



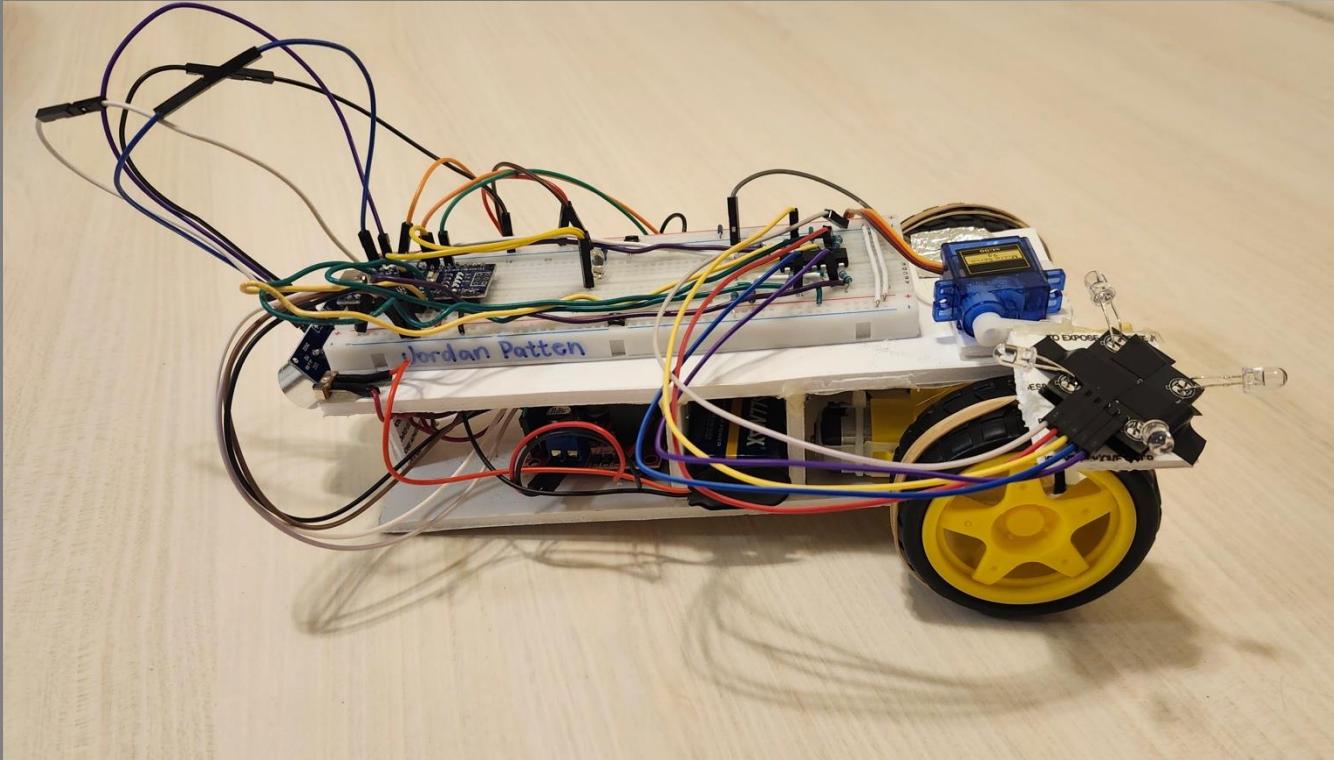
ENGINEERING PORTFOLIO

JORDAN P. HARDY

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LIGHT FOLLOWING ROBOT

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[Link to a Video of the Completed Robot](#)

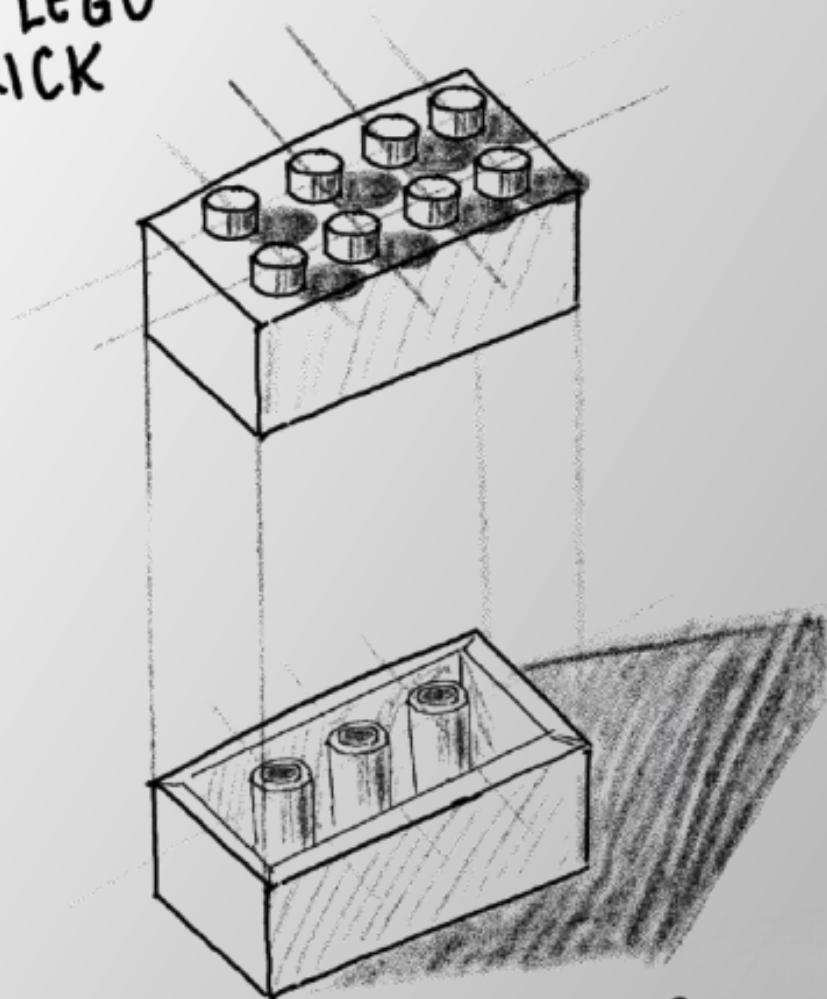
Built a robot capable of following a light source in a dark environment with integrated collision protection and servo control. Key aspects included:

- **Circuit Design:** Assembled and tested circuits using resistors, capacitors, voltage sources (battery), DC motors, and a breadboard.
- **Embedded Systems & Control Logic:** Programmed an Arduino and used a finite state machine to control the robot's behavior.
- **Mechanical Problem Solving:** Diagnosed and resolved wheel slippage by adding rubber bands for traction, improving mobility and performance.

LEGO CONFIGURATION GENERATOR

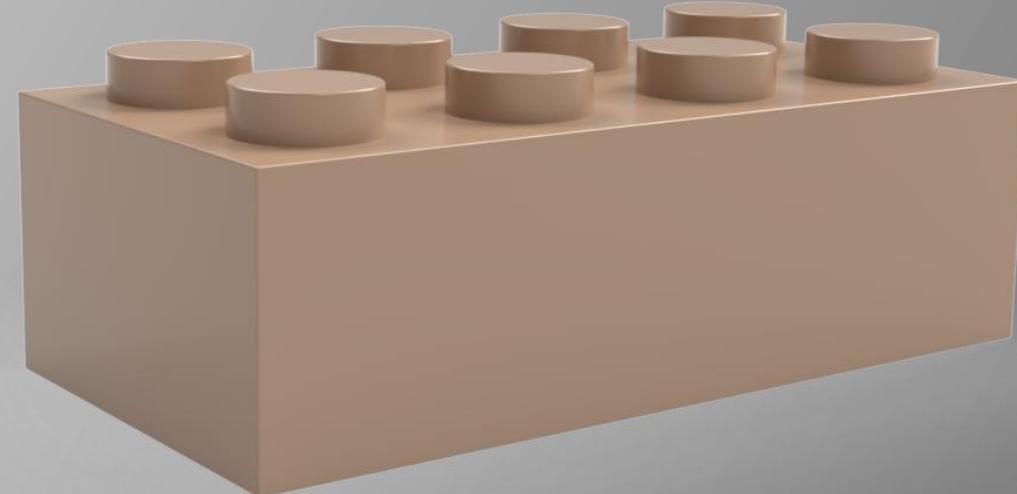
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2x4 LEGO
BRICK



Jordan Patten
04 FEB 2025

2x4 Lego Brick created using
the displayed configuration
table.



Configurations

Width (Studs) 2

Length (Studs) 4

Height

Stud

Tubes

1xX Tubes

Color

Scale 0.397

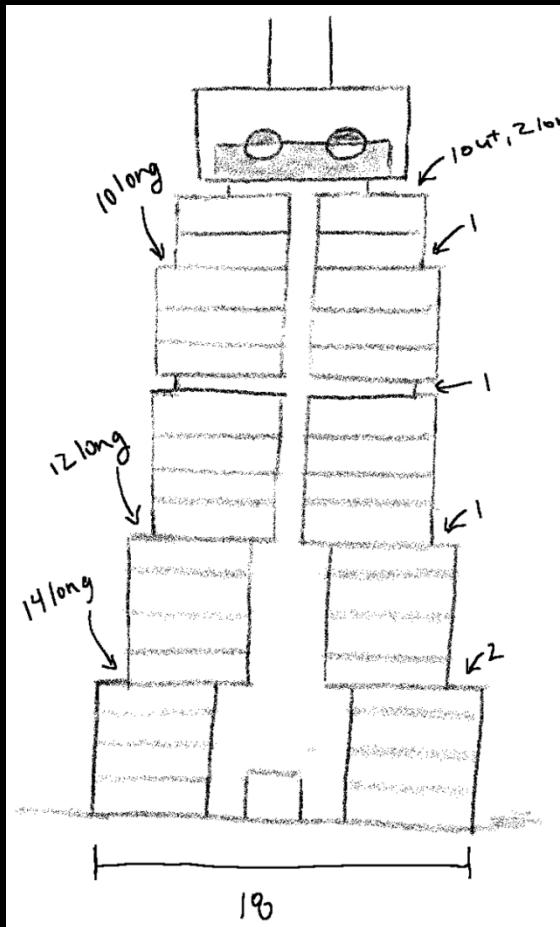
LEGO STRUCTURE - THE ROBOT BUILDING

BANGKOK, THAILAND

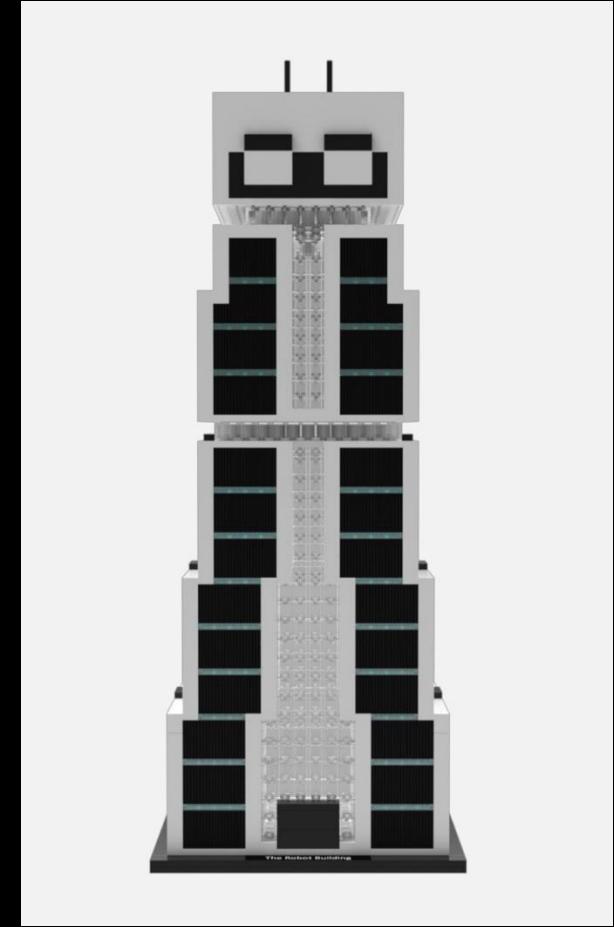
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Inspiration Image



Final Ideation Sketch



Final Lego Assembly

The Lego Structure Assembly was created using the Lego Piece Configuration Generator pictured earlier.

MATERIALS SELECTION TABLE

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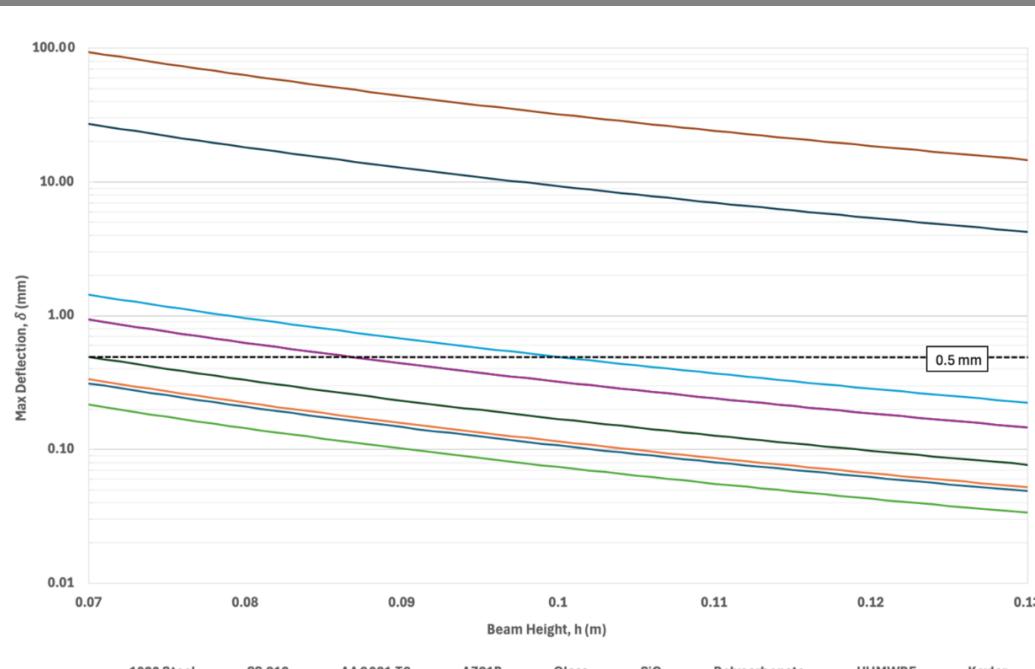


Figure 1. Comparison of the maximum deflection of a crossbeam of a swing set, modeled as a simply supported beam under a center load, for different materials as a function of beam height. Material data from Callister, 10e, Appendix B.

Table 1. Material Comparison for swing set beam. Data from Appendix B in textbook, except where noted. Material properties are taken at the high end of their range.

	Mass (kg)	Cost (\$)	Max Deflection (mm)	Corrosion Resistance	Stress to crack (MPa)	Safety Factor
1020 Steel ¹	487.5	901.85	0.3968	Good	2212.31 ²	10.14 ³
316 Stainless Steel ⁴	496.8	3601.80	0.4255	Good	2948.67 ^b	5.94 ^b
AA6061-T6	167.7	1291.06	1.1903	Good	940.72 ^b	8.00
AZ31B Mg ⁵	109.9	5495.85	1.8251	Poor	908.28	5.80
Glass ⁶	155.3	1412.78	1.1903		24.33	2.00 ⁷
SiC	198.7 ⁸	39744.00 ⁹	0.3968		155.71	15.07 ^e
Polycarbonate	74.5	298.08 ¹⁰	34.5072		64.88	1.80
UHMWPE	58.4	466.99	119.0250		129.75 ¹¹	0.80
Kevlar FRP	86.9 ¹²	5651.10	0.6269		63.58 ¹³	118.84 ¹⁴

¹ Cold rolled

^f Soda-Lime

^j Sheet

^b From [Matweb](#)

^g Flexural Strength

^k From [Link](#)

^c Minimum

^h Sintered

^l 60% volume fraction

^d Hot finished and annealed

ⁱ α -phase

^m 7% with PMMA, from [Link](#)

^e Extruded

ⁿ Tensile Strength

Modeled a swing set crossbeam as a simply supported beam under a center load to identify materials meeting a maximum deflection limit of 0.5 mm. Compared several materials for stiffness, weight, cost, and durability. Created a graph and table in Excel to visualize performance and determine the optimal material under given design constraints.

NES CONTROLLER

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- Modeled using engineering drawings drawn by C. A. Mattson.
- CAD operations used in the completion of this project include lofts, revolves, sweeps, and patterns.
- Many parts were modeled, including the Start/Select Buttons, the A/B Buttons, the D-Pad, the Top and Bottom covers (with supports and rib bosses) and the PCB. Other parts, such as the charging cord, were provided as part of the project.



STATIC ANALYSIS OF A SCISSOR JACK

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- Analyzed the stresses and strains experienced by a scissor jack pin during standard operation using ANSYS.
- Proposed geometric design changes based to increase safety factor, enhance structural integrity, and avoid failure.

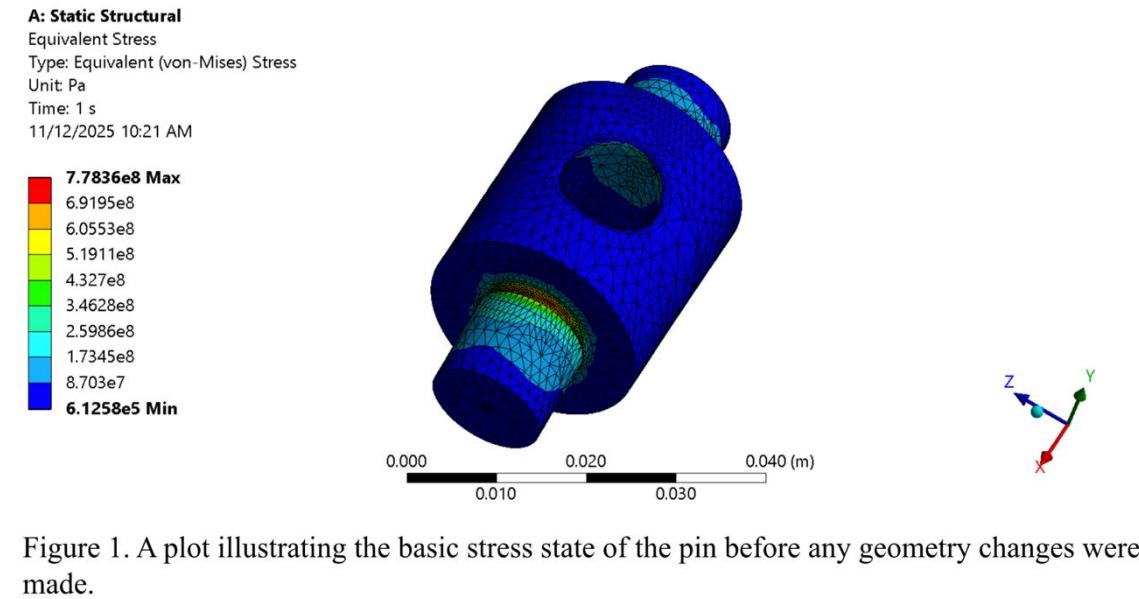


Figure 1. A plot illustrating the basic stress state of the pin before any geometry changes were made.

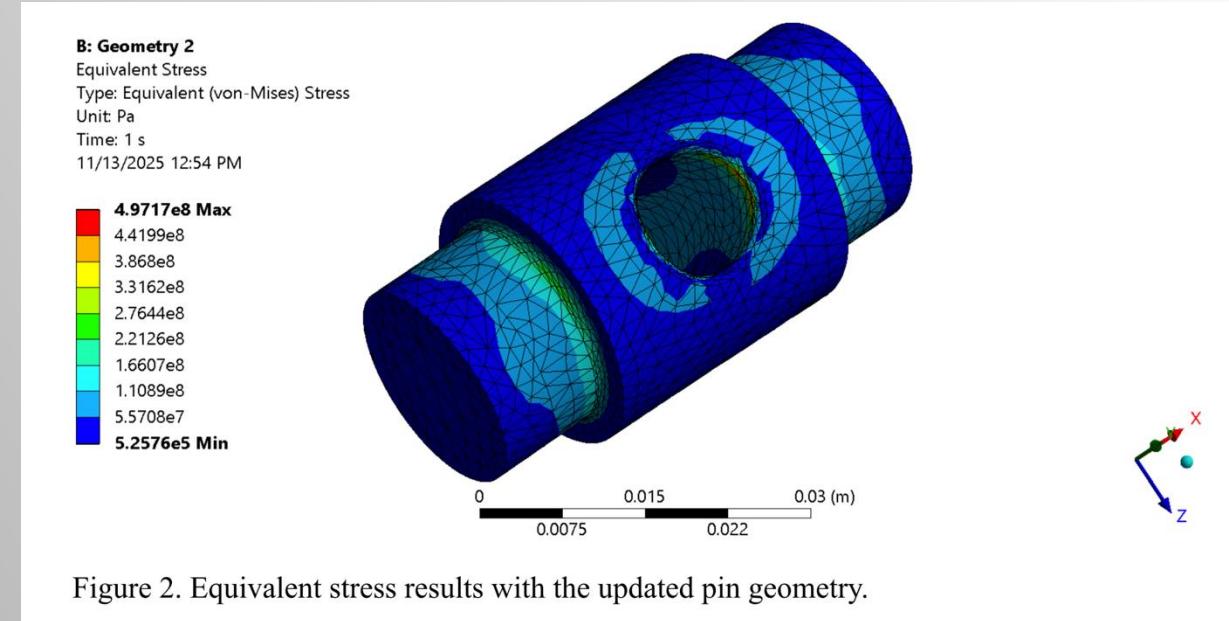


Figure 2. Equivalent stress results with the updated pin geometry.

- **Boundary Conditions:** Applied fixed supports and load vectors to simulate real-world vehicle lifting.
- **Material Properties:** Assigned structural steel properties to the geometry.
- **Meshing & Refinement:** Generated an initial automatic mesh followed by manual refinement in high-stress regions.
- **Validation:** Utilized a mesh convergence tool and validated the results against closed-form hand calculations.

PNEUMATIC PIPSQUEAK ENGINE

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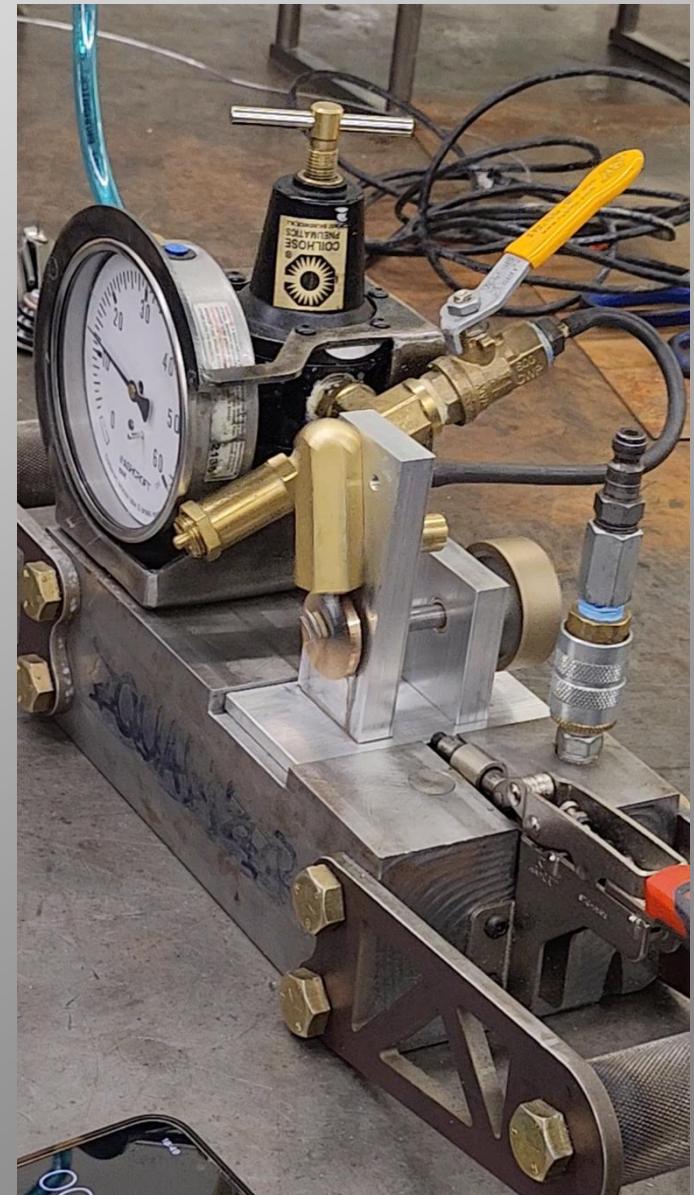
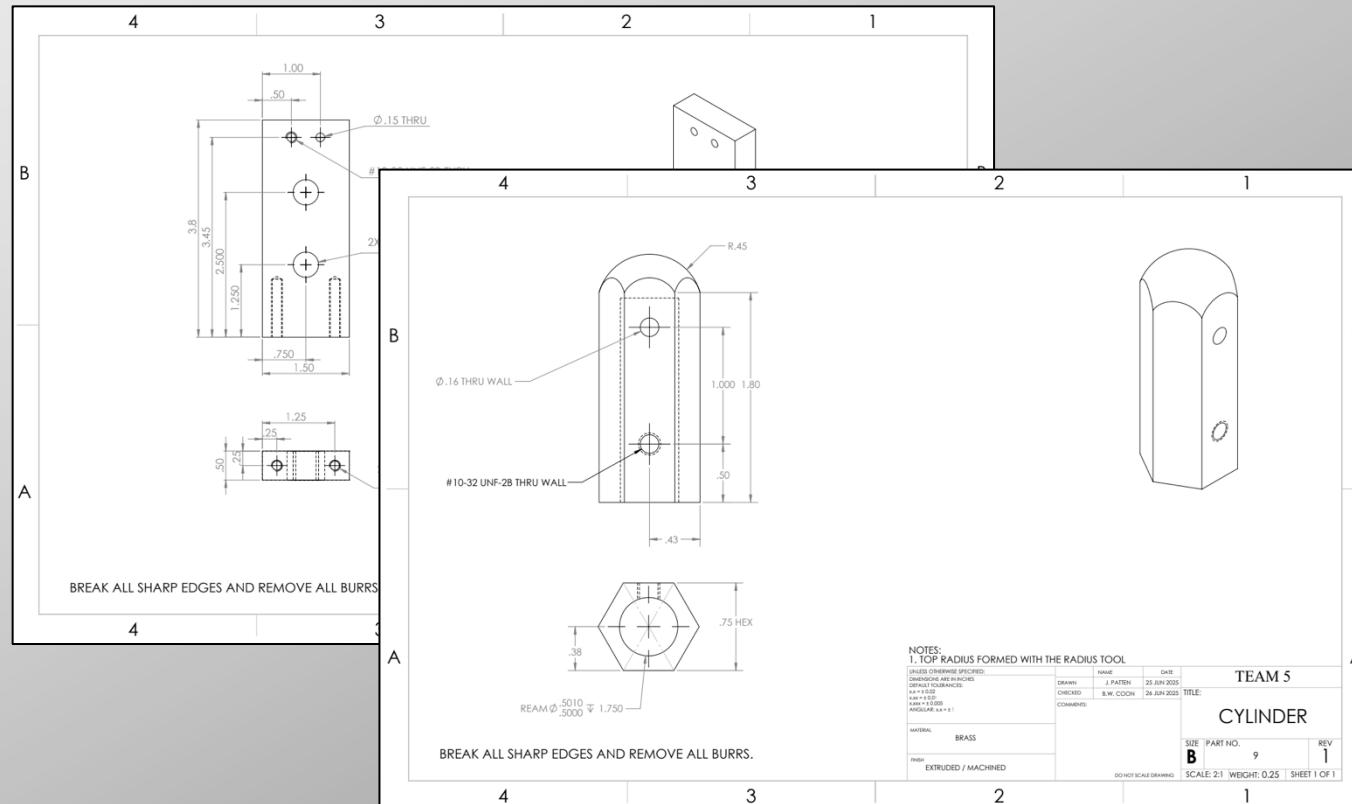
As part of a four-person team tasked with improving an engine design, modifications were proposed and implemented to improve the manufacturability of the pneumatic engine assembly. Detailed process sheets were developed for each component, outlining appropriate tooling and machining operations. Components were manufactured using a range of techniques, including CNC milling, manual turning, sand casting, and powder metallurgy.



PNEUMATIC PIPSQUEAK ENGINE

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Once all components were manufactured, the engine was fully assembled and tested. As a result of the team's design modifications, the engine operated at a lower PSI than any other team's engine built from the same initial design and specifications. A comprehensive design report was compiled, including detailed engineering drawings, process sheets for each part, documentation of implemented design changes, and recommendations for future improvements.



[LINK TO RUN TIME VIDEO](#)

PUNXSUTAWNEY PHIL STATISTICAL ANALYSIS

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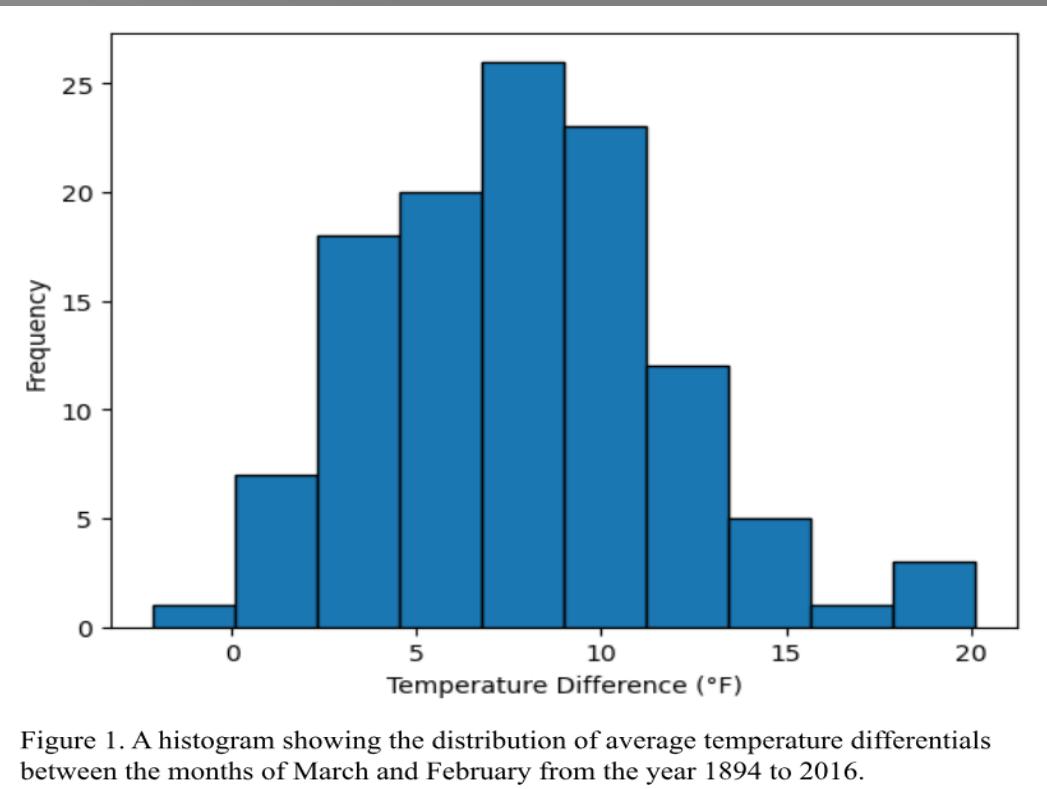


Figure 1. A histogram showing the distribution of average temperature differentials between the months of March and February from the year 1894 to 2016.

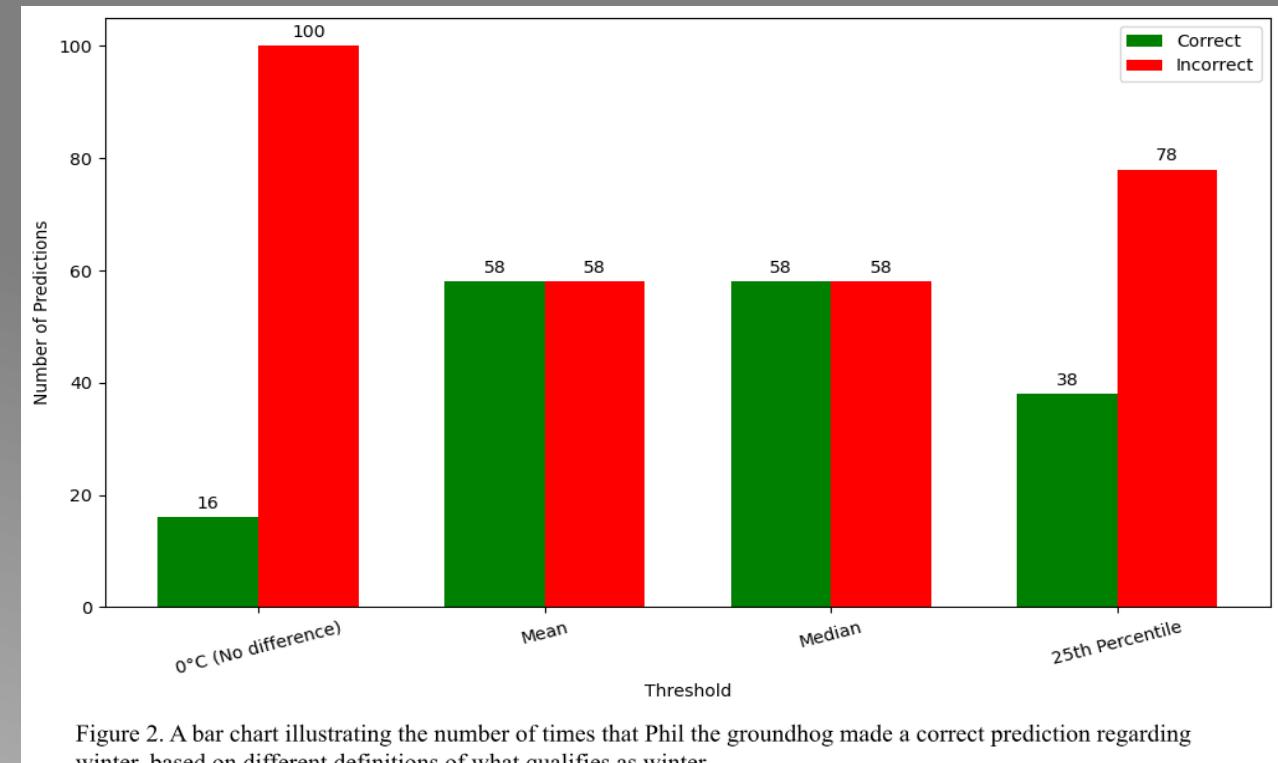
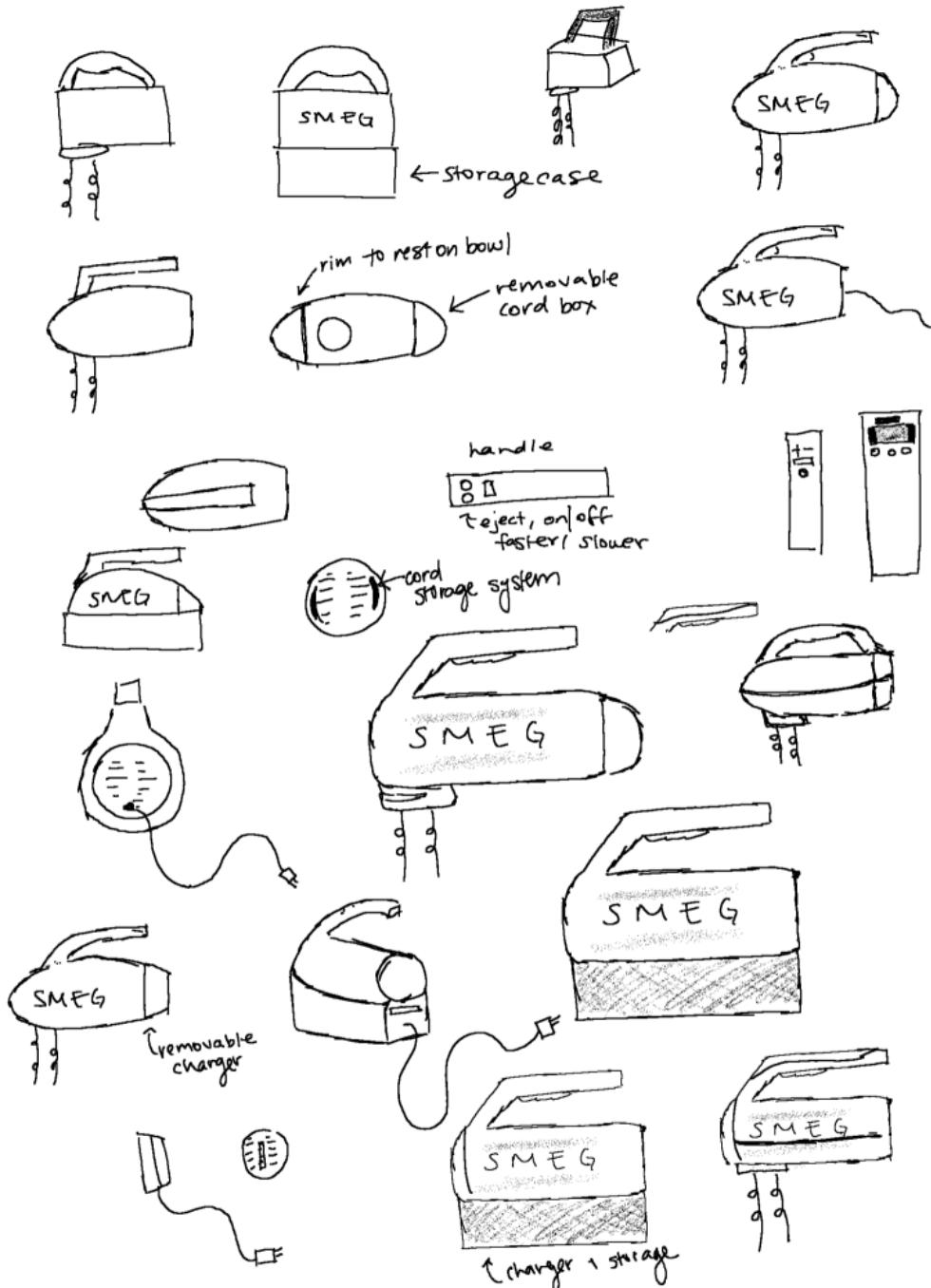


Figure 2. A bar chart illustrating the number of times that Phil the groundhog made a correct prediction regarding winter, based on different definitions of what qualifies as winter.

Analyzed 118 years of Groundhog Day predictions to evaluate the accuracy of Punxsutawney Phil's forecasts using Python and historical weather data. Performed hypothesis testing and confidence interval calculations to determine if Phil's predictions correlate with actual temperature changes between February and March. Created graphs and tables in Python to visualize results and found no significant evidence that Phil's predictions are more accurate than chance.



NEXT GENERATION SMEG HAND MIXER

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Current Generation

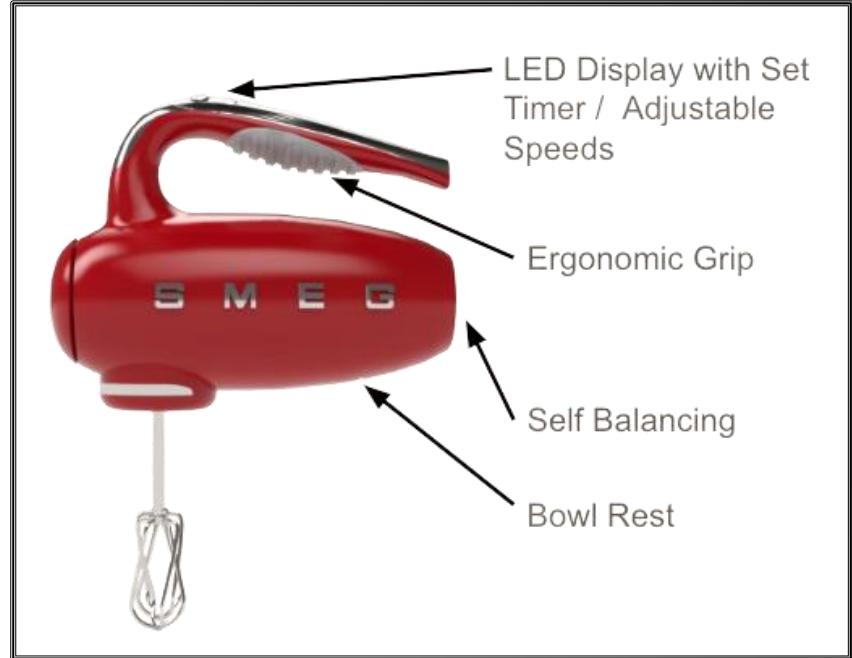


Next Generation Design

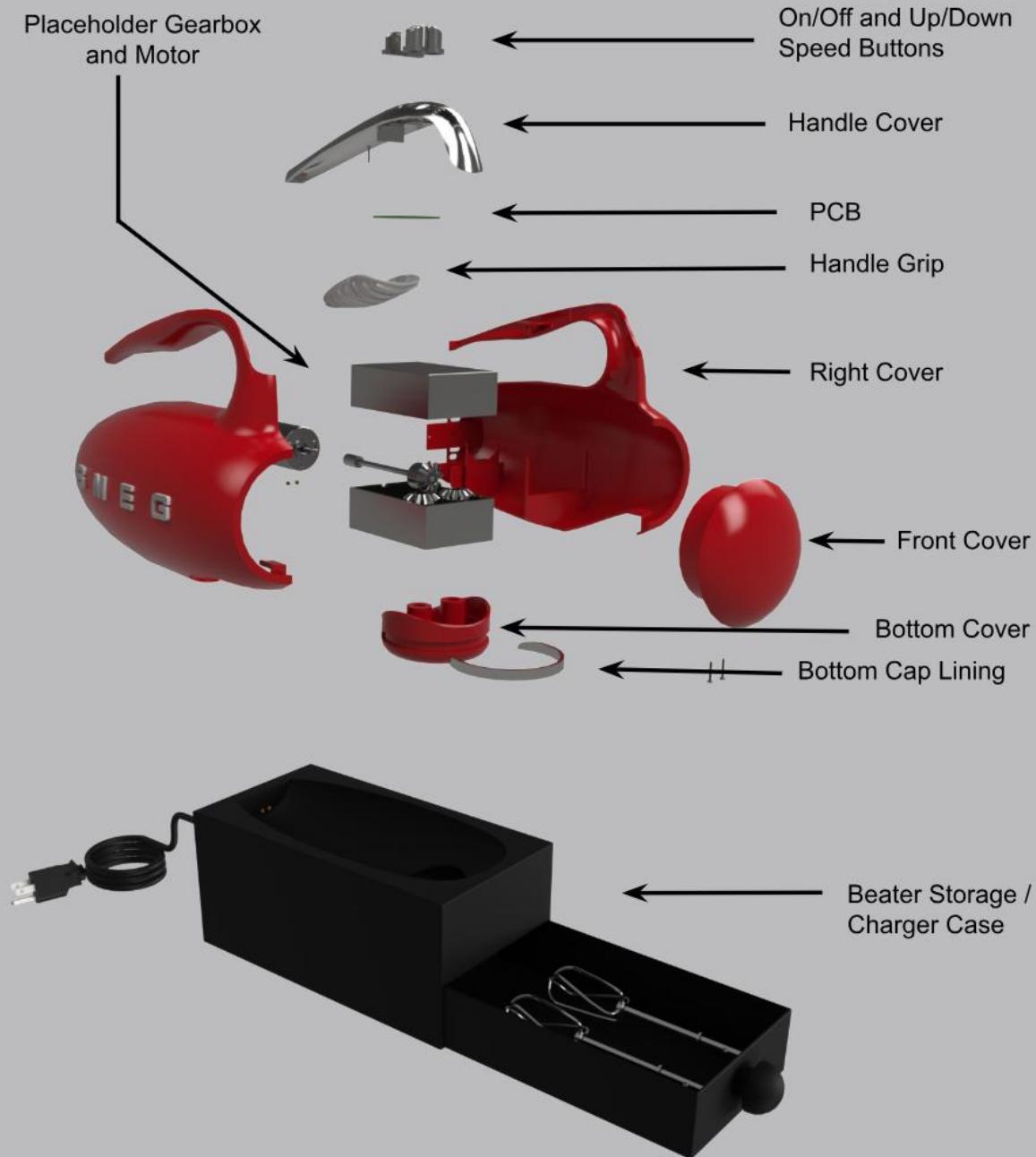
This project aimed to modernize an existing design by enhancing its appearance and implementing mechanical improvements for better functionality.

NEXT GENERATION SMEG HAND MIXER

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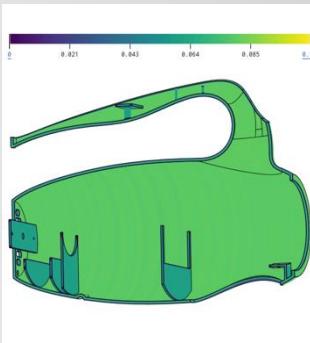


Most parts in the assembly were created using a master model and offset surfaces. The body of the master model was created with a revolve, while the handle was formed using a complex loft that follows a guide curve.

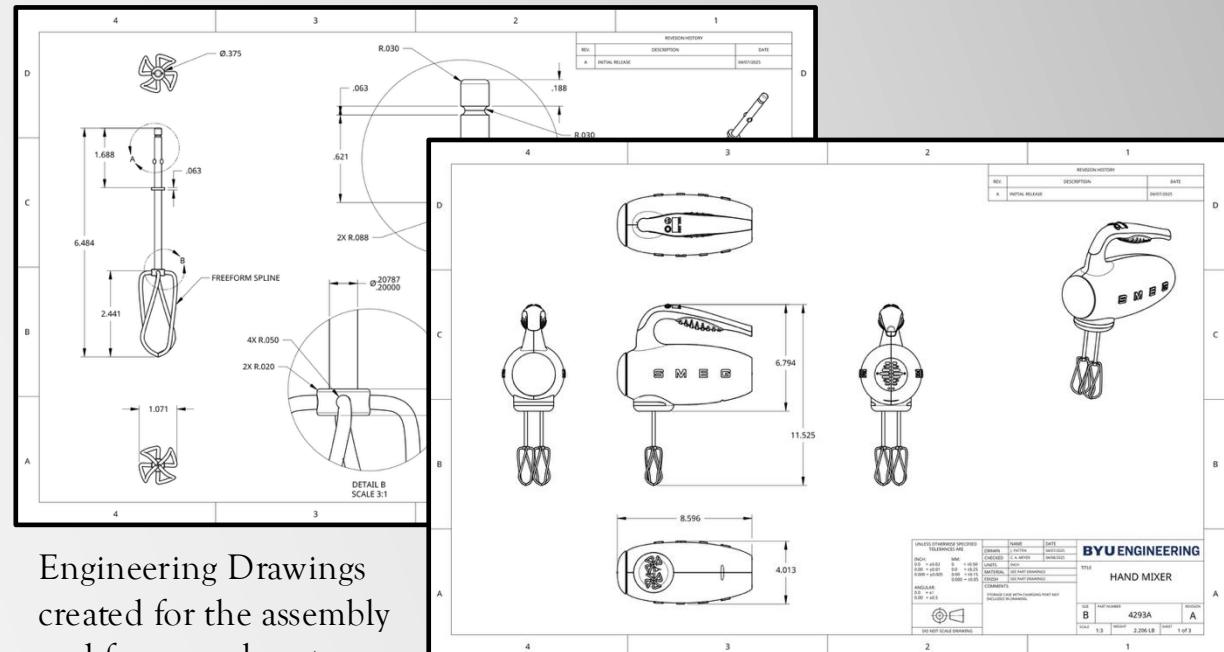


NEXT GENERATION SMEG HAND MIXER

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Many tests were run during the modeling process to make sure that a desirable result was being created. These tests were used to determine whether the interferences that occurred were expected, whether the model had a constant wall thickness so it could be constructed with injection modeling, and whether the model had a constant curvature in the intended areas.



Engineering Drawings
created for the assembly
and for several parts.

