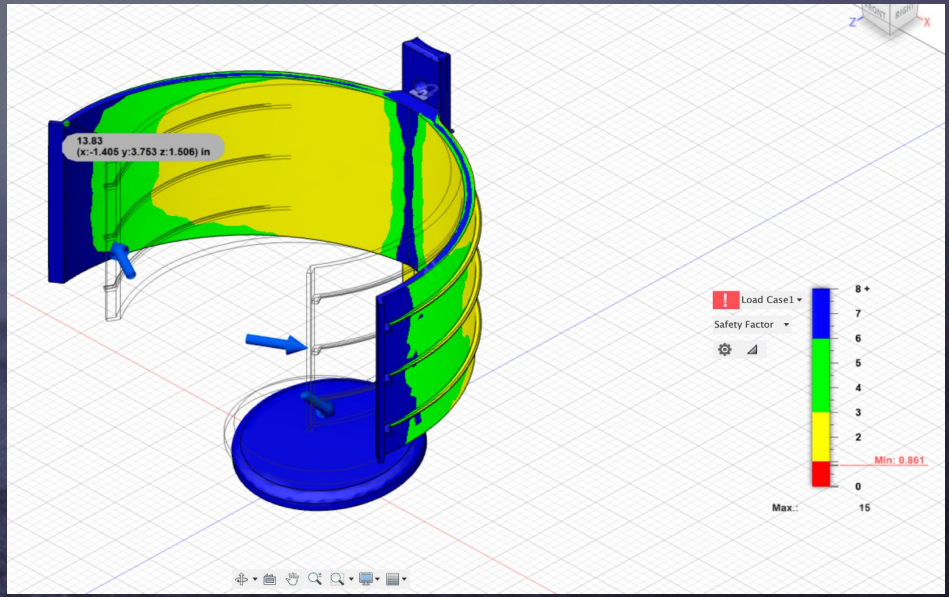
1. Prototyping and Simulations

Prototyping has always been a tool in my design repertoire, but my initial instinct is typically to create an aesthetic prototype, or something that attempts to mimic the look and feel of my final design, as opposed to the functionality. Working in 127 has encouraged me to break from this instinct, working in smaller subregions to validate or challenge my initial assumptions

Although I am not new to simulations, I have previously utilized them to run basic stress tests to understand whether or not a part will fail.
However, in 127, I have had a more in-depth exploration of CAD simulations, accessing different tests ranging from displacements to stress analyses and their respective implications. I have also made point probes a regular facet of my simulations and increased my familiarity with the different scales and sliders to understand weak points of my design simulations.

1. Prototyping and Simulations





Using point probes and the slider to understand more about specific areas of displacement or weakness

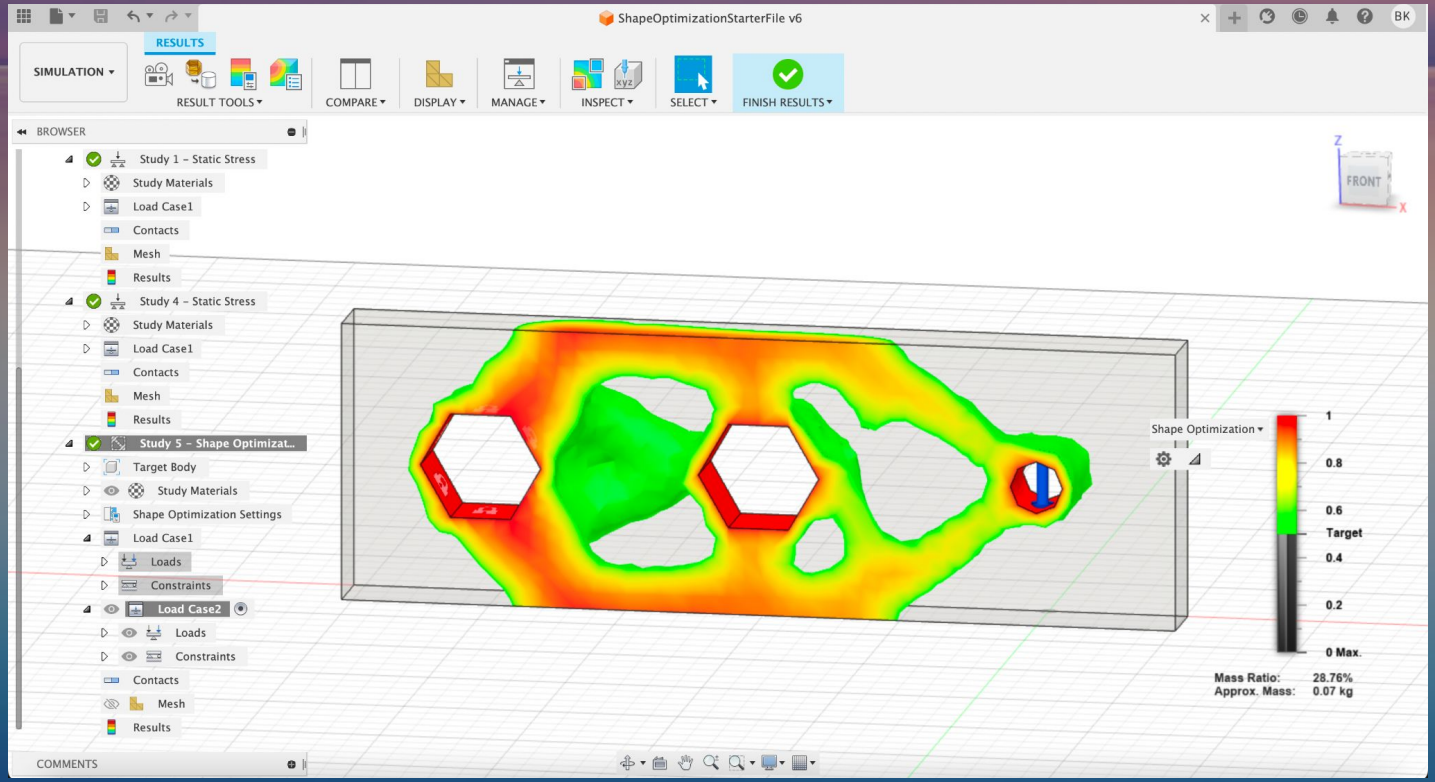
2. Generative Design and Algorithmic Modeling

Although I was previously familiar with simulations, I had yet to explore any form of Algorithmic Modeling. ME 127 gave me the opportunity to work with generative design and shape optimization firsthand.

I have learned that shape optimization is useful in determining areas of a part that experience low stress and thus can be removed from the final design. This is especially useful with incorporating mass efficiency into designs–although I have learned (maybe the hard way) that I need to remember to run another stress simulation to test out the "optimized" part.

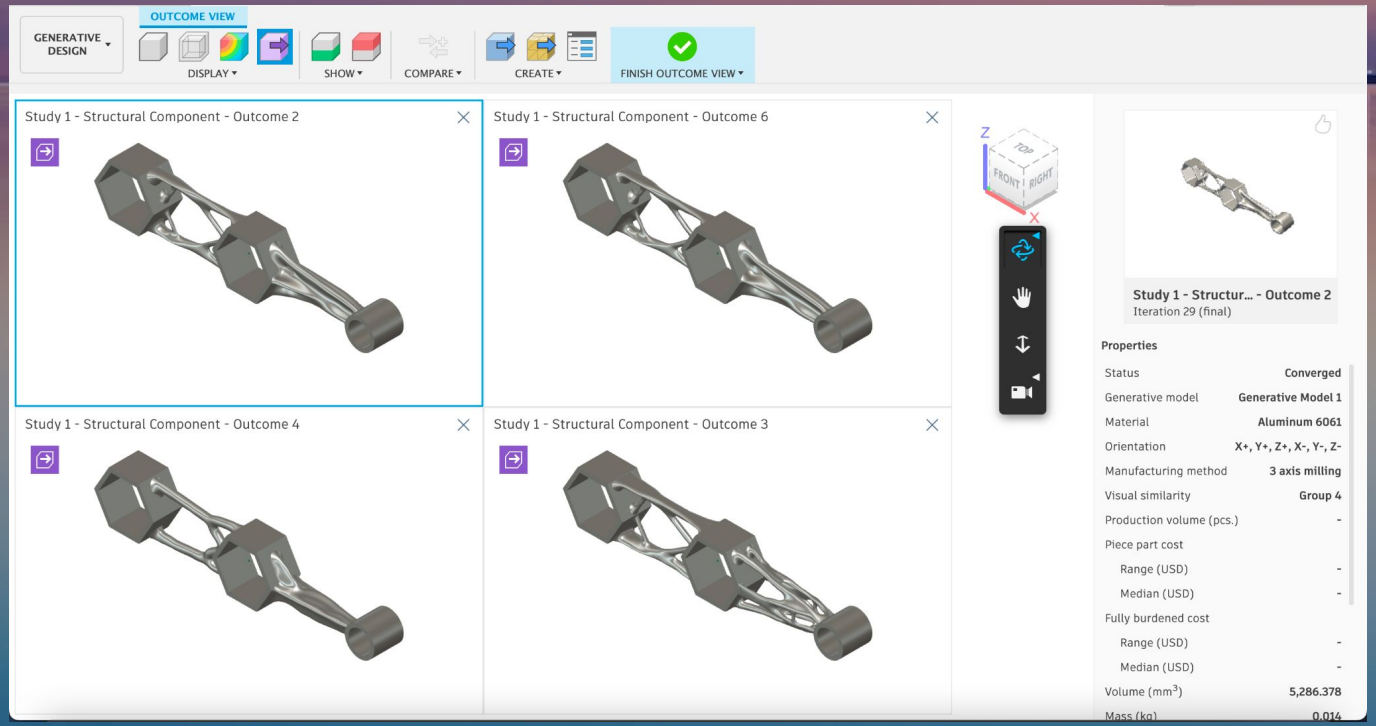
Regarding Generative Design, I have learned and familiarized myself with the process of iterating optimal shapes for a specific mechanism or purpose. By setting obstacle and preserve geometries with specified load cases, I can inform the algorithm how to yield a unique and "optimized" part to withstand the load cases while being mass-efficient.

2. Generative Design and Algorithmic Modeling



Shape Optimization Simulation, with the preserve geometries protected from material

2. Generative Design and Algorithmic Modeling

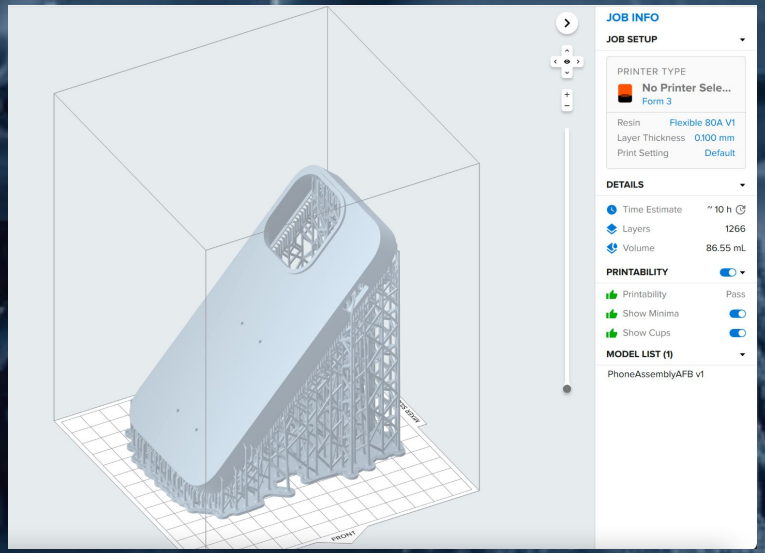


Designs iterated by Generative Design

3. Understanding Material Properties and their Implications

When previously working with Additive Manufacturing, I primarily worked with Tough PLA, partially due to accessibility but also because it is the only material I knew how to use. Essentially, I would make sure the material was loaded properly and push a button. ME 127 pushed me out of my comfort zone in working not only with different materials, but also with different printers. I have worked with SLA FormLabs printers, printing with Flexible 80A and Tough 1500 Resin for my group Phone case and my flexible water bottle holder.

3. Understanding Material Properties and their Implications



More importantly, I have gained not only an understanding but also an appreciation for the specific material properties that result in one material being more advantageous than another. I have learned the drastic impact of using different (or inaccurate) materials when modeling static stress analyses. Additionally, I have learned firsthand the importance of build plate orientation, as the printed materials have direction-specific properties. I needed to account for this in print settings–if not in my design itself–all while taking into consideration the print time of different orientations.

4. Simplicity is Key

I have the worst habit of making a mountain out of a molehill. Just last year when in ME 103, I had grandiose plans to either design a 1) life-size size-changing mannequin or 2) a full-length accessible guitar player. I thought I had learned my lesson about scoping my projects to reality, but found that even in ME 127, I associated complexity with success. Projects like the space wrench were key because I was able to ideate the first solution that entered my mind, without question.

While working in ME 127, I eventually built the habit of developing an appropriate yet feasible design to tackle each problem. Once I knew that my simple solution was successful, I could then progress into complexifying the design into something more robust. This proved successful in working on my Space Wrench as well as the *PortaBottle*, as I knew that I had something I could fall back on if my latest iterations fell through. Throughout this quarter, I had to force myself to realize that simple is not necessarily uninspiring, just as complexity is not always successful.

Final Reflections

A Final Word

Prior to ME 127, I thought that I knew everything about Computer-Aided Design and 3D Printing, but this class had proved me quite wrong. My prior understanding of Additive Manufacturing was quite shallow, and this class was the perfect opportunity to explore this growing field in greater detail. As someone who is trying to translate his Product Design skills into the field of Mechanical Engineering, this class was extremely useful not only in the concepts I have learned (how to use Fusion 360 and print using a variety of different equipment) but also in the skills I have accrued.

This class has encouraged me to think broader, deeper, and always a few steps ahead. I have been forced to second guess my initial instinct, as perhaps Flexible 80A might be a better material to be used for a soft-shell phone case than would Durable or Elastic. I have honed my ability to adapt to new situations, as most of my projects diverged from the intended design–although I am determined to 3D print a Chili's necklace + pendant. I have been training myself to remember that a mistake is not the end of the world, and any moment of failure can be capitalized as a moment for growth.

Ultimately, I have increased my comfort level in working with the machines in Room 36, and I am now fully adept at modeling and printing my own projects, reloading material spools or cartridges, and most importantly, helping anyone who needs assistance.

All the same, this increasing confidence in Room 36 does not mean that I am now fully independent to work individually. I will probably continue to bombard Dan with silly questions, posit the questionable extent of my abilities with Stephen, and discuss Taylor Swift lore at length with Blake.

Thanks!

Special Thanks to Dan, Blake, and Stephen for an extremely fun and engaging quarter