Wayside Power & Distribution

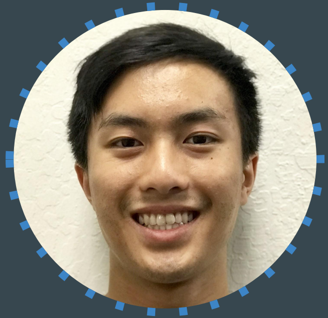
San Jose State University
Charles W. Davidson College of Engineering
ME195B Senior Design Project I- Section 04
Professor Furman
May 8, 2020

Aryamitra Bake (Melody), Shane Sharp, Reynaldo Jahja, Waylon Chan, Alex Ng

Meet the Wayside Team!

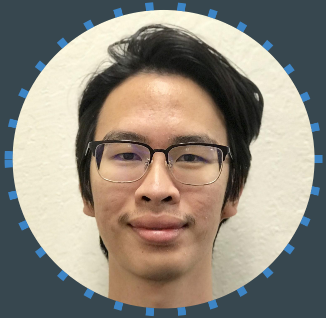
Shane Sharp
(ME Design, Fabrication)

Alex Ng
(ME Design, Fabrication)



Waylon Chan
(Electrical, Prototyping)

Melody Bake
(Electrical, Prototyping)



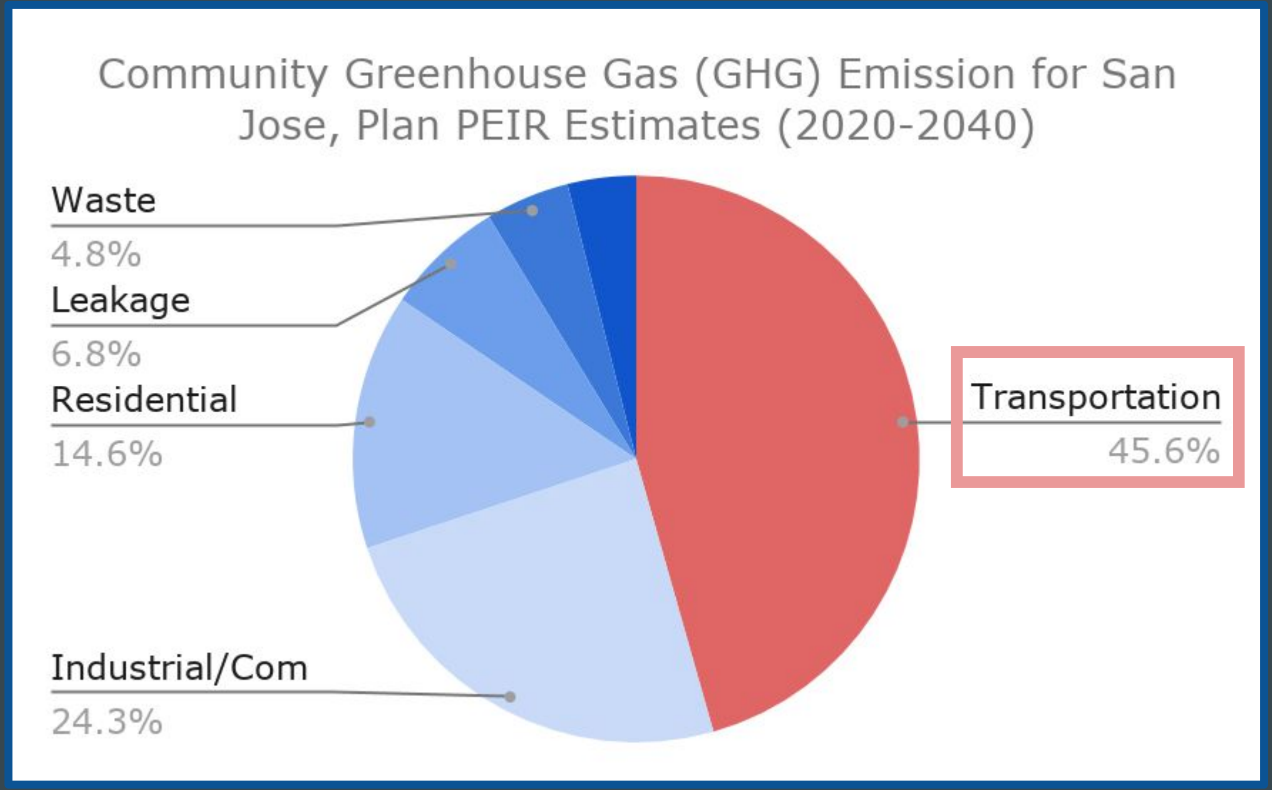
Reynaldo Jahja
(ME Design, Drafter)

SPARTAN SUPERWAY

Alex

What is Superway?

Climate change and traffic congestion must be resolved



Data Source: https://www.sanjoseca.gov/home/showdocument?id=22093

SPARTAN SUPERWAY

Melody

SPARTAN Superway utilizes renewable energy and relieves traffic congestion

Source: sites.google.com

SPARTAN SUPERWAY

Melody

SPARTAN Superway utilizes renewable energy and relieves traffic congestion

Morgantown

Heathrow

Masdar City

Rotterdam Shuttle

Suncheon Bay

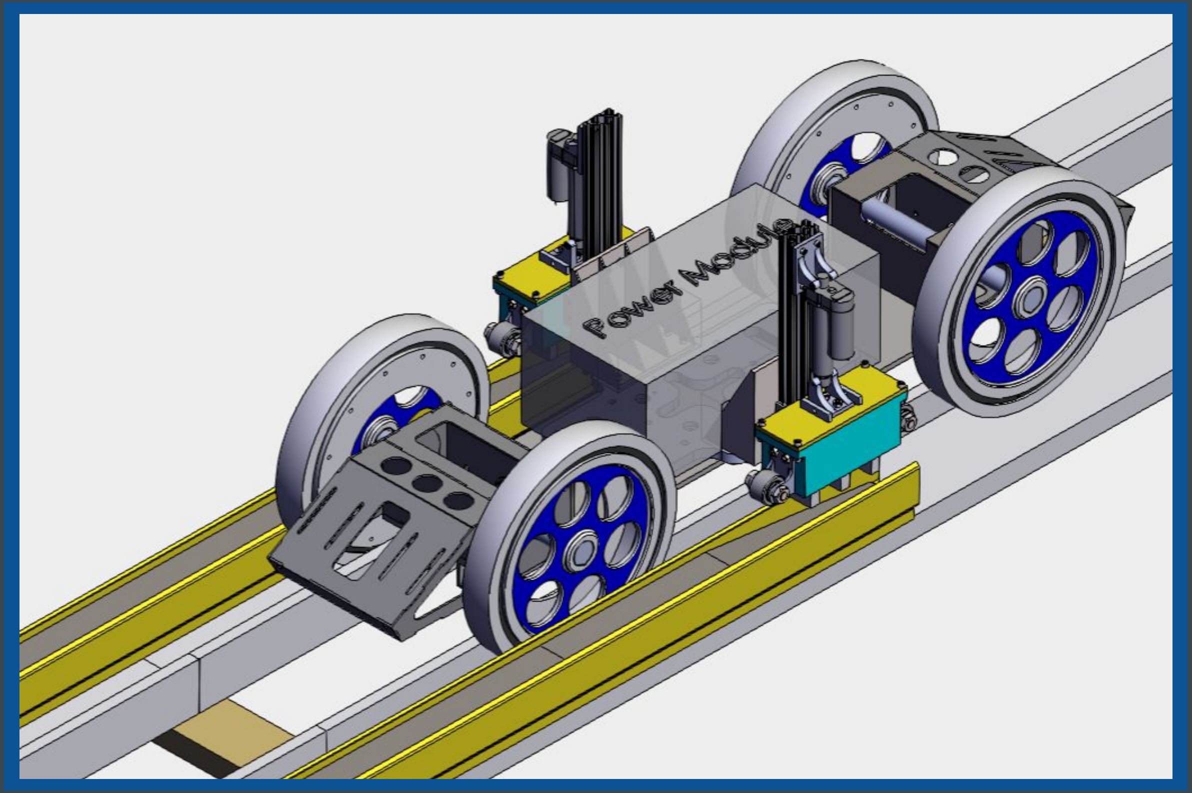
SPARTAN SUPERWAY

Source: https://transweb.sjsu.edu/sites/default/files/1227-automated-transit-networks.pdf

Melody

Goal of Wayside Power

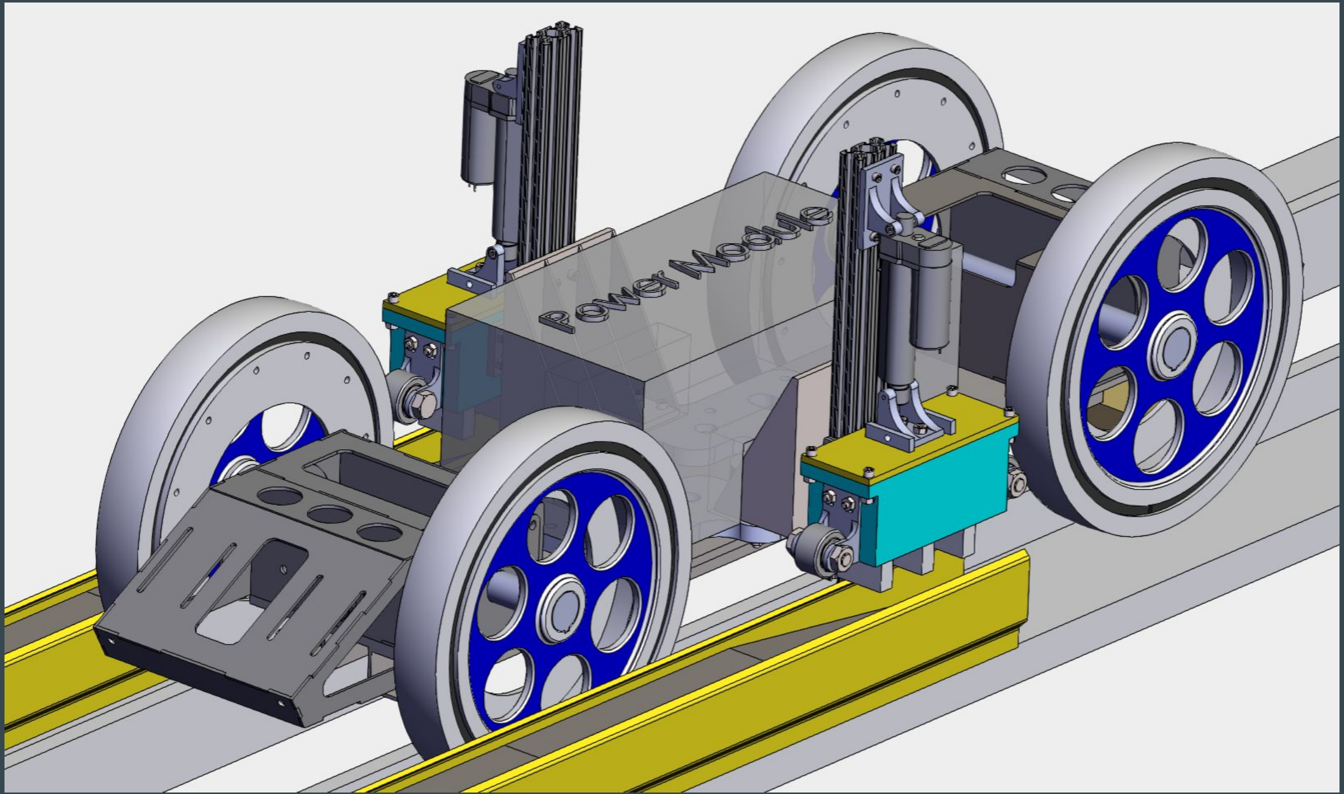
Today's rails use costly and inefficient wayside power systems that span the entirety of guideways



SPARTAN SUPERWAY

Melody

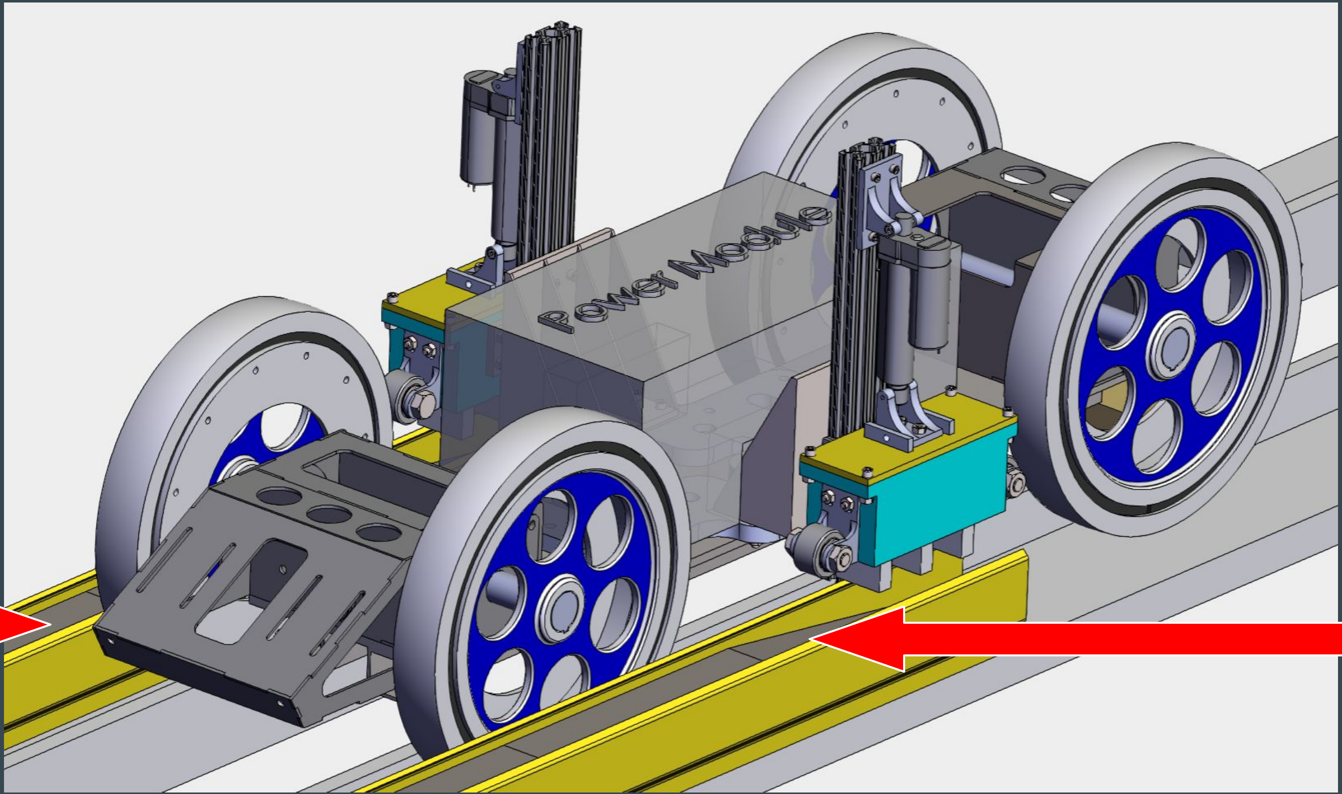
The third rail power system and pick-up mechanism are key components for propulsion



SPARTAN SUPERWAY

Shane

The third rail power system and pick-up mechanism are key components for propulsion



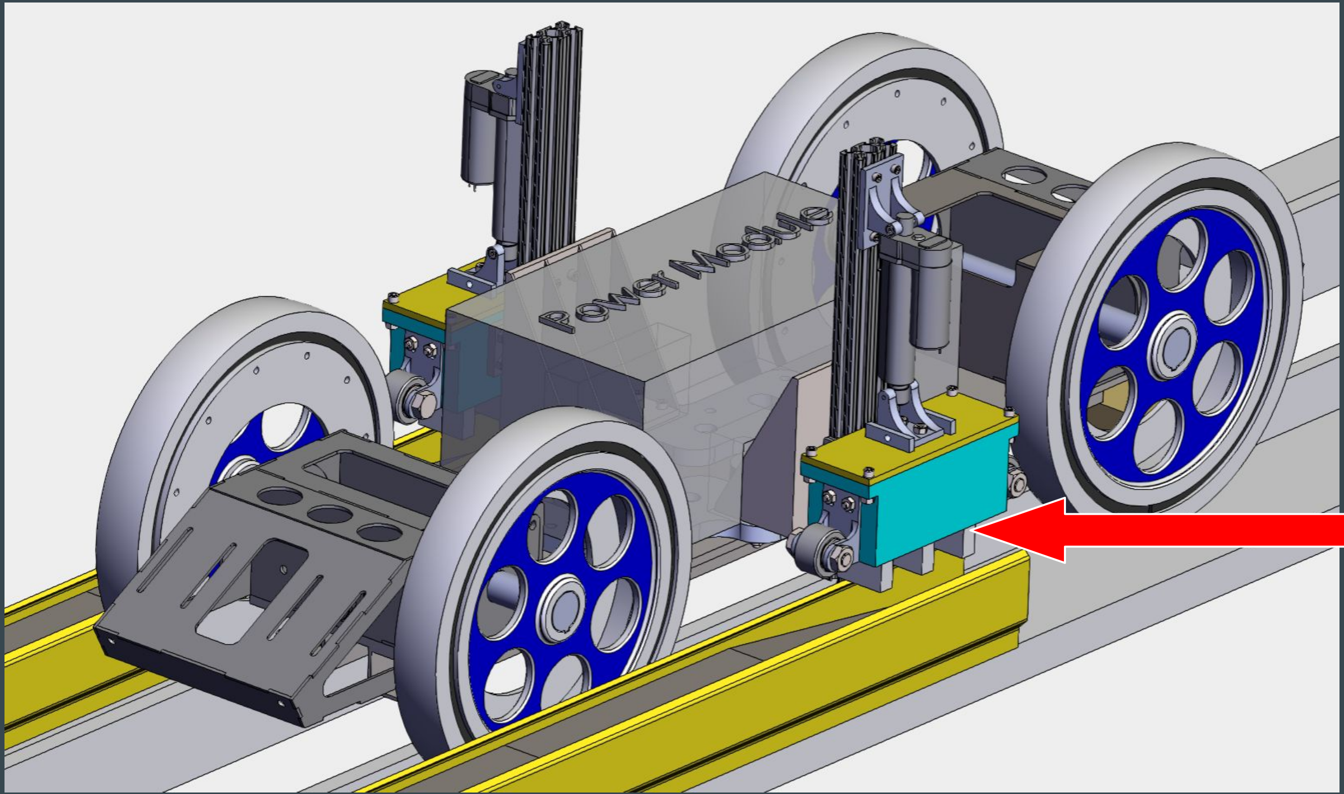
Third Rail

Third Rail

Spartan Superway

Shane

The third rail power system and pick-up mechanism are key components for propulsion

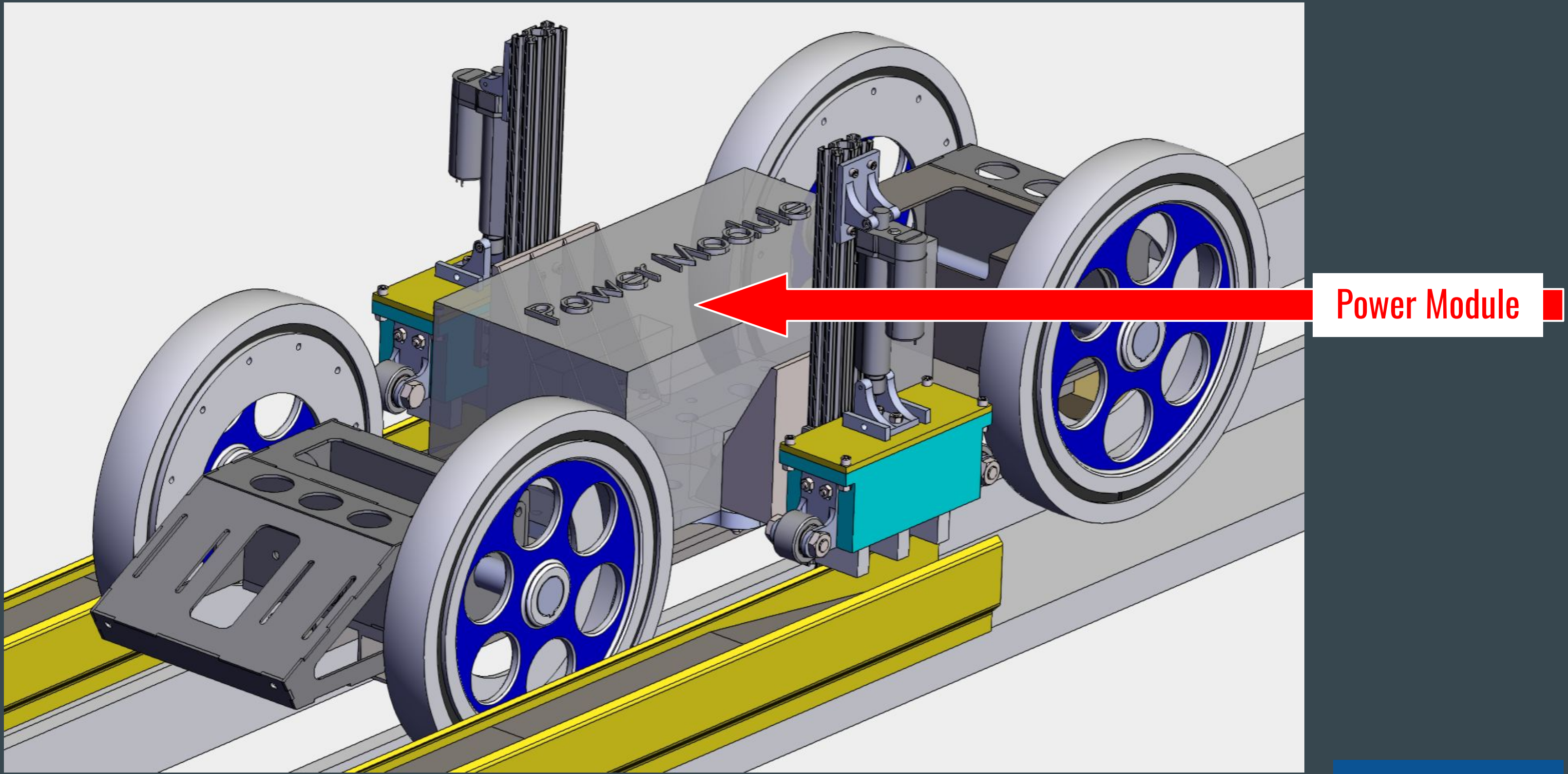


Conductor Shoe

SPARTAN SUPERWAY

Shane

The third rail power system and pick-up mechanism are key components for propulsion



SPARTAN SUPERWAY

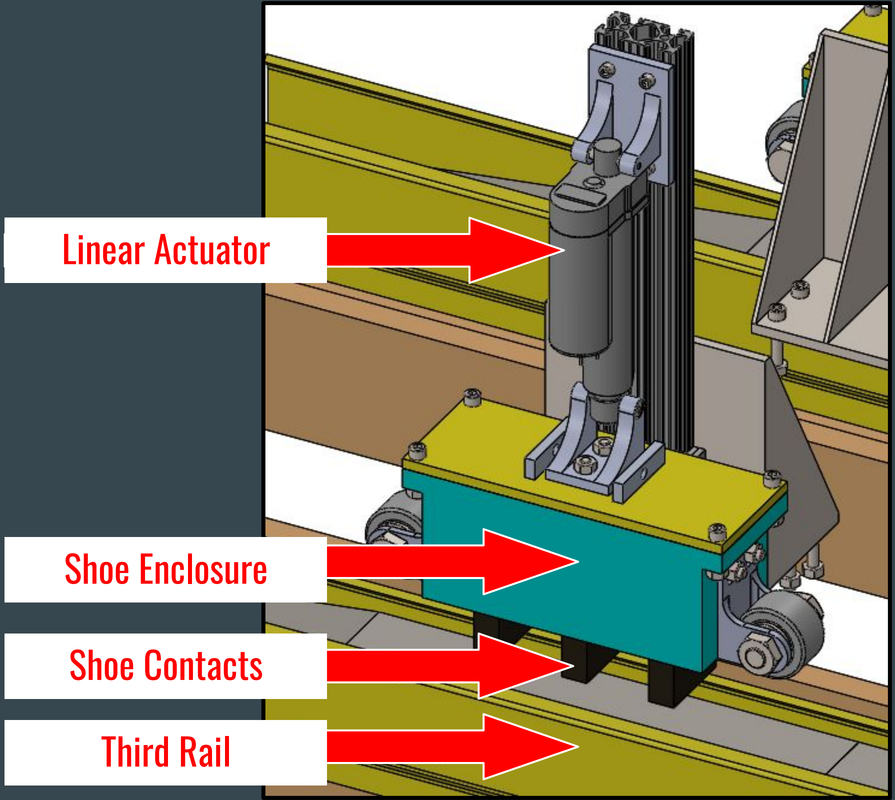
Shane

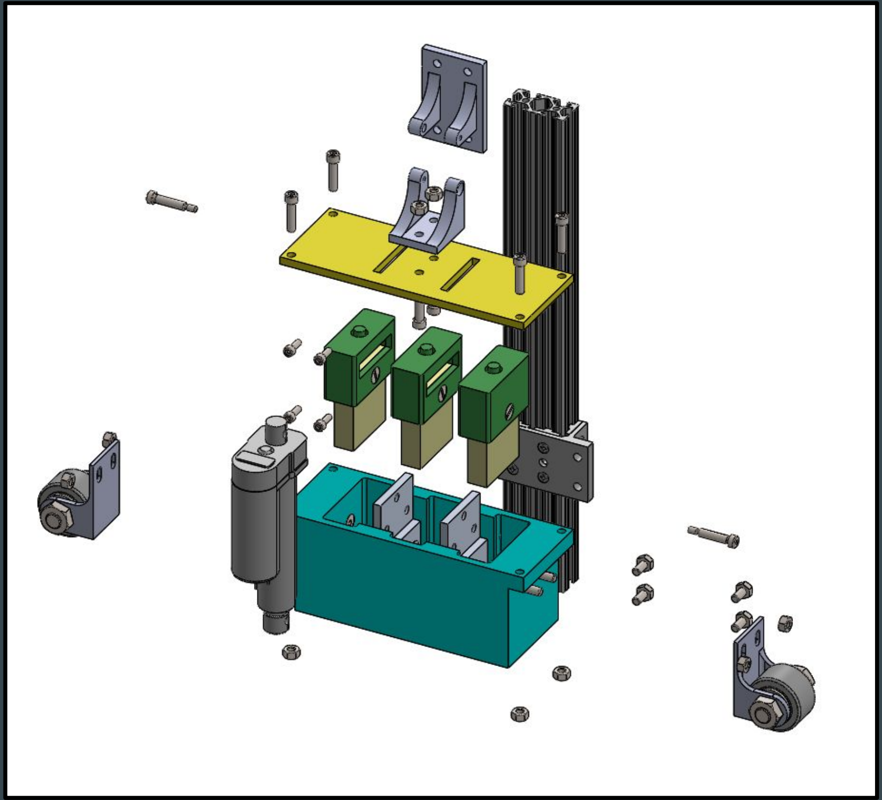
The third rail power system and pick-up mechanism are key components for propulsion

Full Scale Specifications		
Description	**Specification**	**Units**
Track length	30	ft
Velocity of pod car	3	ft/s
Current output of third rail	33.3	A
Supply voltage	36	V
Current collector shoe force	5-7.5	lbf
Shoe Spring Constant	6.8	lb/in

Literature Review

Patent research inspired our state-of-the-art design





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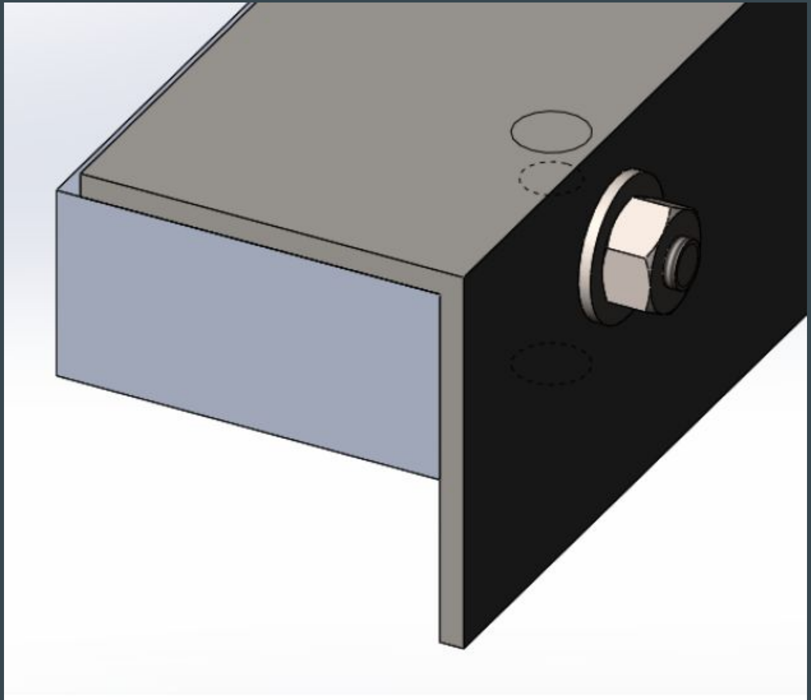

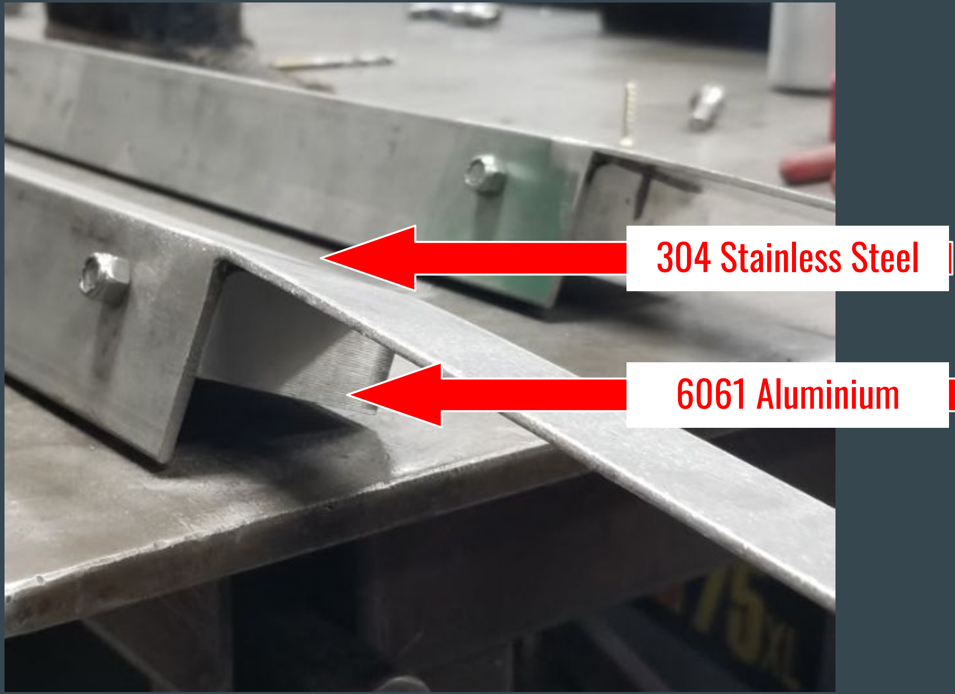

SPARTAN SUPERWAY

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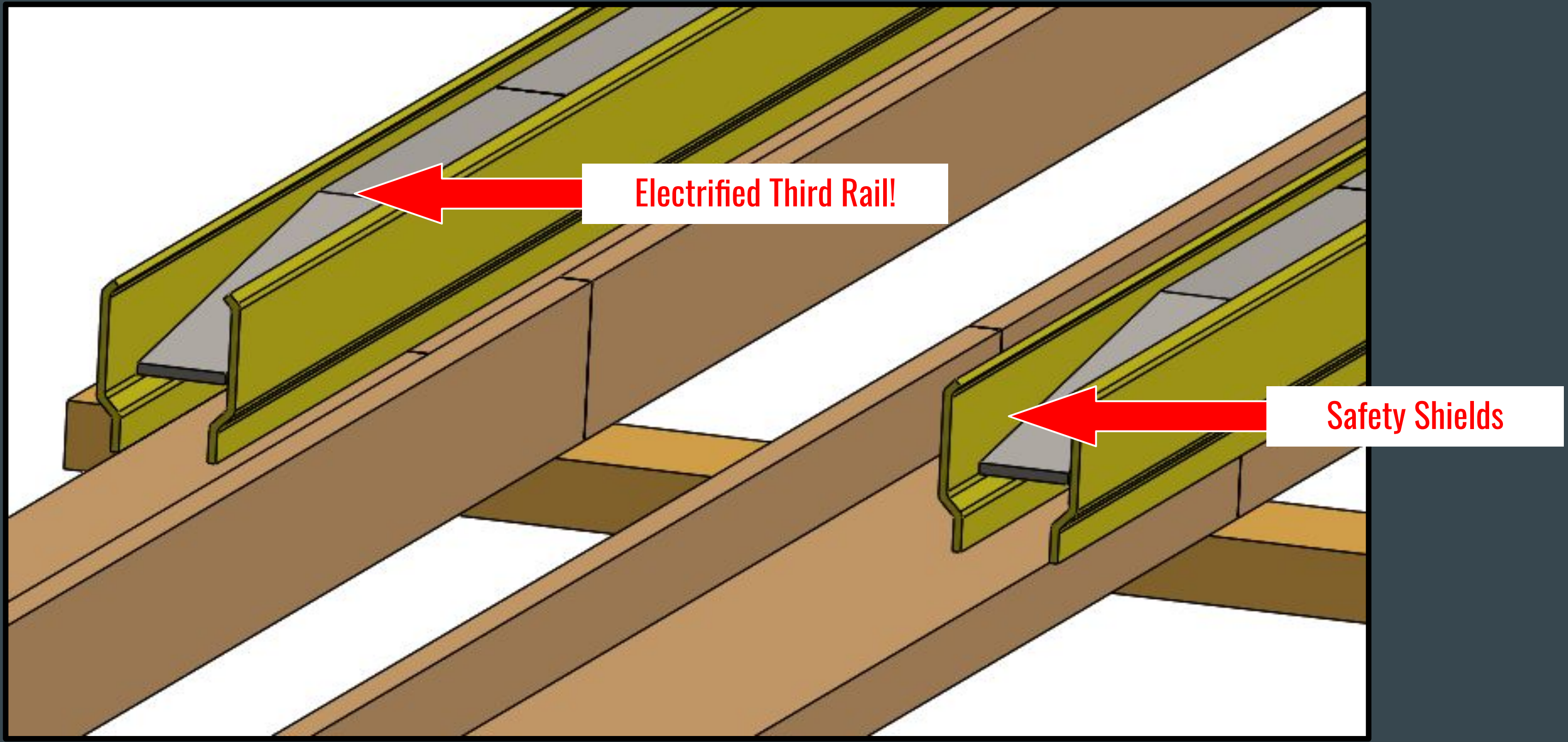


SPARTAN SUPERWAY

Shane

Patent research inspired our state-of-the-art designs

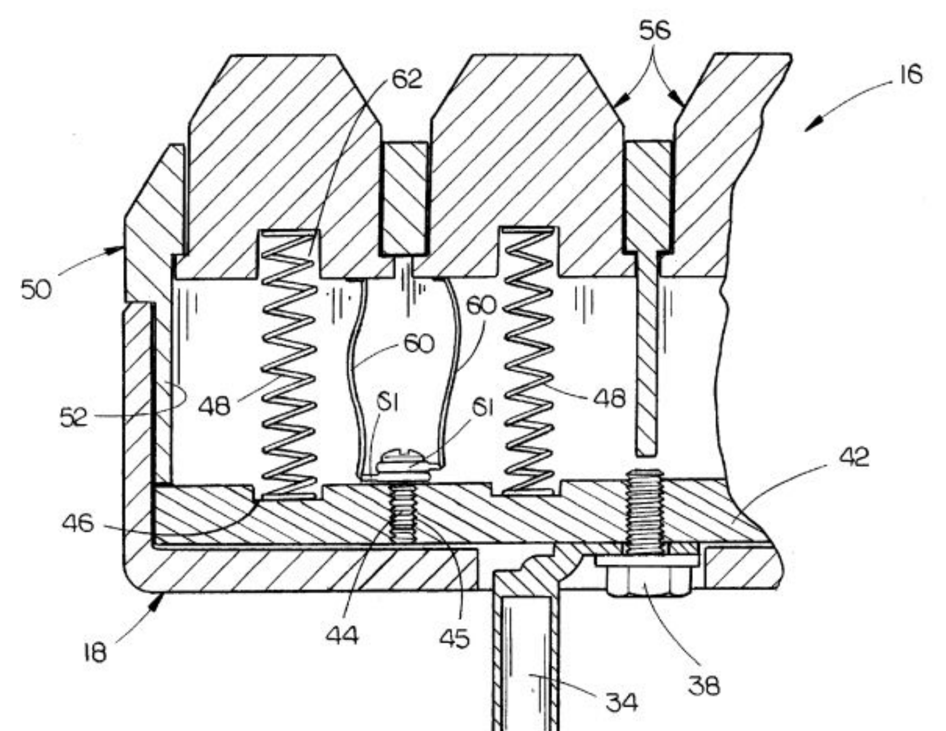
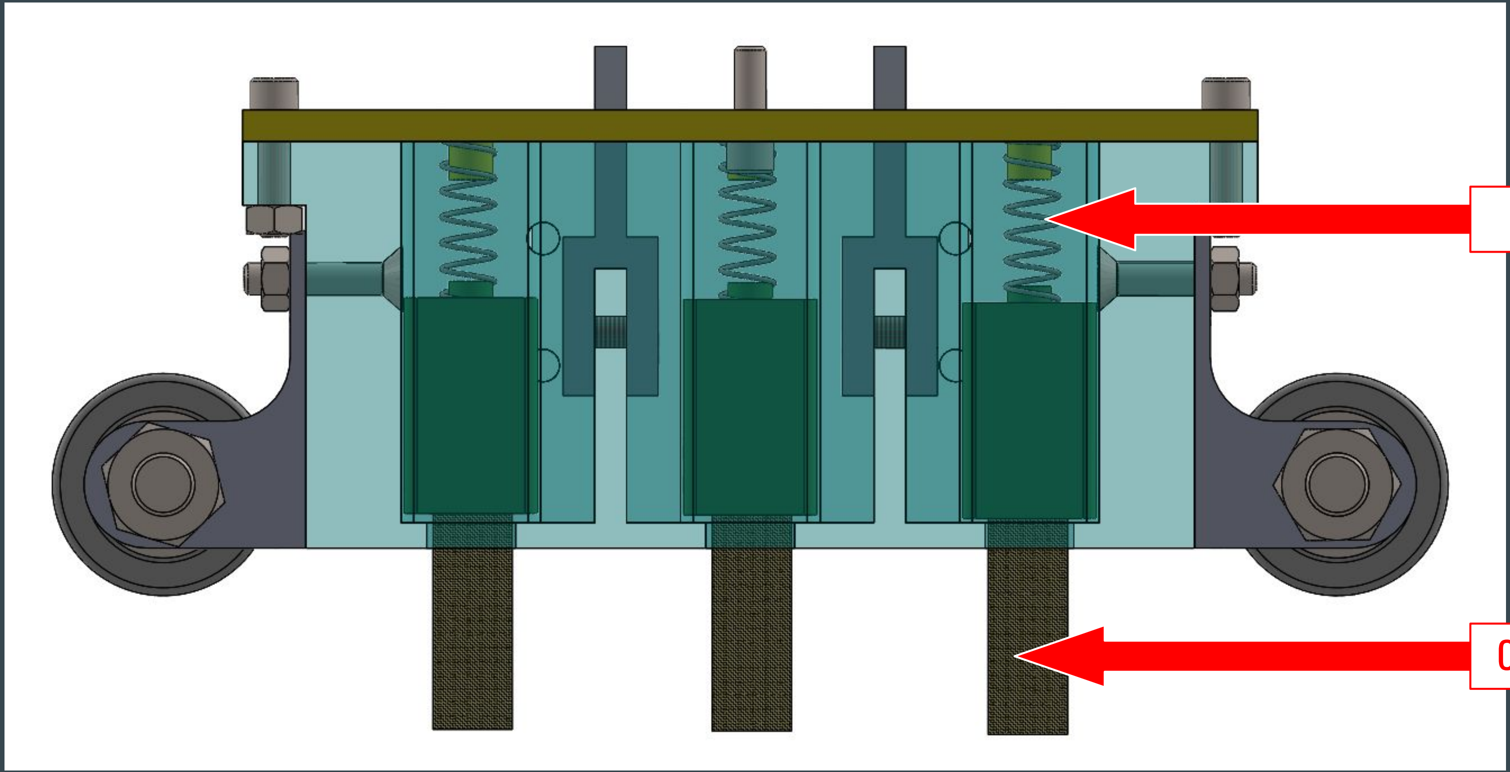


FIG. 4

HEBENTHAL Pub. No.: US 2013/0213754 A1 Pub. Date: Aug. 22, 2013

Shane

Patent research inspired our state-of-the-art designs



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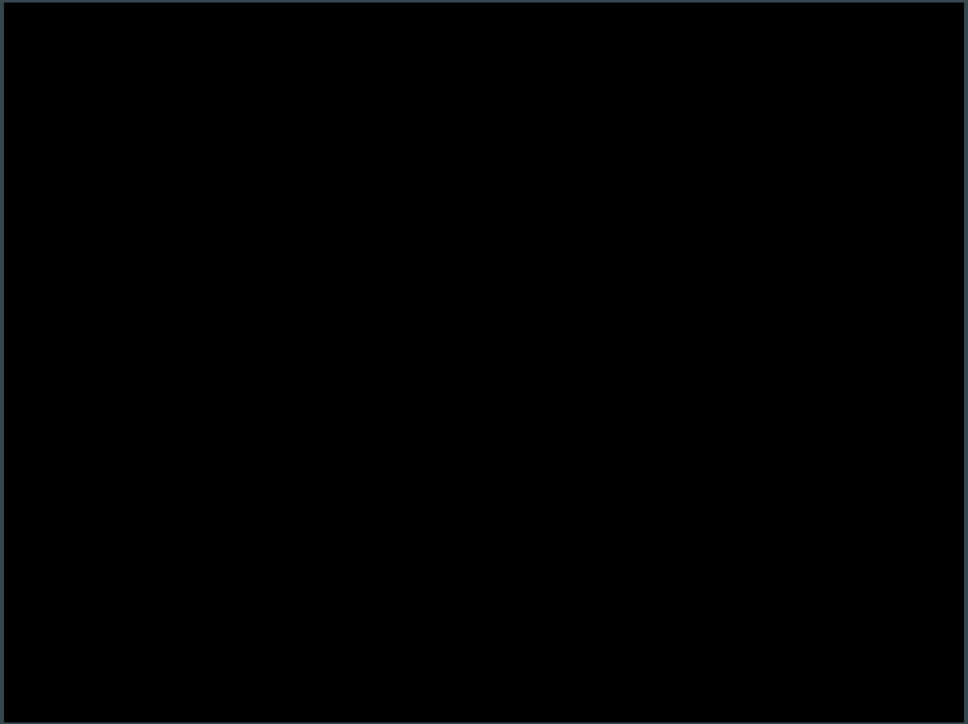

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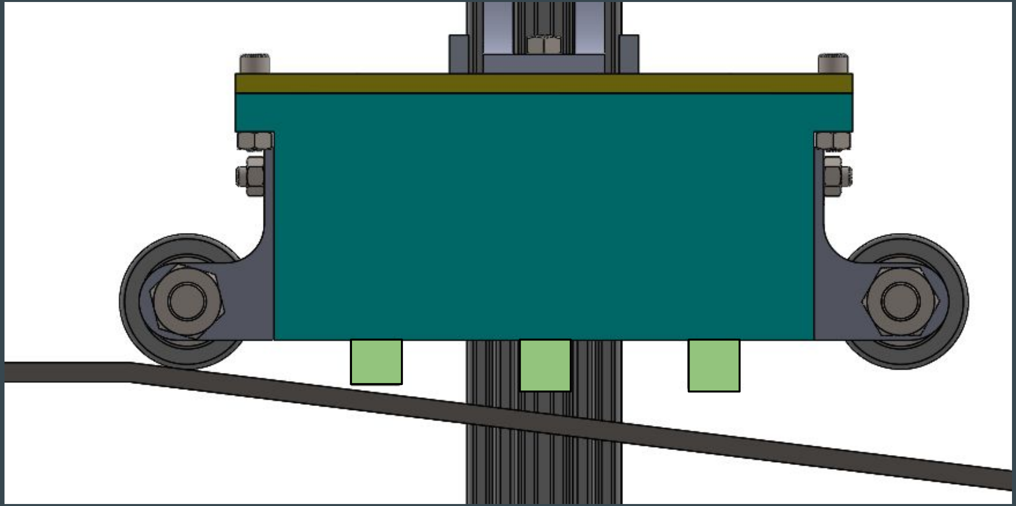

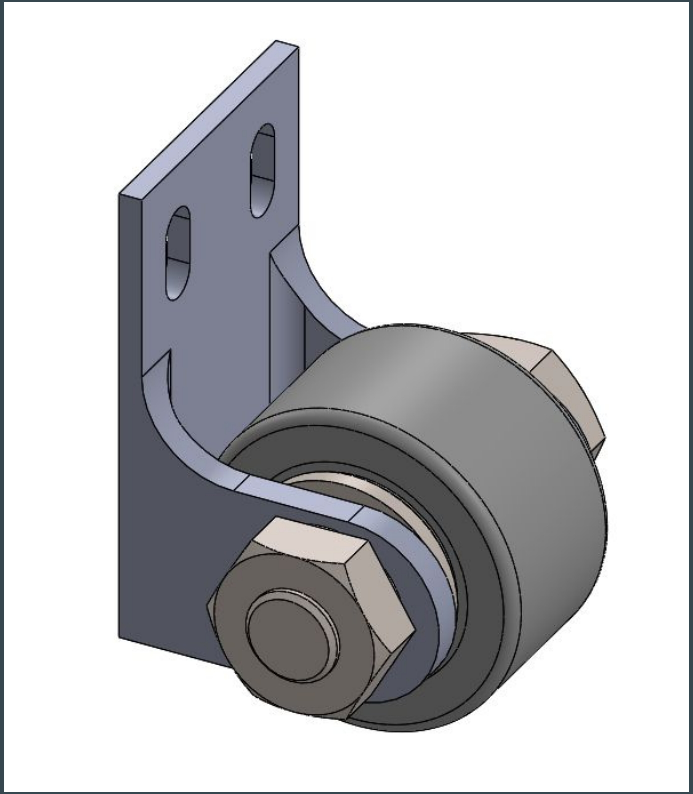

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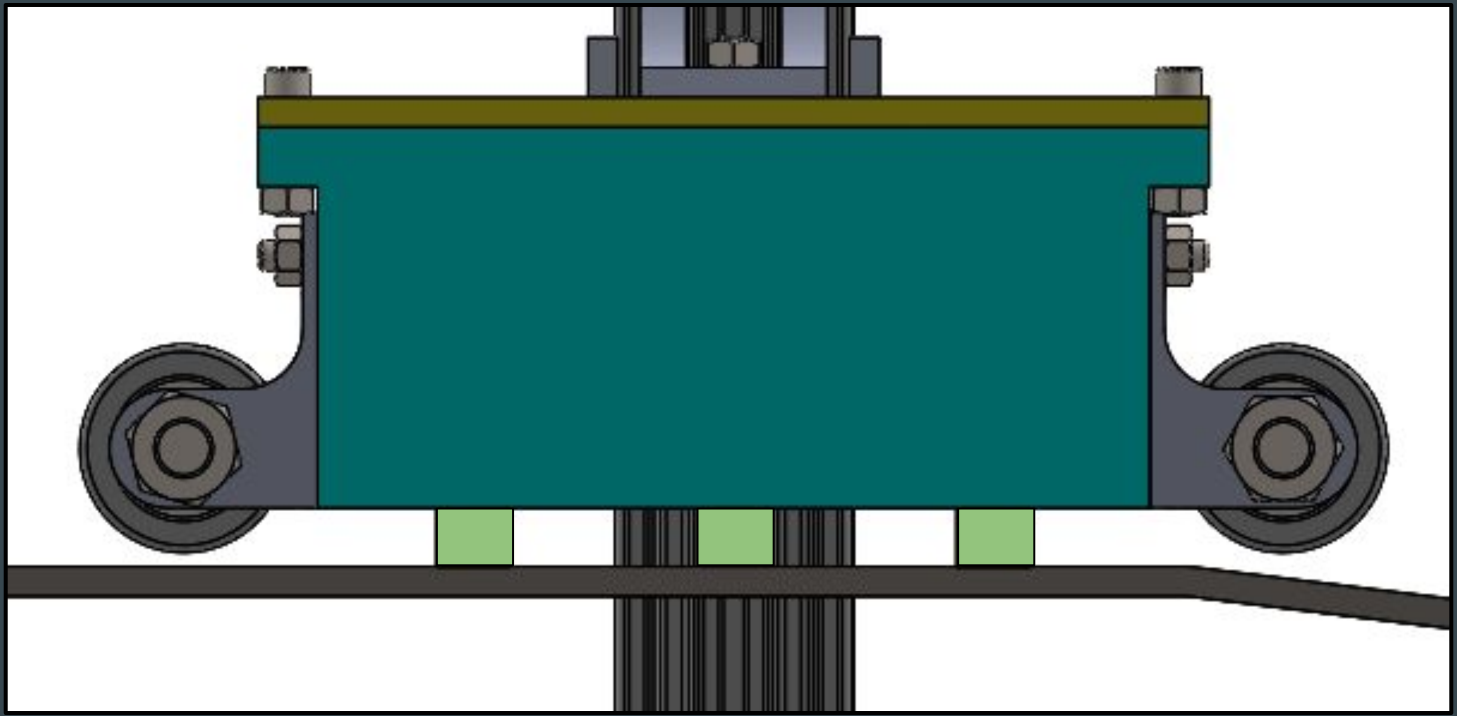

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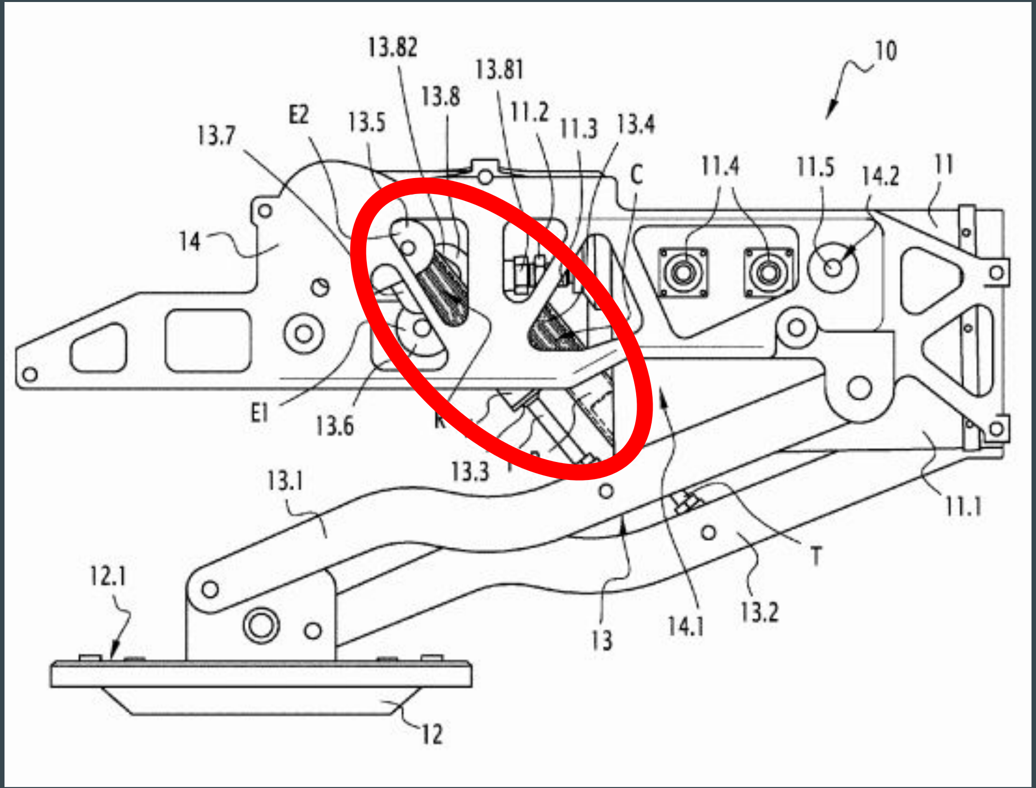

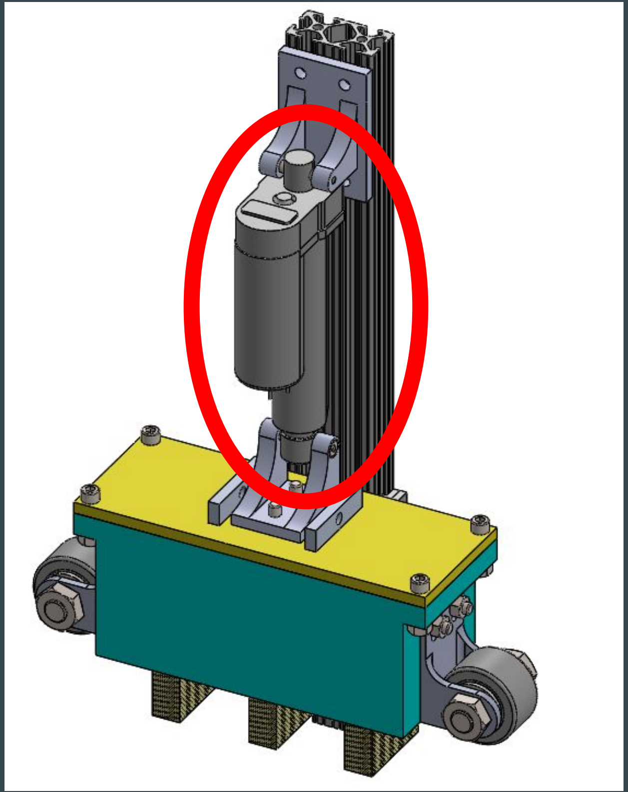

DUPRAT et al . Pub . No . : US 2019 / 0001823 A1 Pub . Date : Jan . 3 , 2019

SPARTAN SUPERWAY

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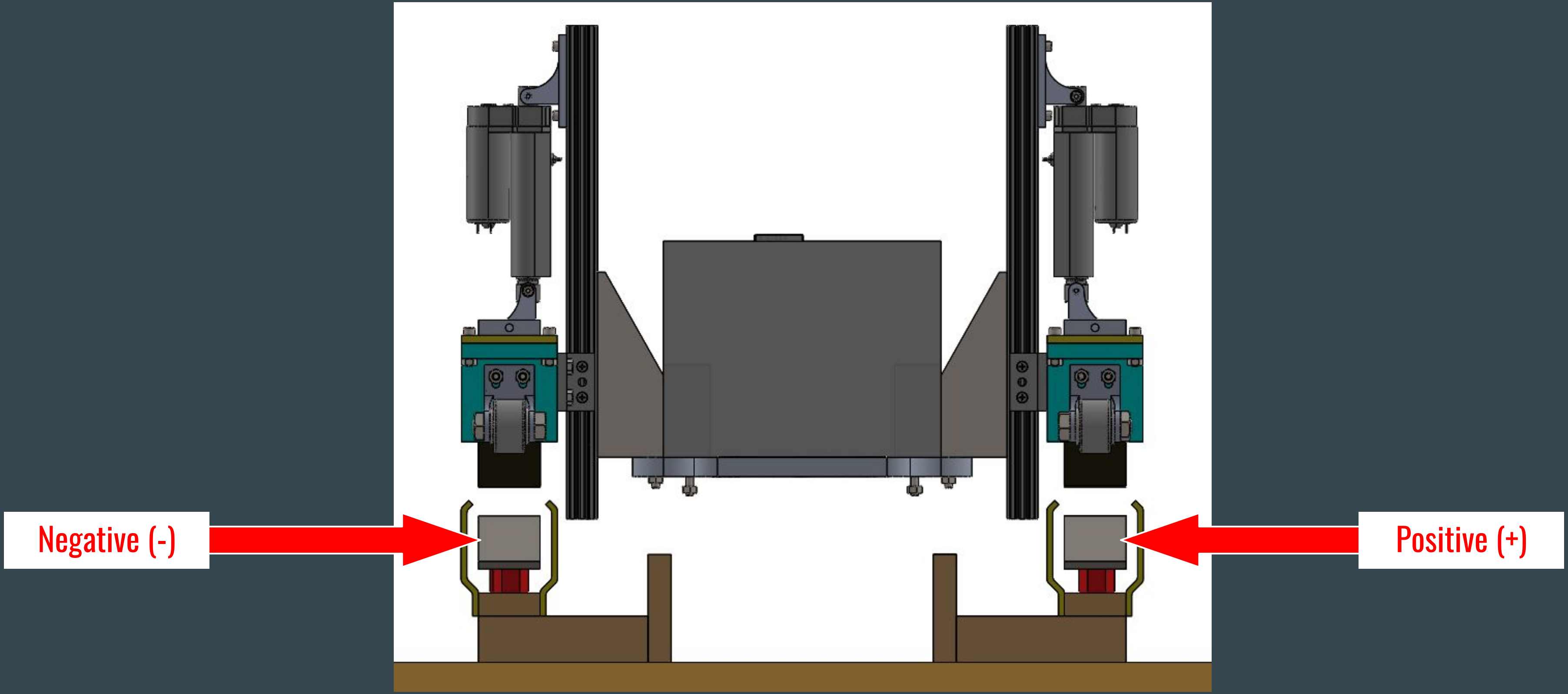
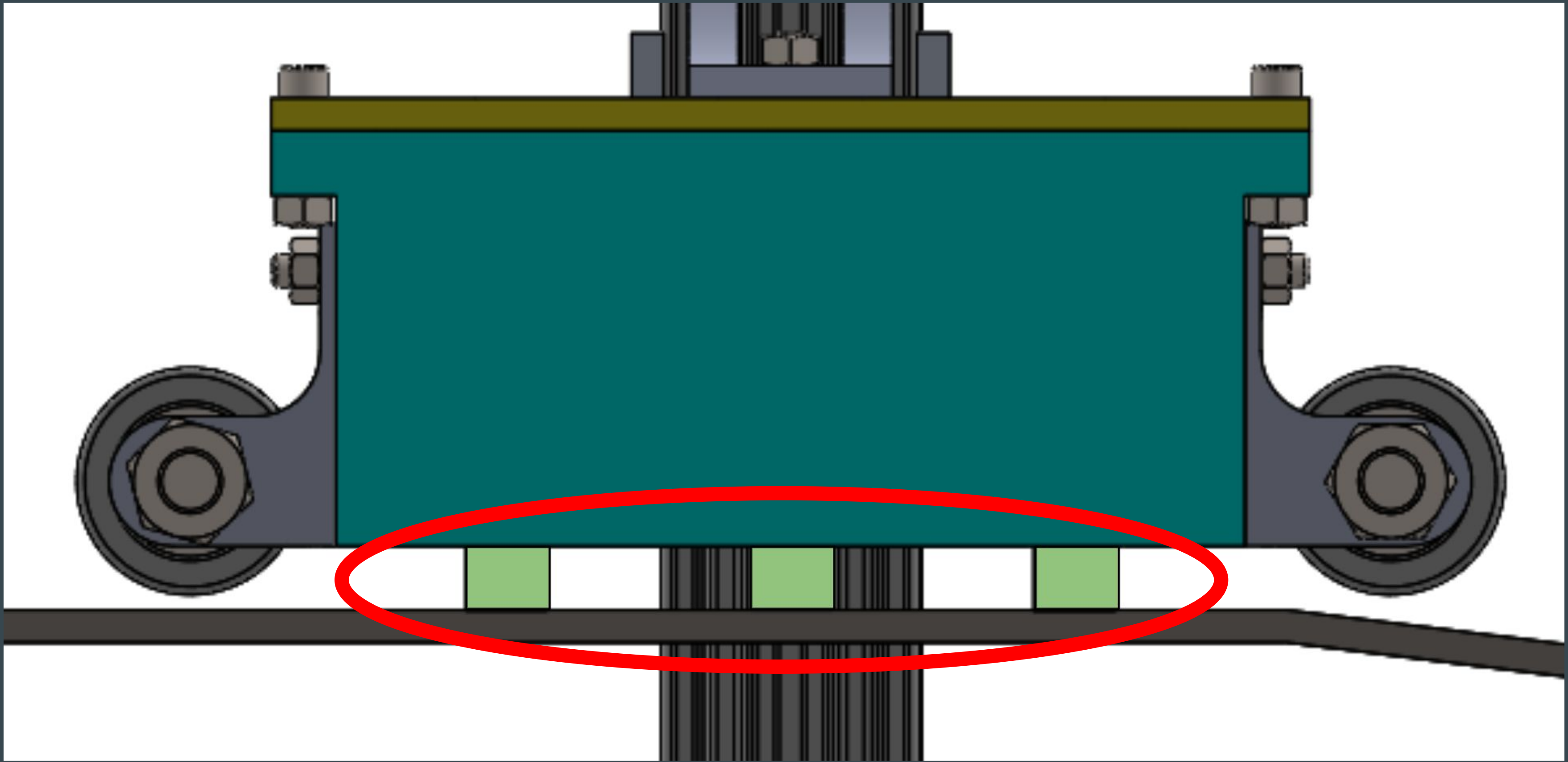


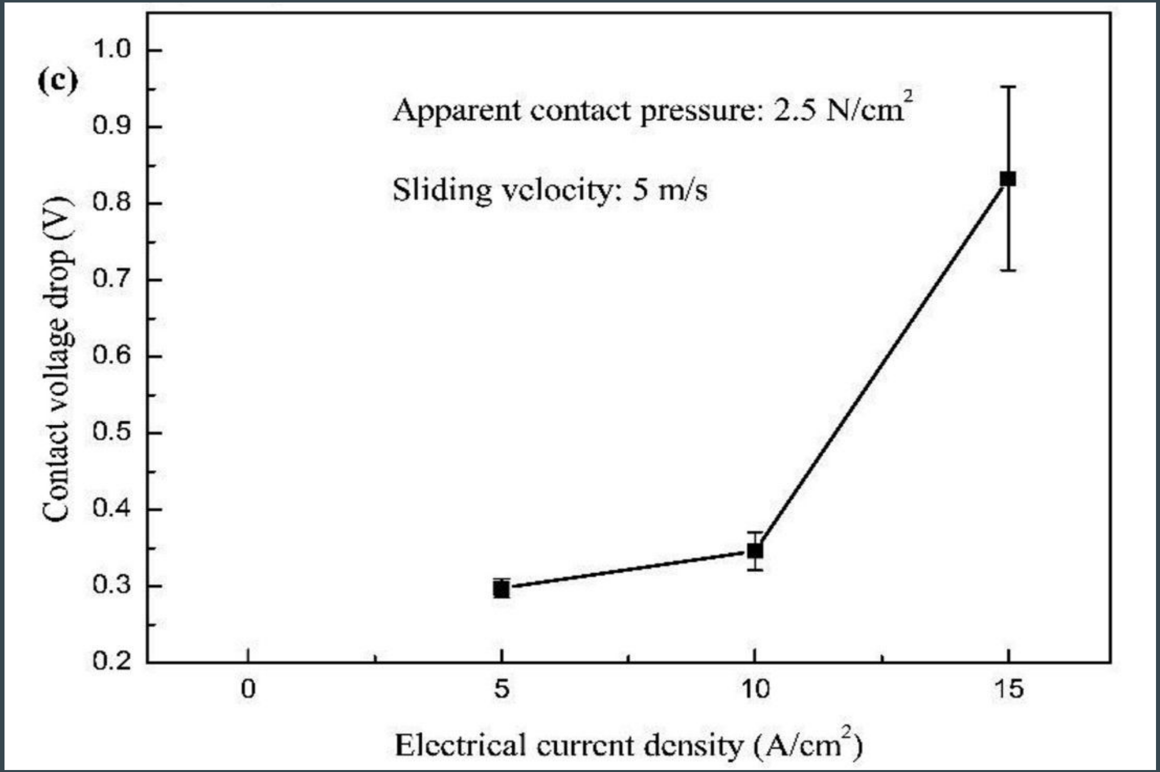
Shane

Sliding wear behavior is crucial to our electrical design



Waylon

Voltage drop increases as current density increases

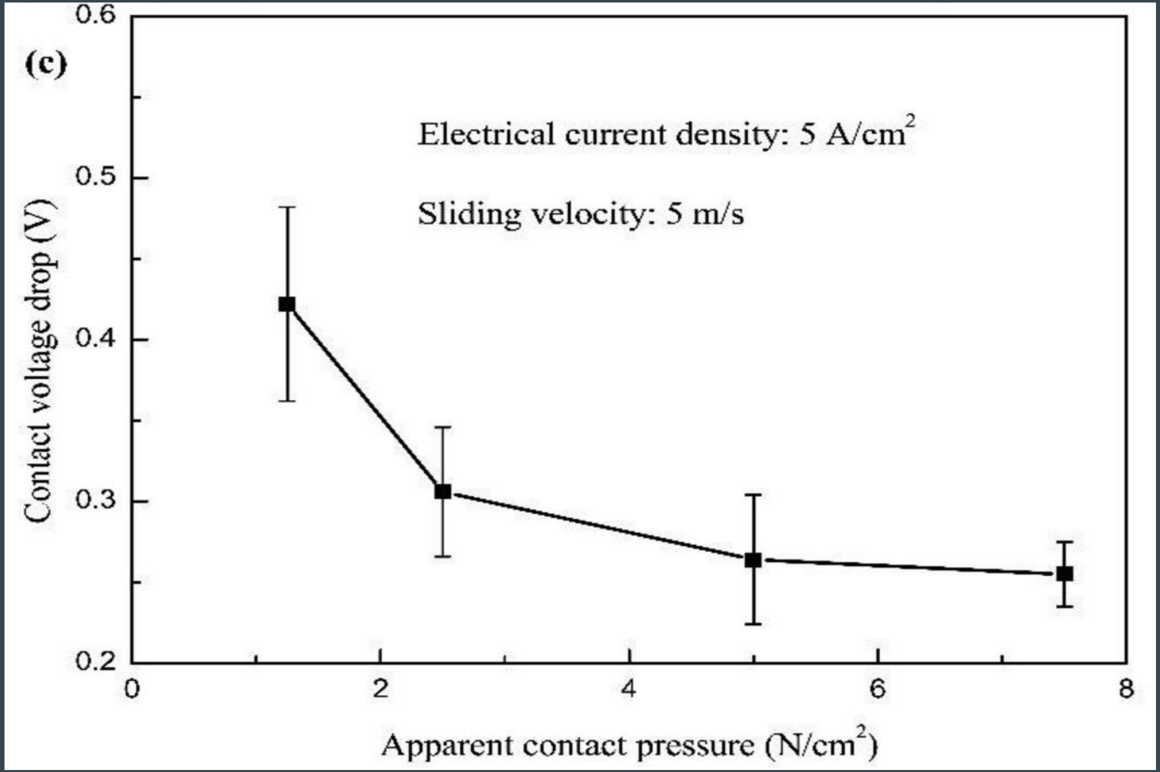


(Zhao, et al., 2020)

SPARTAN SUPERWAY

Waylon

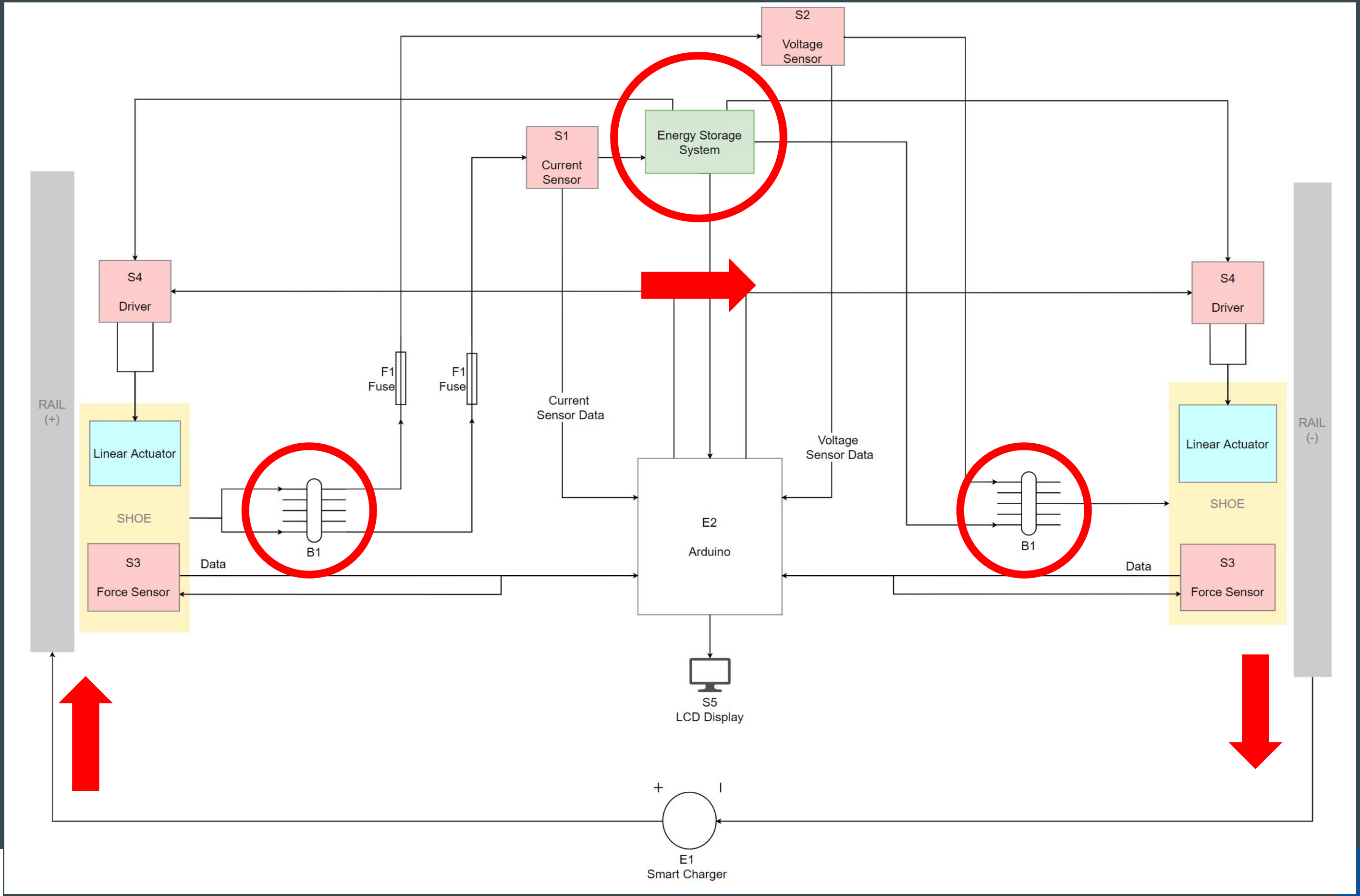
Voltage drop decreases as contact pressure increases



(Zhao, et al., 2020)

Waylon

This is our overall electrical schematic

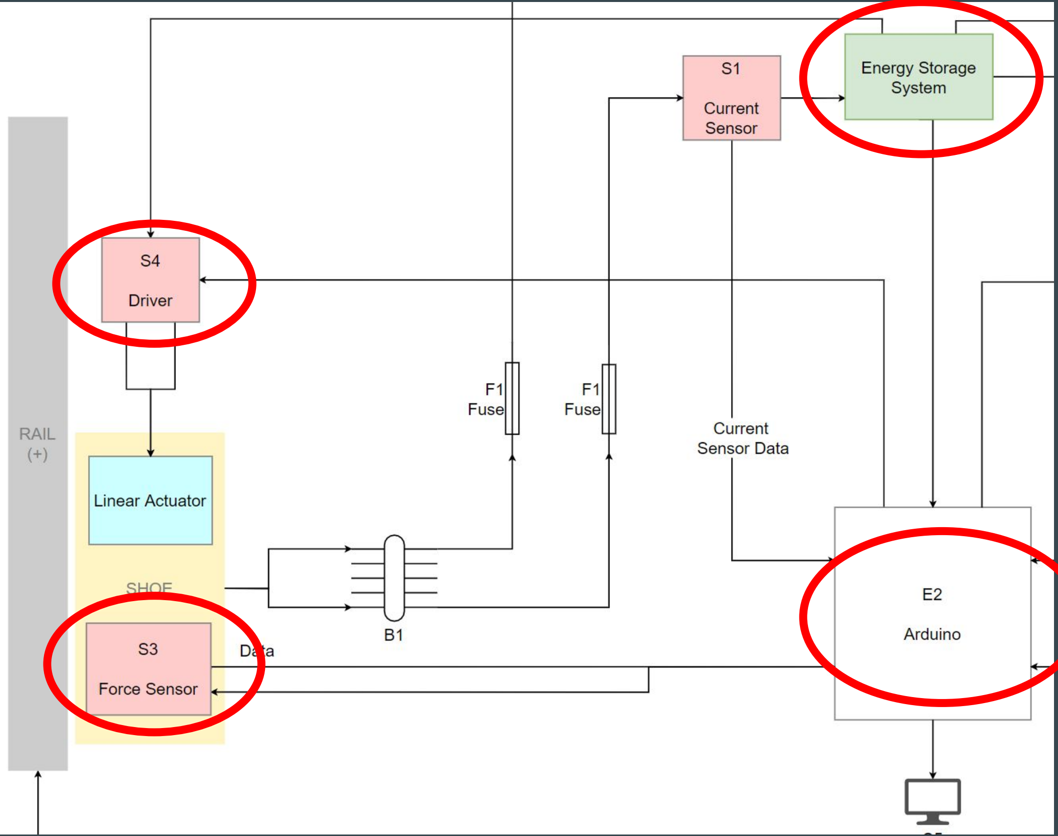


SPARTAN SUPERWAY

Waylon

Taking a closer look at the 2D schematic

Wayside Part Number	Item Name	Description	Qty
E2	Arduino		1
S3	Force Sensor	one on each shoe	2
S4	Driver	Drives actuator	2
B1	Bus Bar	Collects and Distributes cables	2

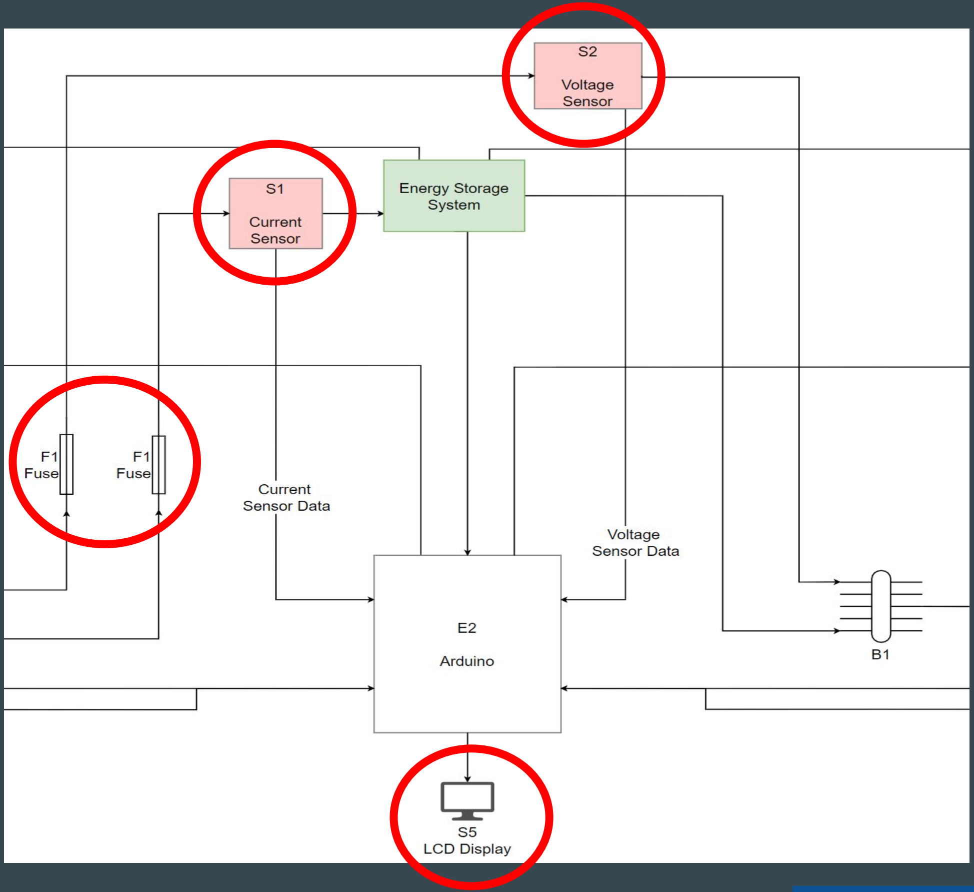


SPARTAN SUPERWAY

Waylon

Taking a closer look at the 2D schematic

Wayside Part Number	Item Name	Description	Qty
S1	Current Sensor	before motor	1
S2	Voltage Sensor	in parallel with + & - side of shoe	1
B1	Bus Bar	Collects and Distributes cables	2
F1	Fuse	Protects sensors	2



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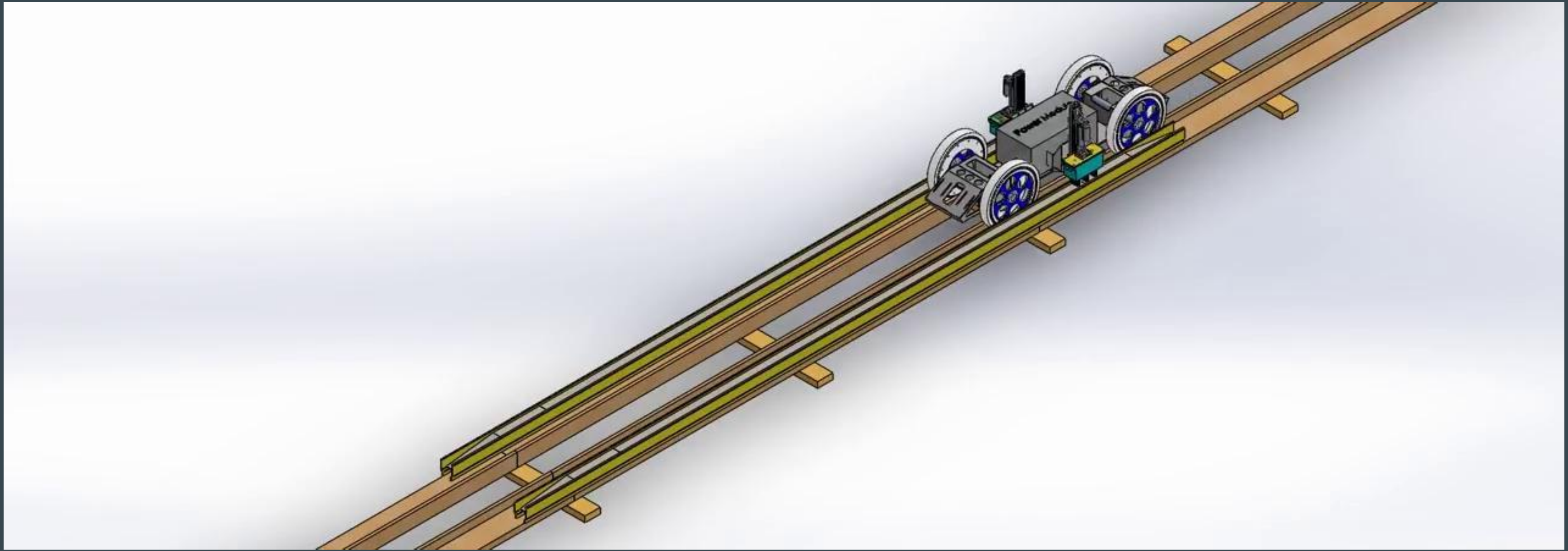
Waylon

Analysis and Testing

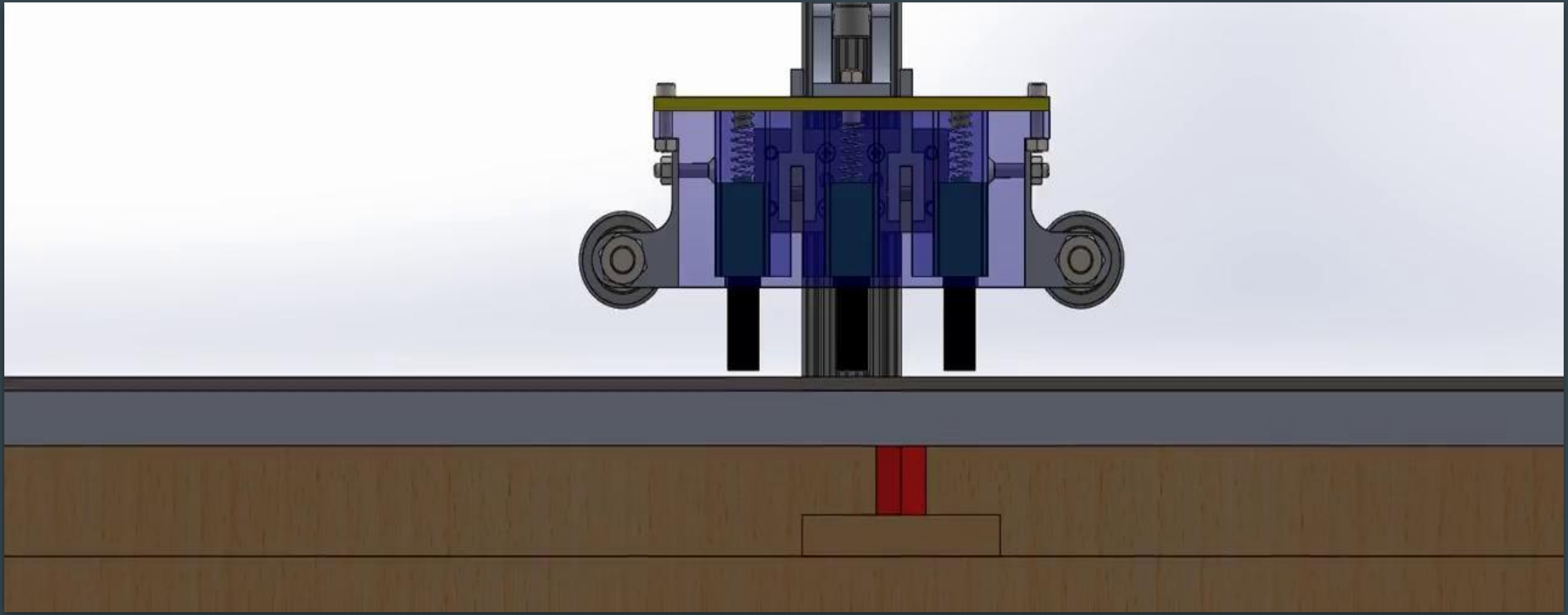
Solidworks animation to demonstrate how the test bogie run on the wooden rail



SPARTAN SUPERWAY

Reynaldo

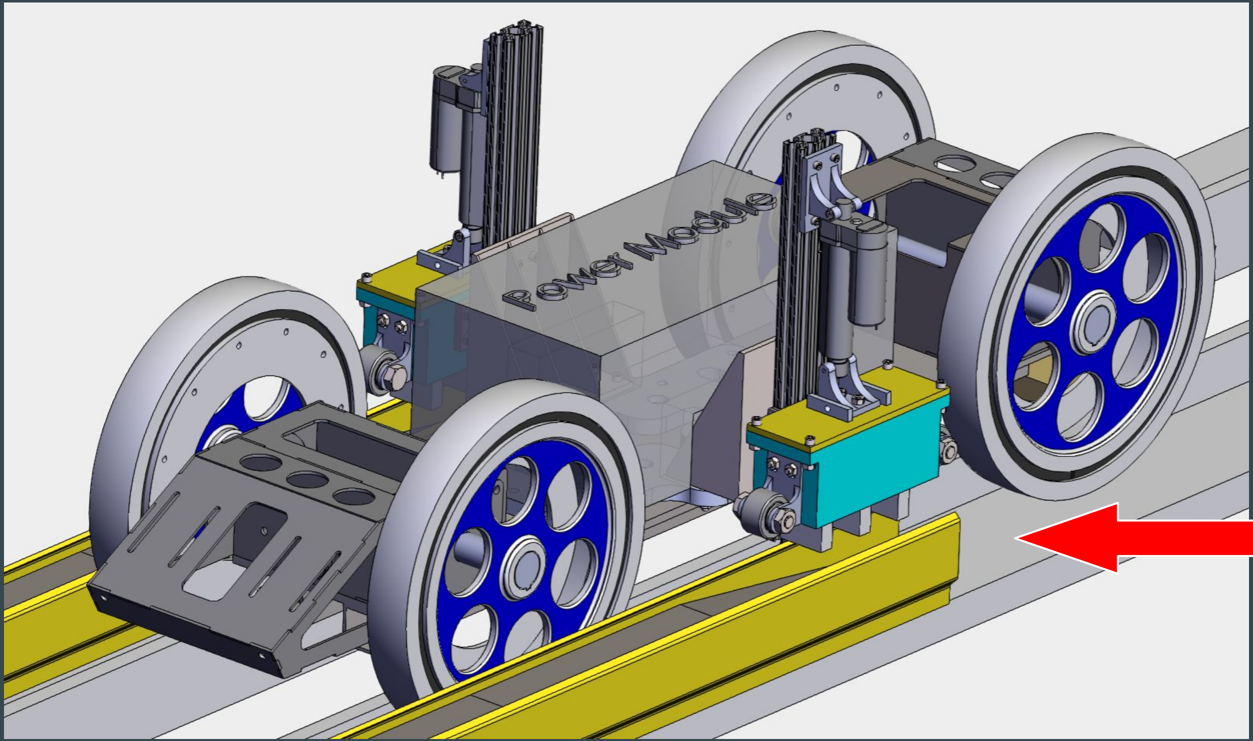
Solidworks animation to demonstrate how the contact between the shoe and the rail



SPARTAN SUPERWAY

Reynaldo

Stress analysis simulation of the parts and assembly to prove the concept



Wooden Rail

SPARTAN SUPERWAY

Reynaldo

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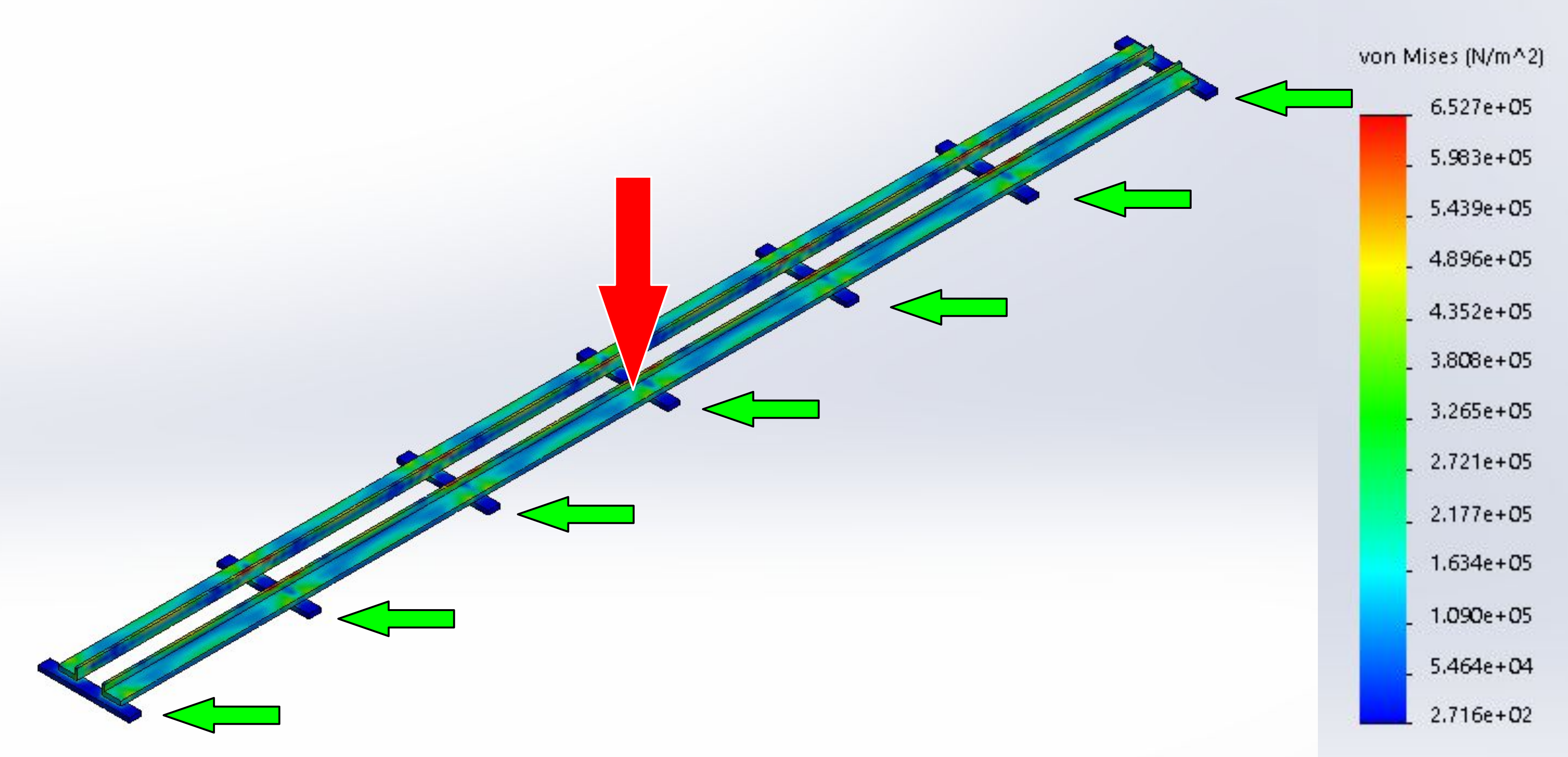

Max von Mises stress : 0.6527 MPa

Min von Mises stress : 0.2716 kPa

SPARTAN SUPERWAY

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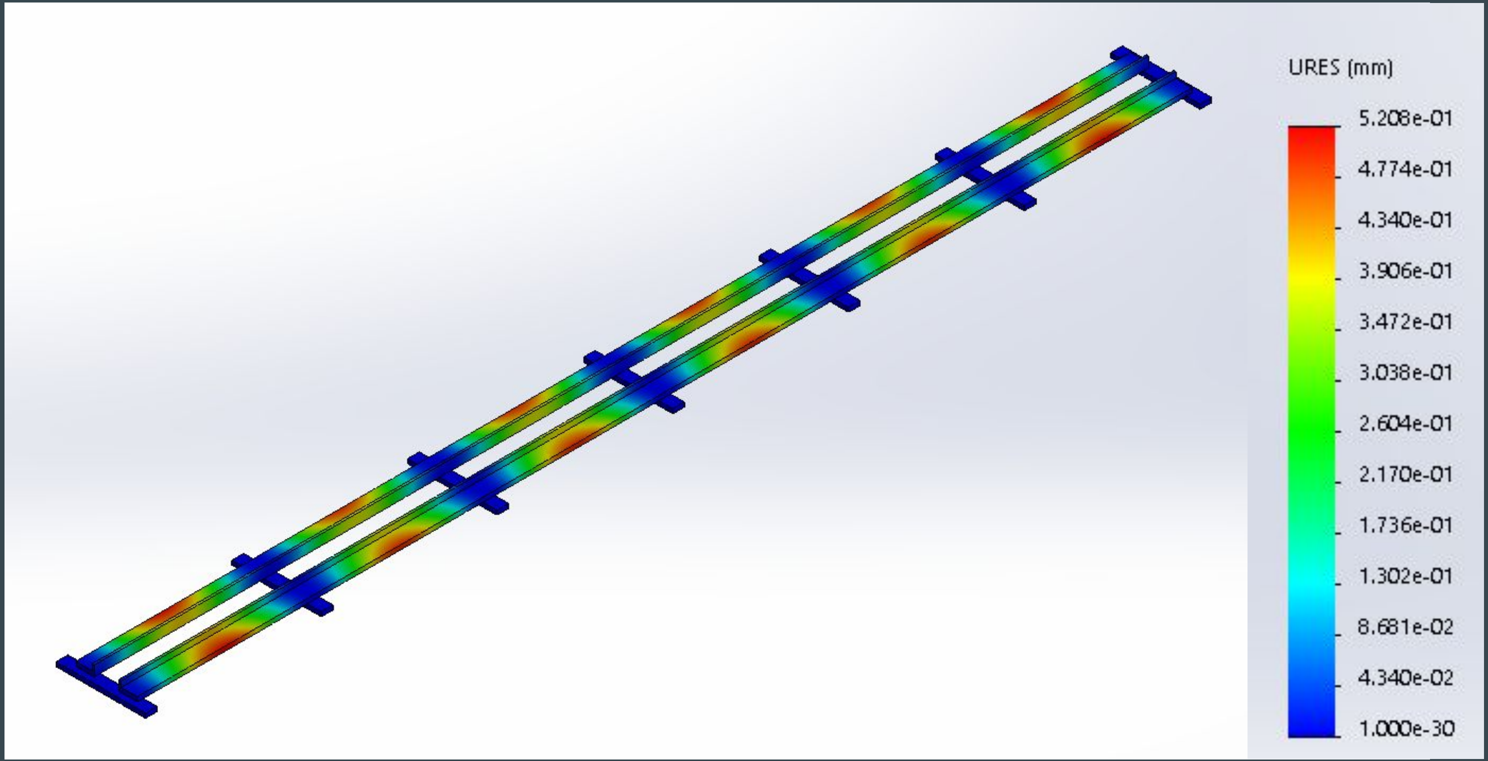

Max displacement: 0.5208 mm

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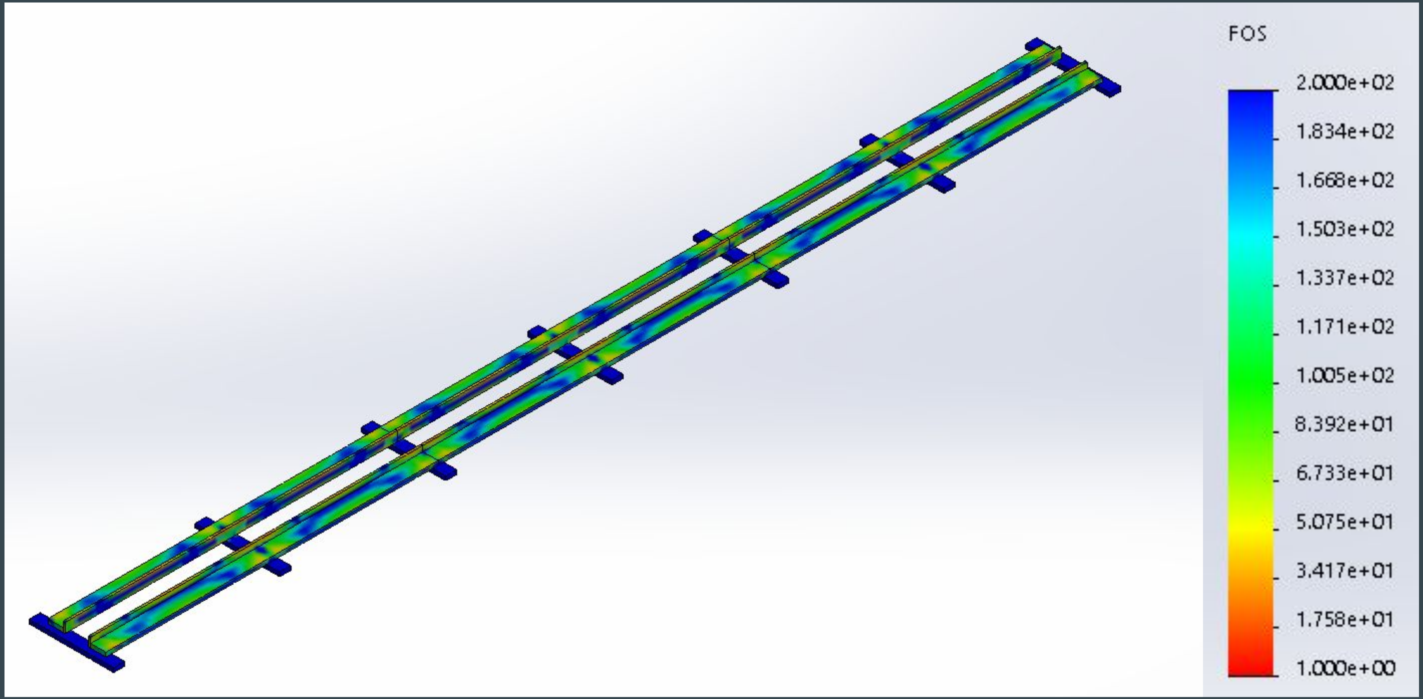

Min Factor of Safety (FOS): 31

SPARTAN SUPERWAY

Reynaldo

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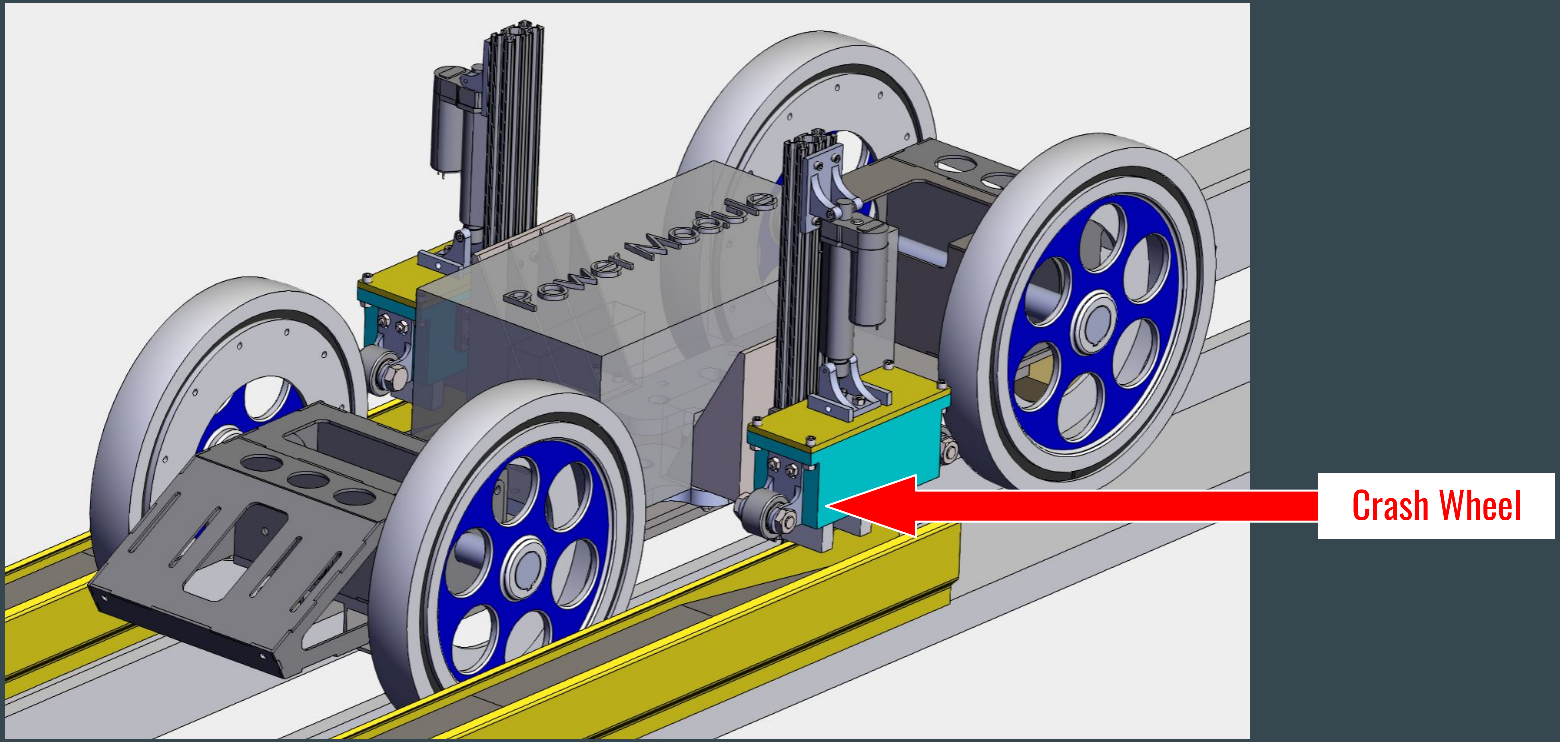

SPARTAN SUPERWAY

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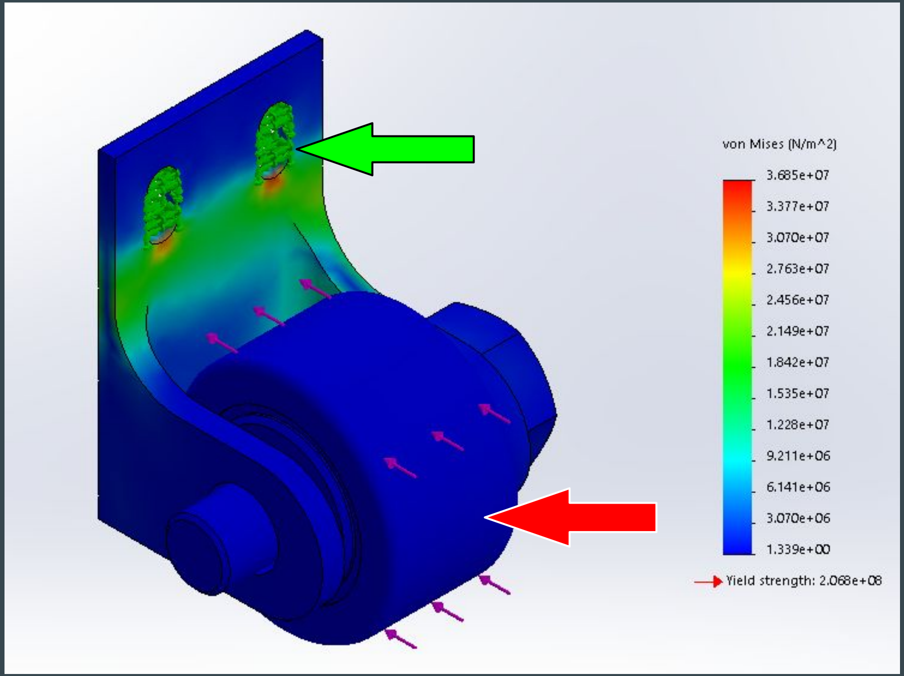

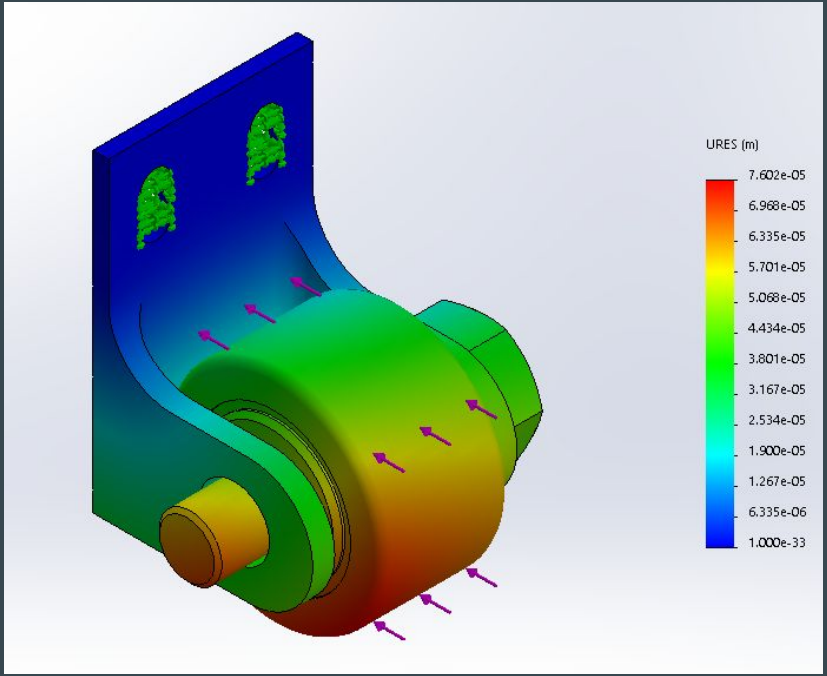

Max von Mises stress:
36.85 MPa

Max Displacement:
0.076 mm

SPARTAN SUPERWAY

Reynaldo

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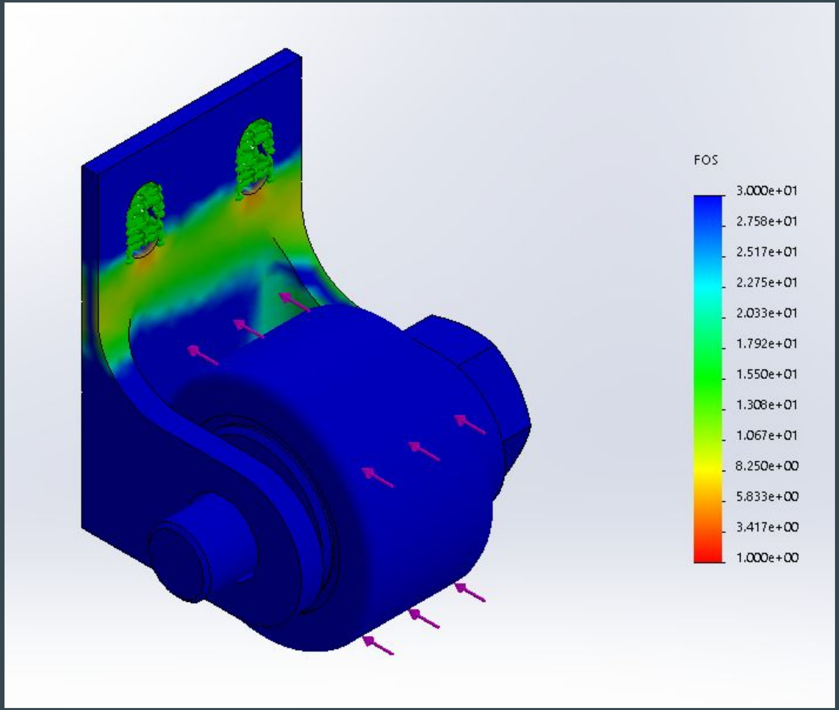

Min Factor of Safety (FOS): 5.6

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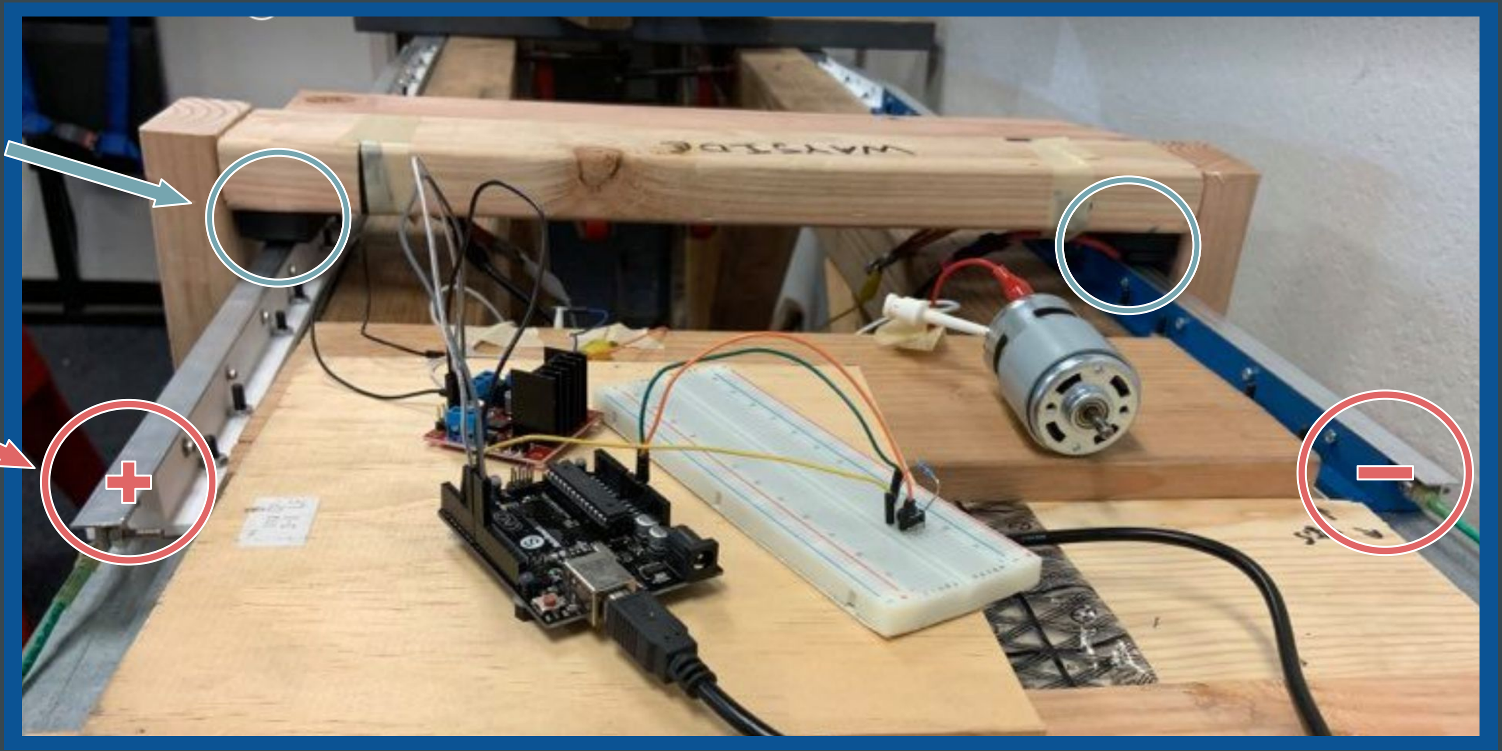
Reynaldo

The team successfully completed and tested a tabletop setup

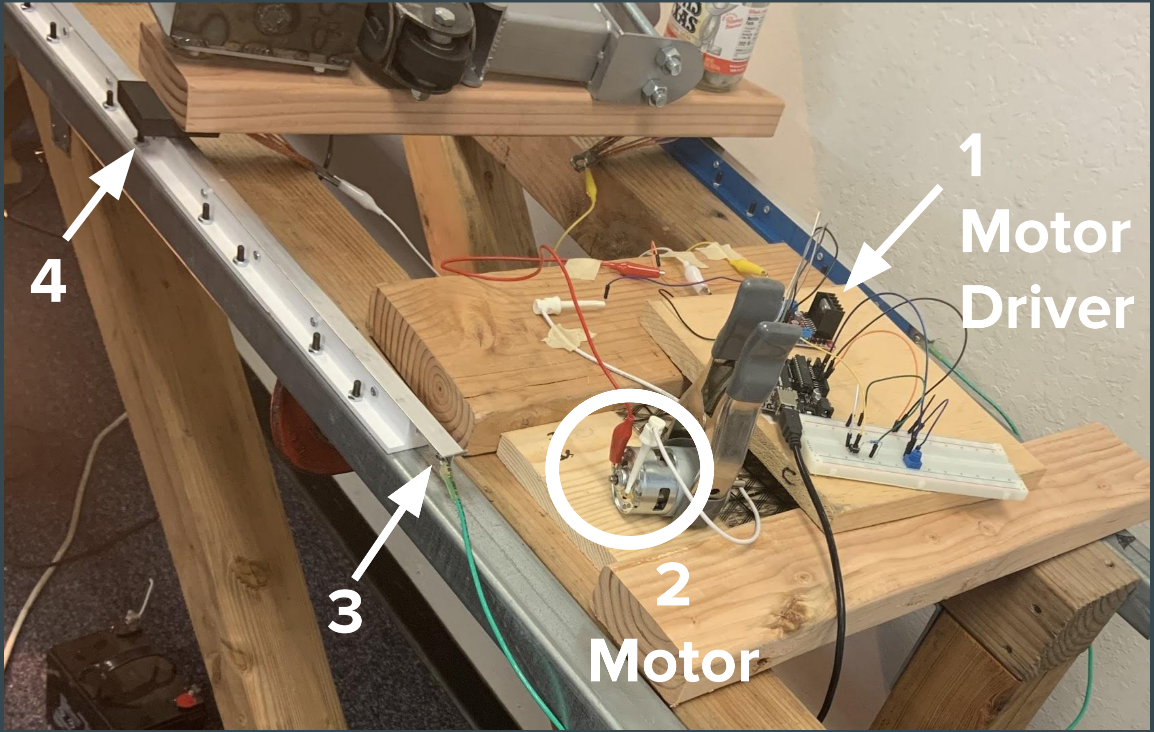
Shoe

Third Rail



The chart below reports the voltage and current at each segment of the third rail power distribution system.

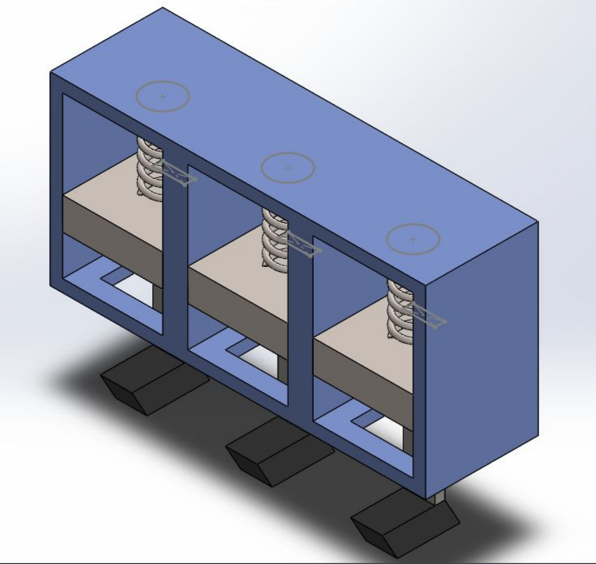
	Desc.	Voltage (V)	Current (A)
1	IN	5.05	
2	OUT	5.4	
3	Rail	11.73	1.3
4	Shoe	9.28	1.4

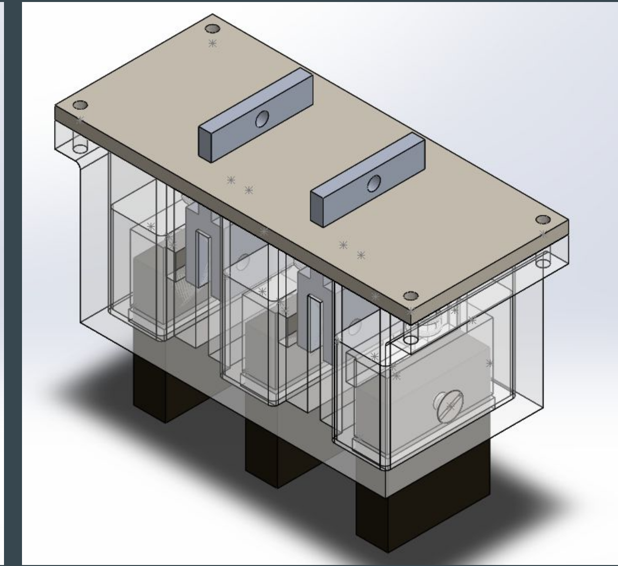


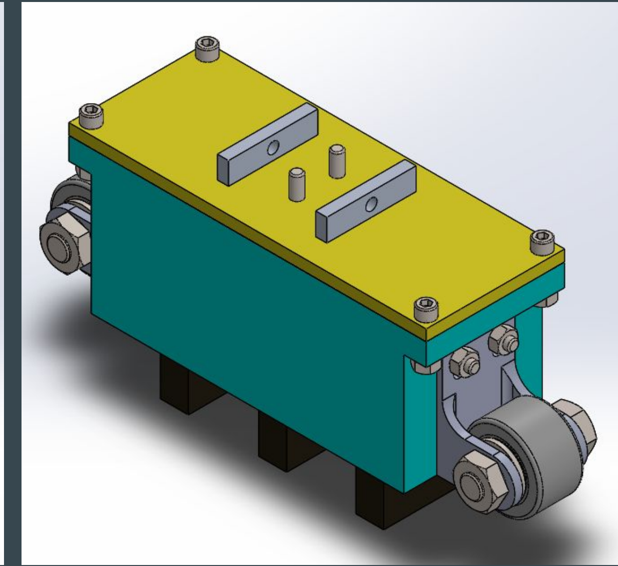
Melody

Conclusions and Findings

Rigorous design and revision work led the team to successfully achieving the desired design specifications







Evolution of Design

SPARTAN SUPERWAY

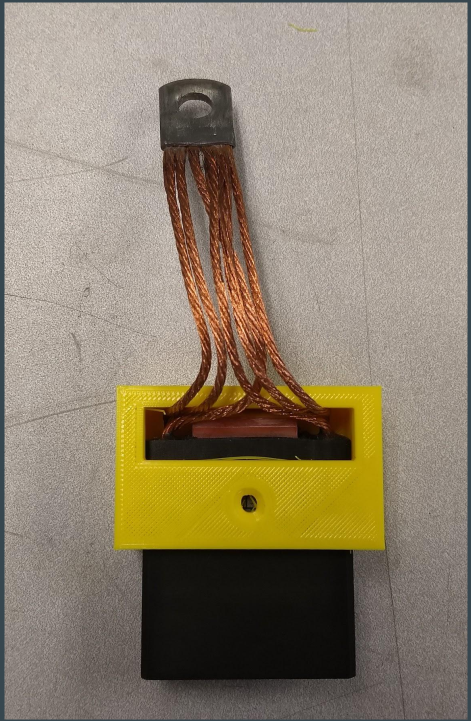
Alex

Beginning and completing design work earlier would significantly improve the wayside power project

SPARTAN SUPERWAY

Alex

Future Superway engineers should improve the current wayside power design and build the physical project



The wayside power system will reduce the economic cost, environmental cost, and geographical restrictions of city transportation

SPARTAN SUPERWAY

Alex

The Wayside Power & Distribution is the economically and environmentally friendly power solution for the SPARTAN Superway

SPARTAN SUPERWAY

Alex

Special thanks to:

-Mike Perkins
-App. Specialist Admir Karabegovic

-Sr. Engr. Alan J. Ng
-Jr. Engr. Francisco Alolong Jr.

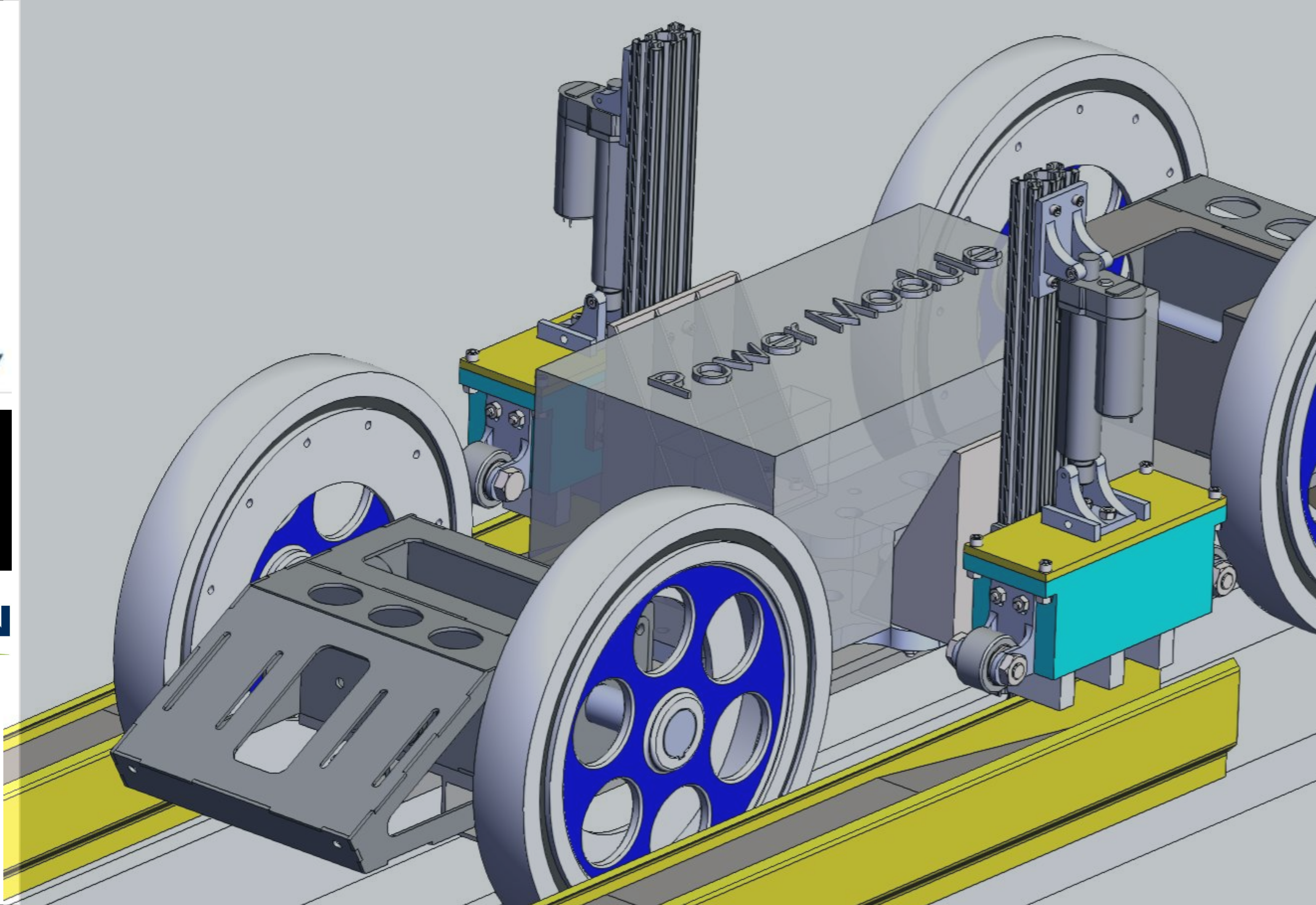
Special thanks to:

Professor Burford Furman
Ron Swenson
Eric Hagstrom
Chuong Nguyen
Ryan Tong
Husain Bootwala

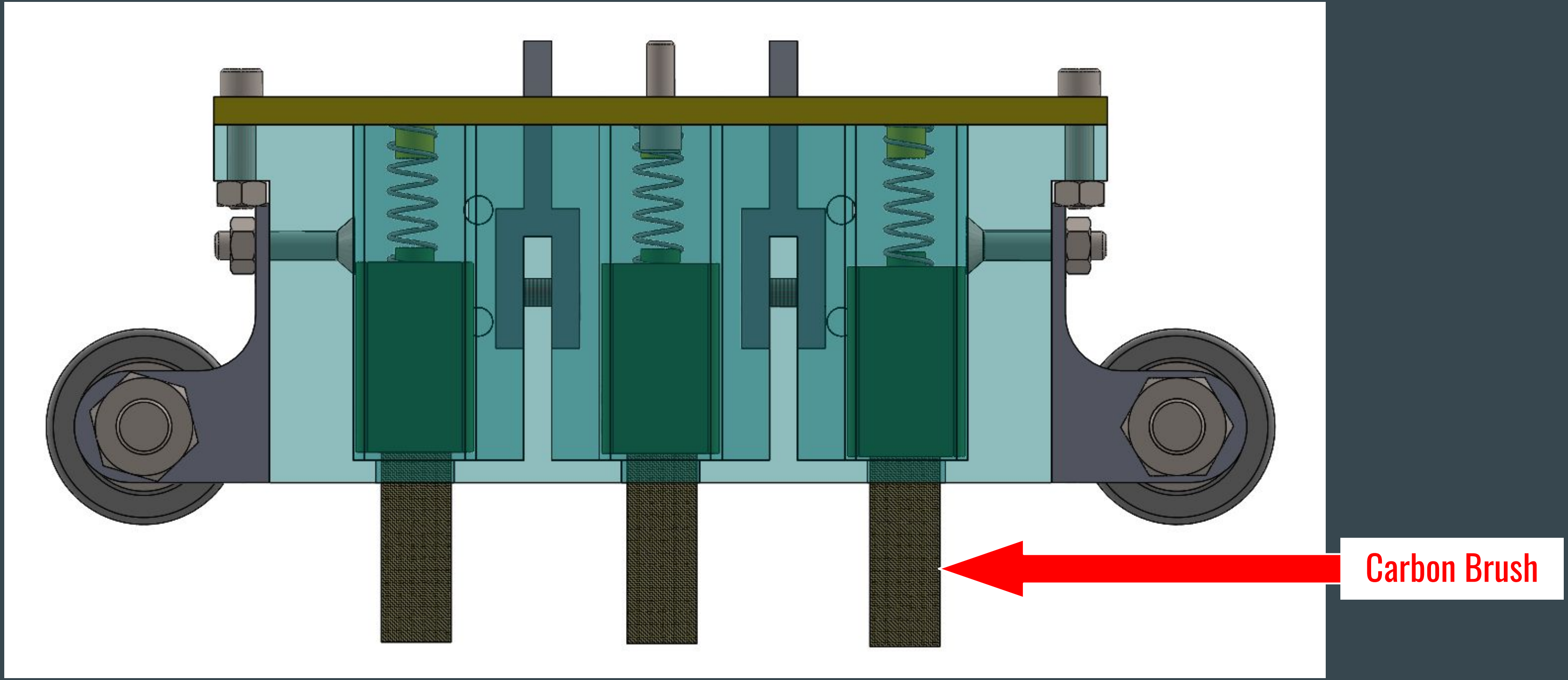
SPARTAN SUPERWAY

THANK YOU!

Prof. Furman
Ron Swenson
Eric Hagstrom
Chuong Nguyen
Ryan Tong
Husain Bootwala



Stress analysis simulation of the parts and assembly to prove the concept



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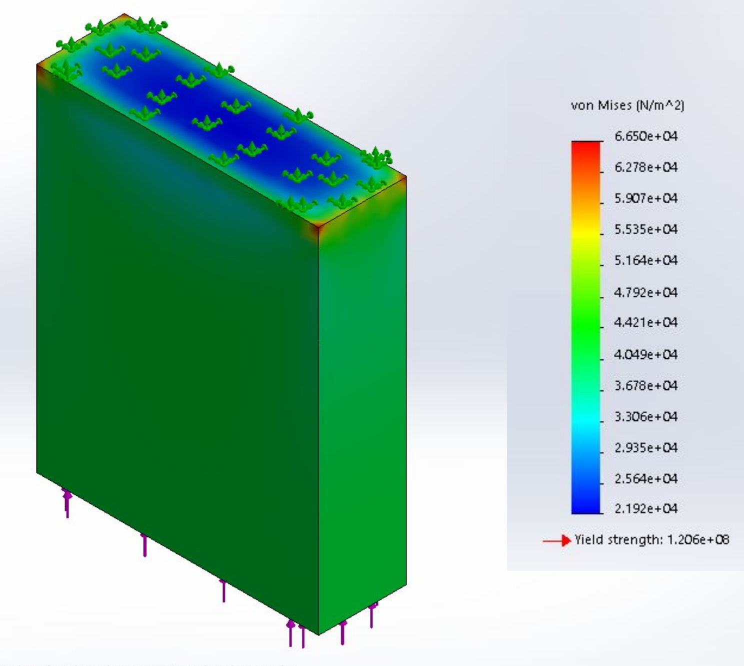

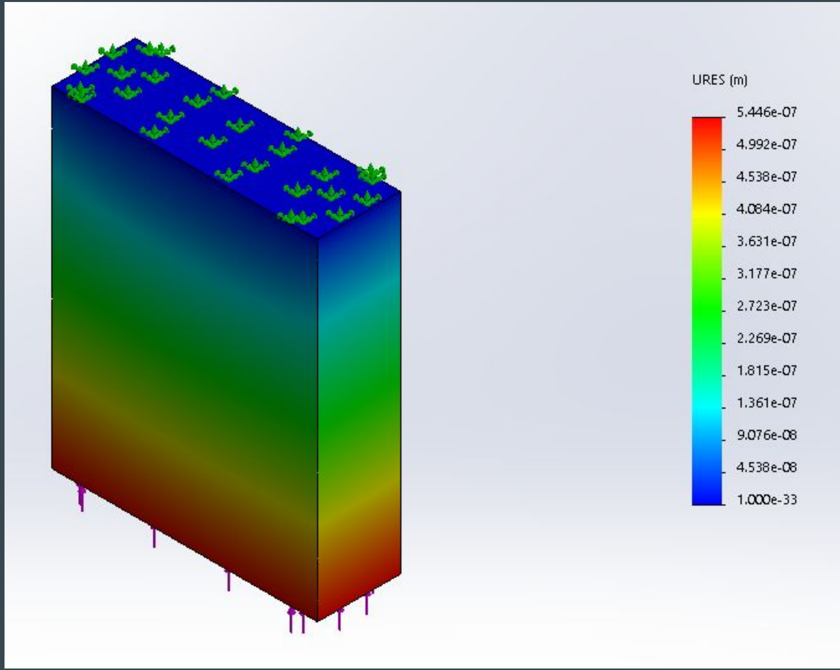

SPARTAN SUPERWAY

Reynaldo

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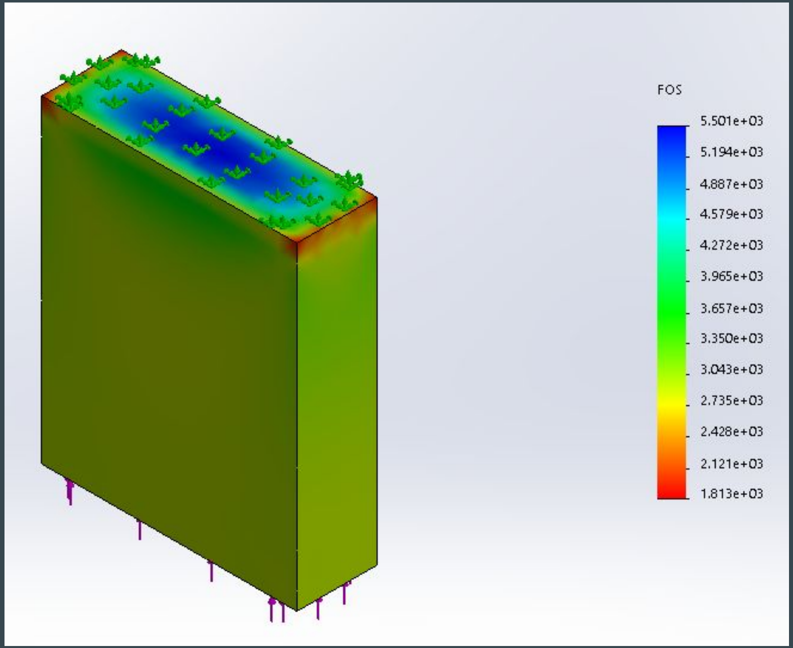

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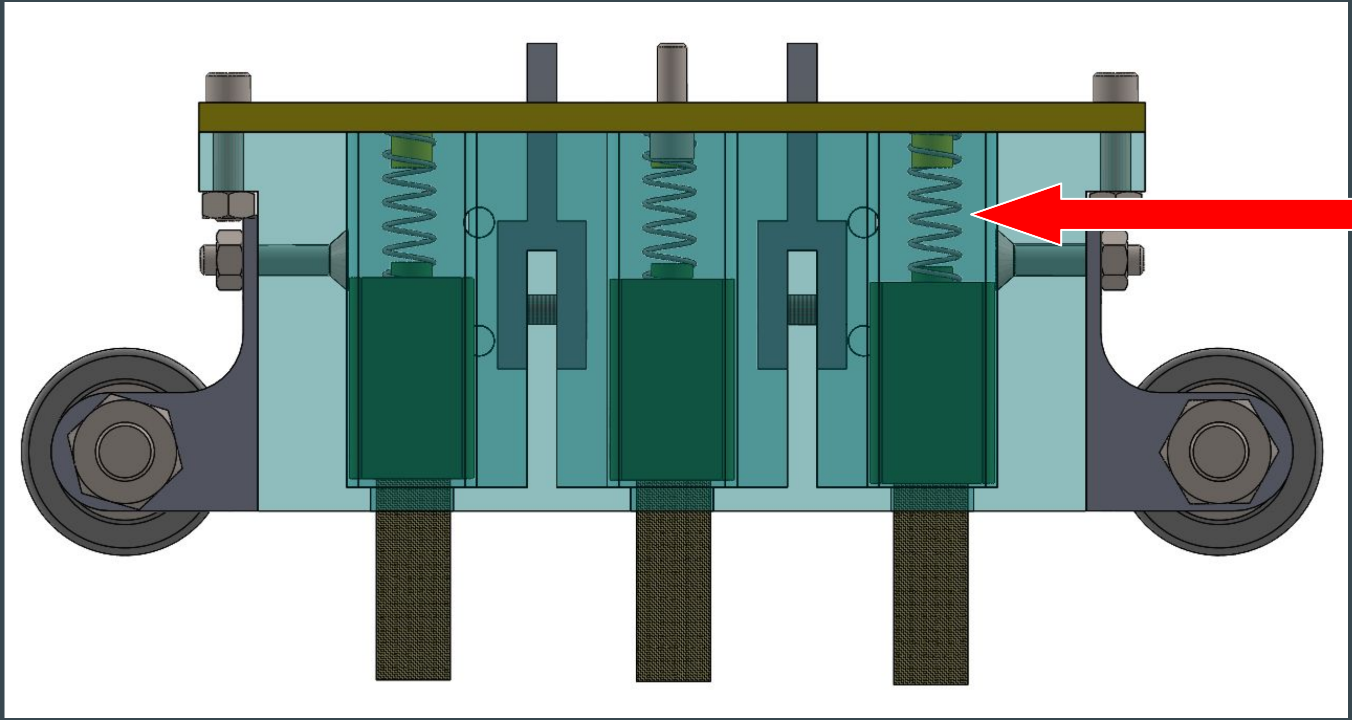
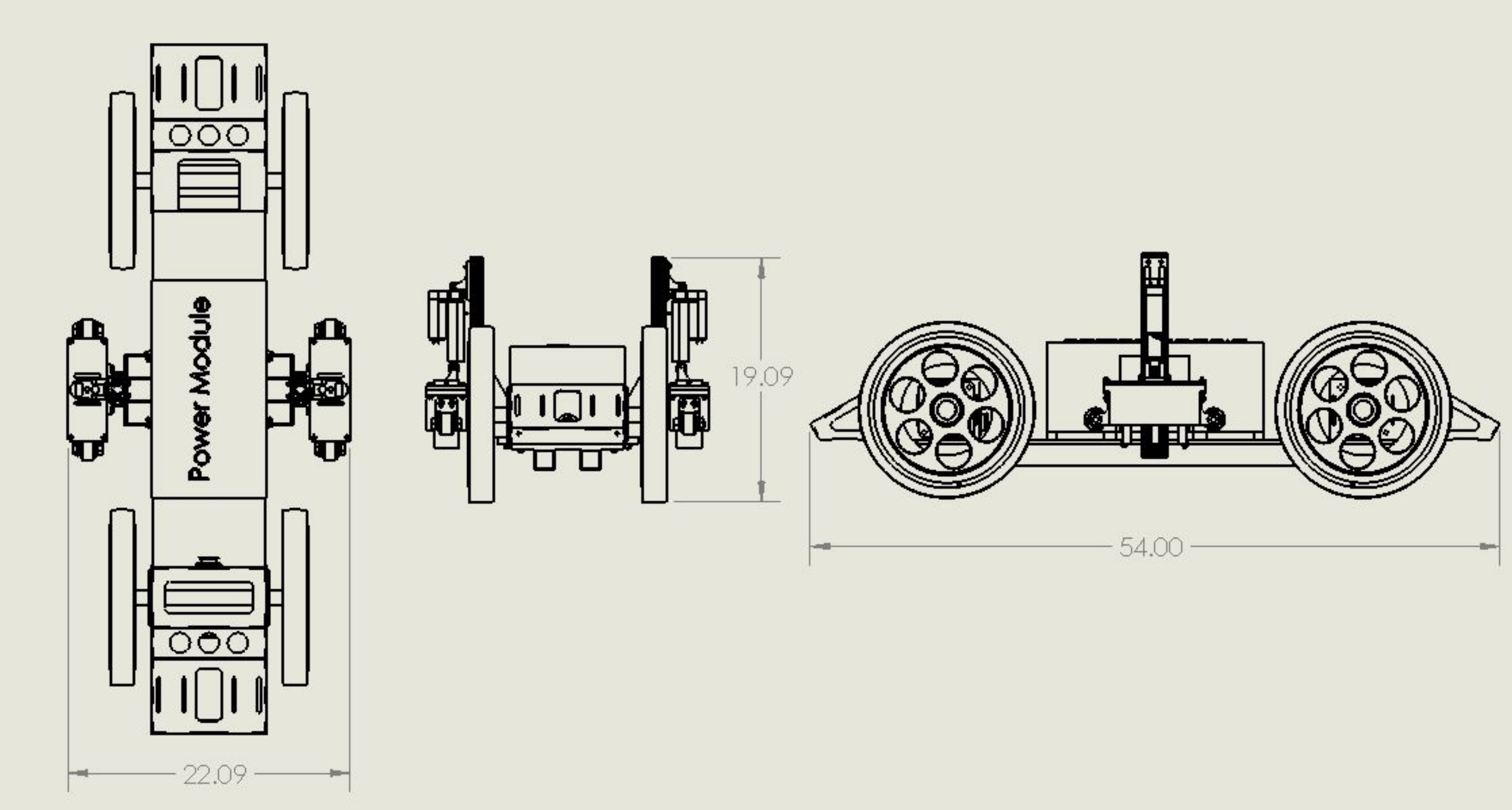


Compression Spring

Reynaldo

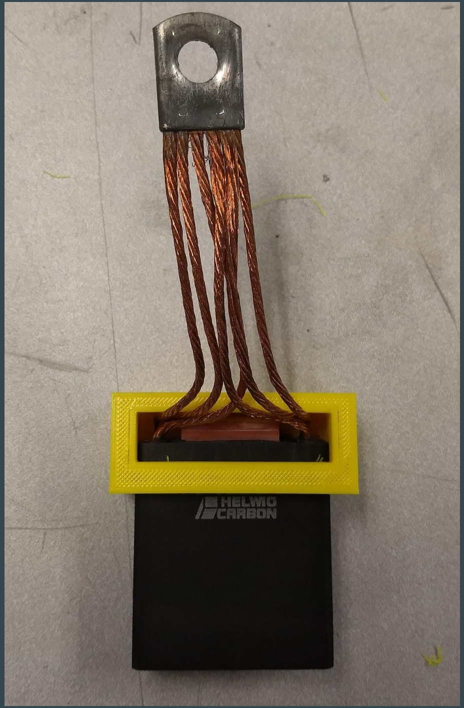
Spatial Envelope

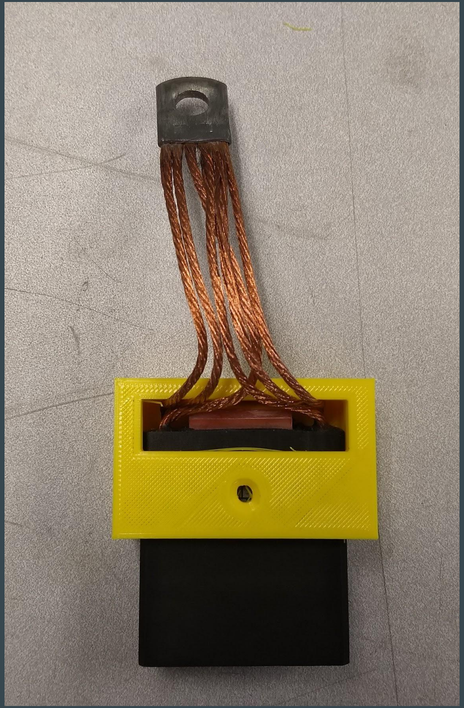


SPARTAN SUPERWAY

Alex

Design Trial and Error





SPARTAN SUPERWAY

Alex

Variance in Shoe Pressure

7 lb/in Springs

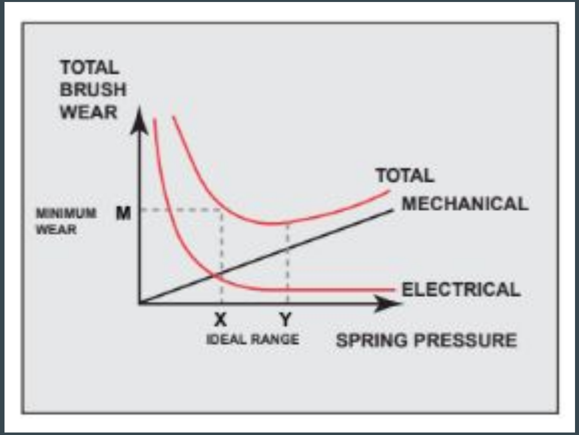
+/- 1/16 inch tolerance in vertical assembly

gives a +/- 0.44 lb/in variance

Recommended Range of Spring Pressures	
Industrial D.C. Applications	4-6 P.S.I.
WRIM & Sync. Rings	3.5 – 4.5 P.S.I.
High Speed Turbine Rings, Soft Graphite Grades	2.5 – 3.5 P.S.I.
Metal Graphite Brushes	4.5 – 5.5 P.S.I.
FHP Brushes	4-7 P.S.I.
Traction Brushes	5-8 P.S.I.

For brushes with top and bottom angles greater than 25 degrees, add an extra .5 — 1 P.S.I.

$$\text{Spring (P.S.I.) Pressure} = \frac{\text{Measured Force (lbs.)}}{\text{Brush Thickness (in)} \times \text{Brush Width (in)}}$$



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