MAE 435: Intelligent Ground Vehicle Competition

Presented by

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Jared DiMillio

Reece Jordan

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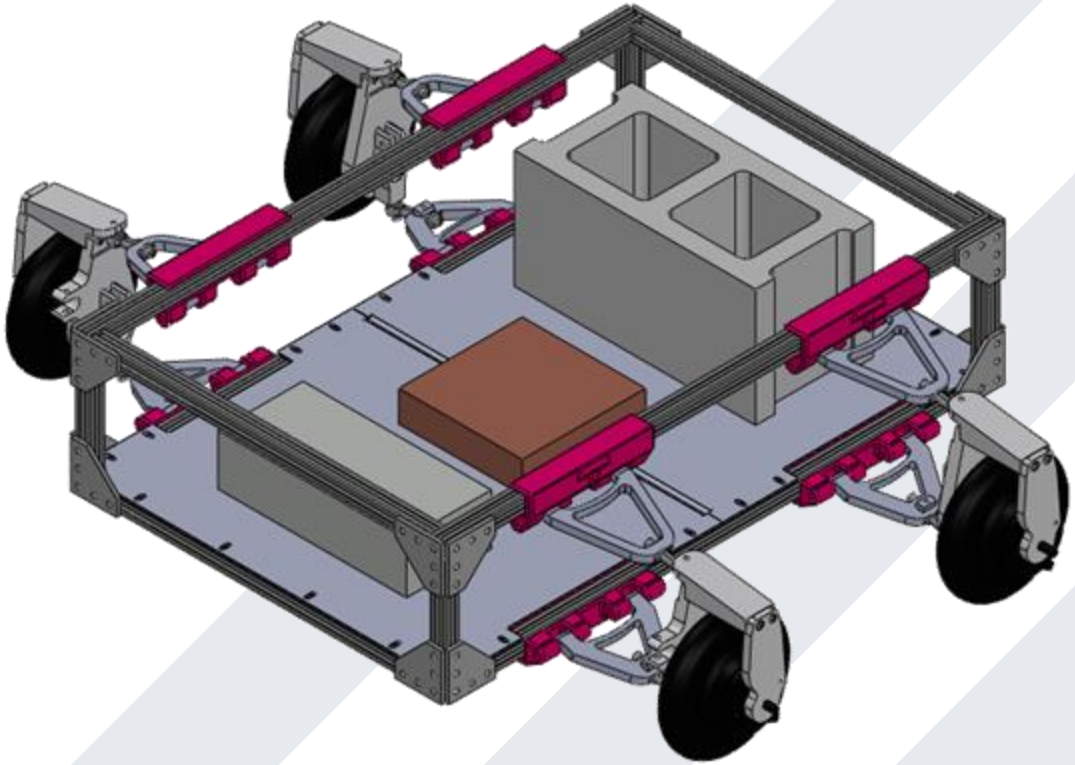
Introduction

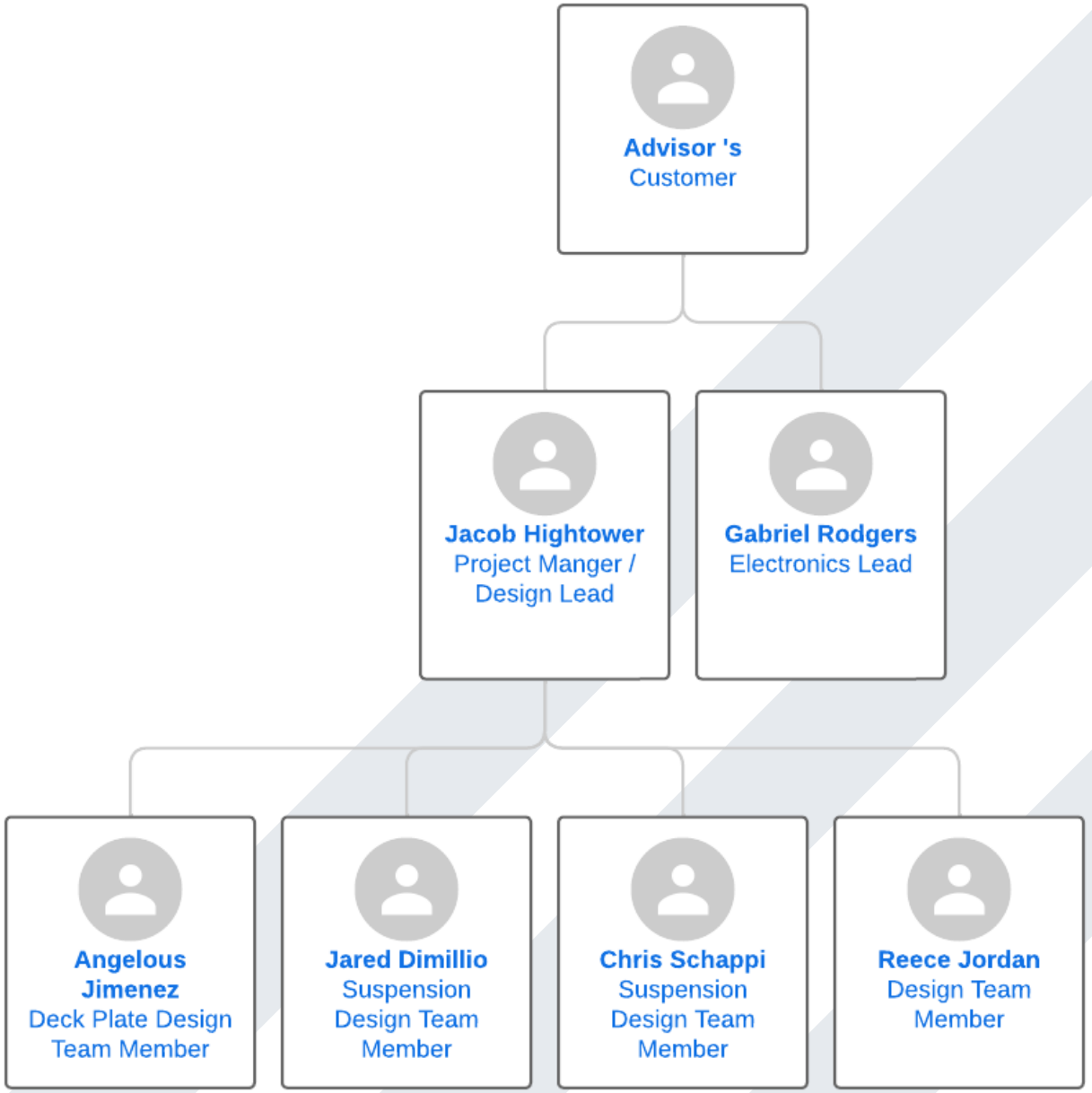
- The IGVC project is a self-driving robotics competition ran by Oakland University
- Our goal is to provide a remotely piloted vehicle capable of translational motion
- Team Structure
  - Project Management
  - Mechanical Design
  - Electrical System Design



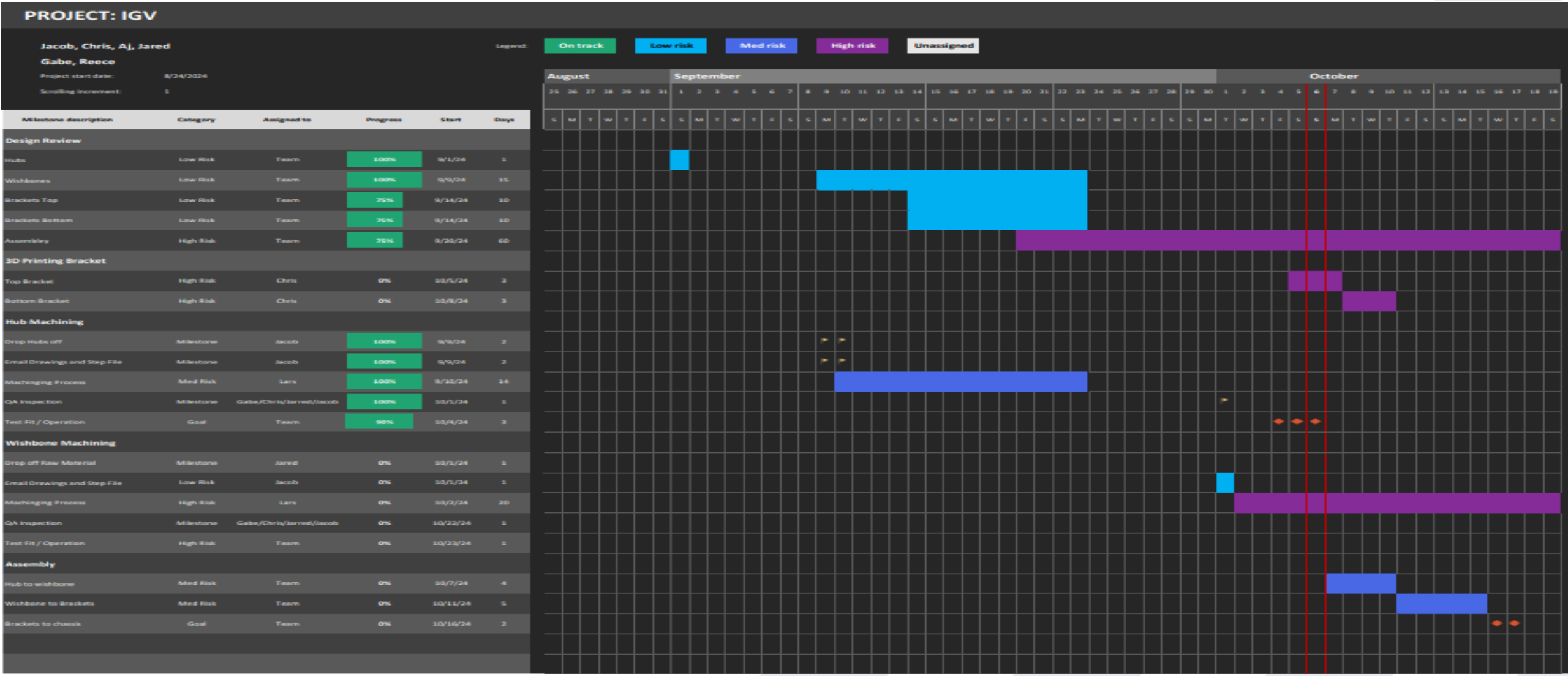
First Iteration of Full IGV SolidWorks Model

Project Management

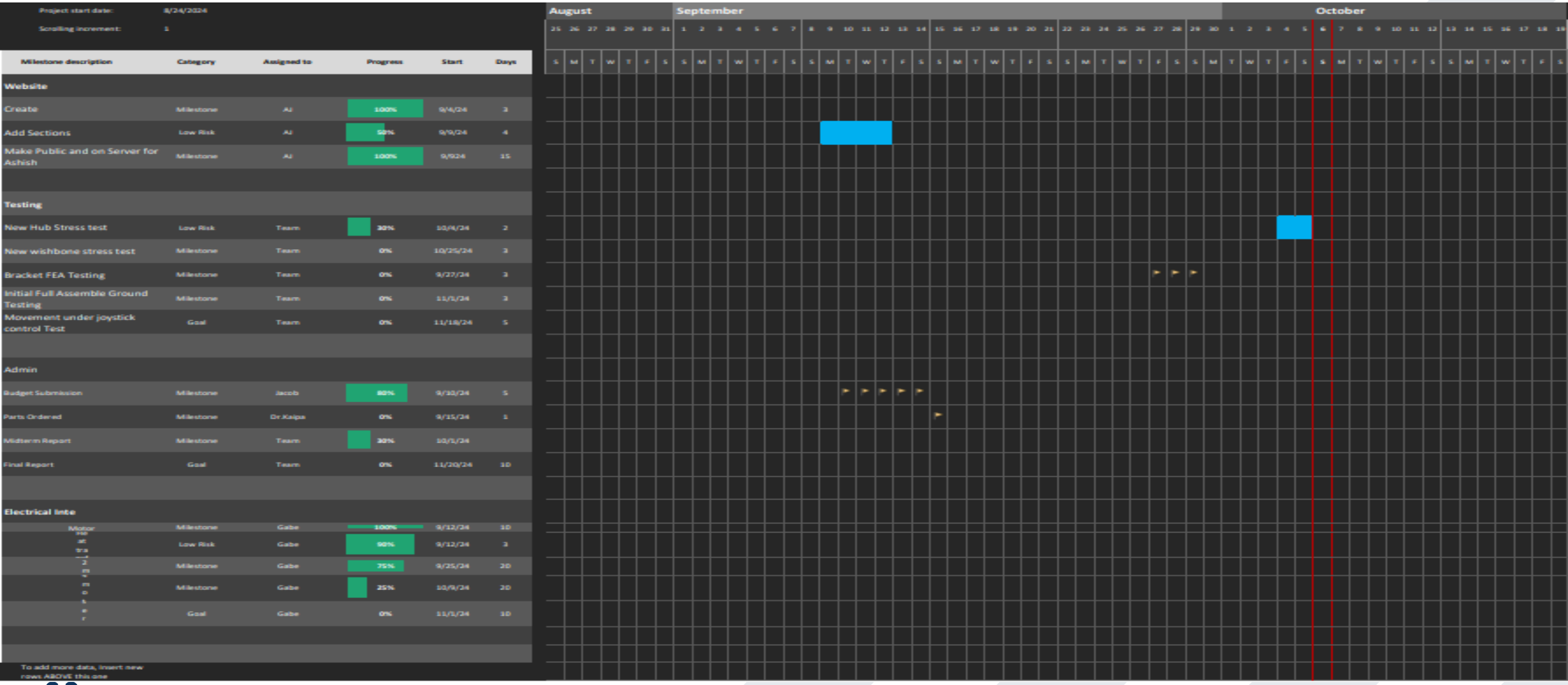
- Schedule Meetings
- Communicate to Customers
- Submitting and Tracking of budget and parts
- Supervise Team goals and Gantt Chart progress



Gantt Chart


PROJECT: IGV
Jacob, Chris, Aj, Jared
Gabe, Reece
Project start date: 8/24/2024
Scrolling increment: 1
Legend:
On track
Low risk
Med risk
High risk
Unassigned
August
September
October
Milestone description
Category
Assigned to
Progress
Start
Days
Design Review
Hubs
Low Risk
Team
100%
9/1/24
1
Wishbones
Low Risk
Team
100%
9/9/24
15
Brackets Top
Low Risk
Team
75%
9/14/24
10
Brackets Bottom
Low Risk
Team
75%
9/14/24
10
Assembley
High Risk
Team
75%
9/30/24
60
3D Printing Bracket
Top Bracket
High Risk
Chris
0%
10/5/24
3
Bottom Bracket
High Risk
Chris
0%
10/8/24
3
Hub Machining
Drop Hubs off
Milestone
Jacob
100%
9/9/24
2
Email Drawings and Step File
Milestone
Jacob
100%
9/9/24
2
Machinging Process
Med Risk
Lars
100%
9/10/24
14
QA Inspection
Milestone
Gabe/Chris/Jarred/Jacob
100%
10/1/24
1
Test Fit / Operation
Goal
Team
90%
10/4/24
3
Wishbone Machining
Drop off Raw Material
Milestone
Jared
0%
10/1/24
1
Email Drawings and Step File
Low Risk
Jacob
0%
10/1/24
1
Machinging Process
High Risk
Lars
0%
10/2/24
20
QA Inspection
Milestone
Gabe/Chris/Jarred/Jacob
0%
10/22/24
1
Test Fit / Operation
High Risk
Team
0%
10/23/24
1
Assembly
Hub to wishbone
Med Risk
Team
0%
10/7/24
4
Wishbone to Brackets
Med Risk
Team
0%
10/11/24
5
Brackets to chassis
Goal
Team
0%
10/16/24
2

Gantt Chart



Project start date: 8/24/2024

Scrolling increment: 1

Milestone description	Category	Assigned to	Progress	Start	Days
Website					
Create	Milestone	AJ	100%	9/4/24	3
Add Sections	Low Risk	AJ	50%	9/9/24	4
Make Public and on Server for Ashish	Milestone	AJ	100%	9/924	15
Testing					
New Hub Stress test	Low Risk	Team	30%	10/4/24	2
New wishbone stress test	Milestone	Team	0%	10/25/24	3
Bracket FEA Testing	Milestone	Team	0%	9/27/24	2
Initial Full Assemble Ground Testing	Milestone	Team	0%	11/1/24	2
Movement under joystick control Test	Goal	Team	0%	11/18/24	5
Admin					
Budget Submission	Milestone	Jacob	80%	9/10/24	5
Parts Ordered	Milestone	Dr.Kaipa	0%	9/15/24	1
Midterm Report	Milestone	Team	30%	10/1/24	
Final Report	Goal	Team	0%	11/20/24	10
Electrical Inte					
Motor	Milestone	Gabe	100%	9/12/24	10
[illegible]	Low Risk	Gabe	90%	9/12/24	3
[illegible]	Milestone	Gabe	75%	9/25/24	20
[illegible]	Milestone	Gabe	25%	10/9/24	20
[illegible]	Goal	Gabe	0%	11/1/24	10

To add more data, insert new rows ABOVE this one

August

September

October

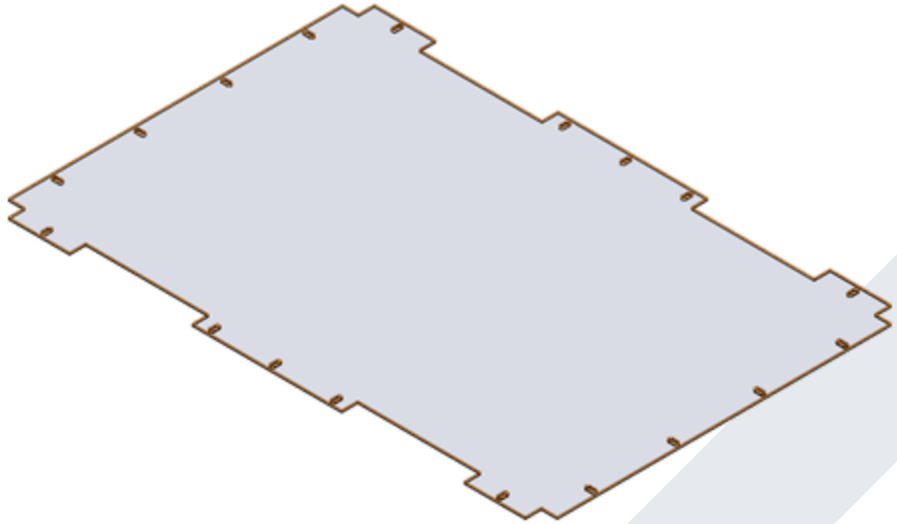
Budget Outline

Part Name	QTY	P/N	Price per unit	Units	Source	Hyper Link	Total
Oversized Multipurpose 6061 Aluminum Sheets(12"x24")	1	89155K13	188.76	1	McMaster-CARR	https://www.mcmaster.com/catalog/130/42	188.76
Frame Fastner Nuts (4 Pack)	20	47065T147	6.12	5	McMaster-CARR	https://www.mcmaster.com/products/80%2	30.6
T-Slotted Framing Structural Bracket	5	3136N159	17.88	1	McMaster-CARR	https://www.mcmaster.com/products/80%2	17.88
Top Whishbone ball joint to frame	10	60645K51	8.29	1	McMaster-CARR	https://www.mcmaster.com/catalog/130/12	82.9
Bolts For Ball Joint	25	92196A318	29.73	1	McMaster-CARR	https://www.mcmaster.com/catalog/130/35	29.73
Washer For Ball Joint	50	92916A395	22.86	1	McMaster-CARR	https://www.mcmaster.com/catalog/130/36	22.86
Black-Oxide Alloy Steel Socket Head Screw, 5/16"-18 Thread Size, 2" Long, Partially Threaded	25	91251A591	10.61	1	McMaster-CARR	https://www.mcmaster.com/products/screv	10.61
Inline Ball Joint Linkage, M6 x 1 mm Right-Hand Internal Thread	10	8412K14	6.82	1	McMaster-CARR	https://www.mcmaster.com/catalog/130/14	68.2
Black Oxide 18-8 Stainless Steel Socket Head Screw	25	96006A705	9.99	1	McMaster-CARR	https://www.mcmaster.com/96006A705/	9.99
T-Slotted Framing, End-Feed Double Nut for 1" High Single Rail, 1/4"-20 Thread	20	3136N274	11.17	2	McMaster-CARR	https://www.mcmaster.com/3136N274/	22.34
PETG HF (Color White)	4	33100	23	1	bambu	https://us.store.bambulab.com/collections/	23
TPU (color white)	1	51102	42	1	bambu	https://us.store.bambulab.com/collections/	42
20 lb shocks	4	GGN20-020-C	10.65	1	Guden	https://www.guden.com/Item/Standard-No	42.6
Hex Nuts for Motor M12 x 1.25 mm Thread sinc platted	25	91415A235	12.83	1	McMaster-CARR	https://www.mcmaster.com/91415A235/	12.83
Lower Wishbone - 5/16" -18 Black Oxide 18-8 SS bolt Partial Thread	5	96006A836	5.45	1	McMaster-CARR	https://www.mcmaster.com/96006A836/	5.45
Washers for Motors (Metric Tab Lock Washer)	10	97471A106	16.88	2	McMaster-CARR	https://www.mcmaster.com/97471A106/	33.76
							0
							0
Emergency Funds	1	0	300	1	n/a		
Grand Total	643.51						

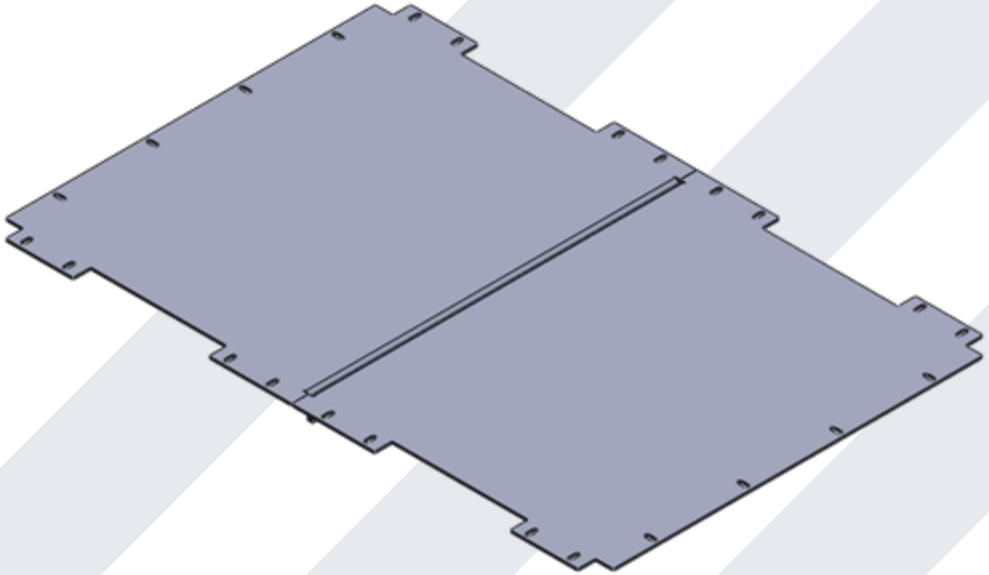
Deck Plate

Final/Current Version

- We revised the deck plate for easier disassembly
  - Previously, disassembly required full tear down of the robot
- We decided to split the plate into 2 symmetrical pieces and added a bend in the middle for more stiffness
- 1/8" Aluminum plate



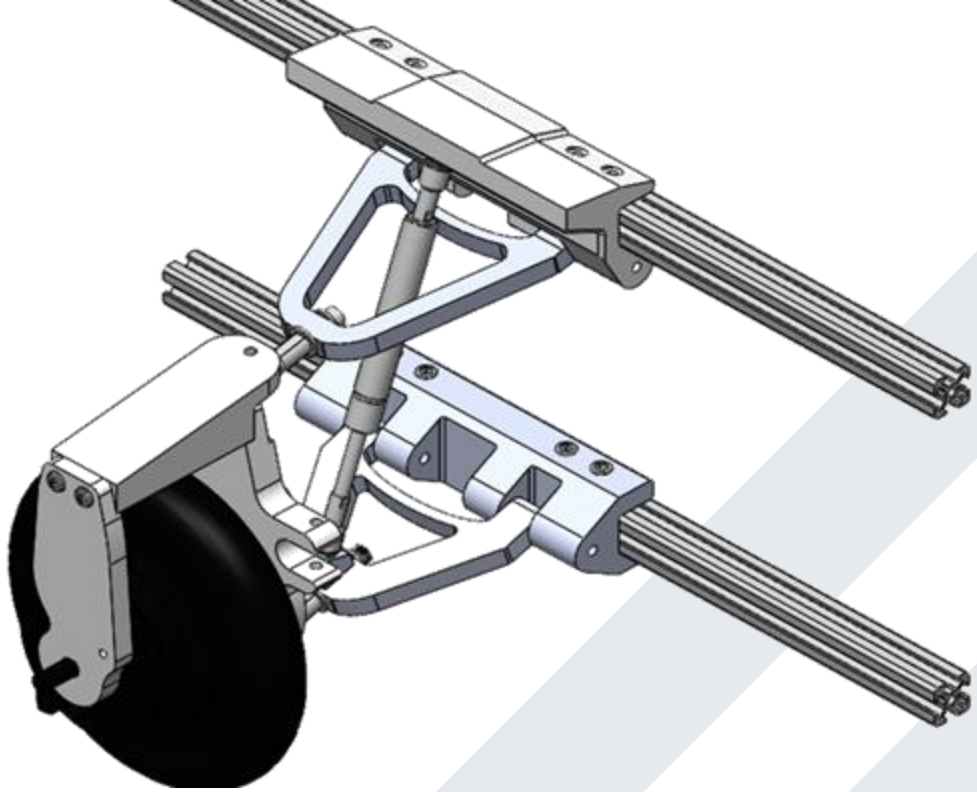
V1 - Single Plate Design



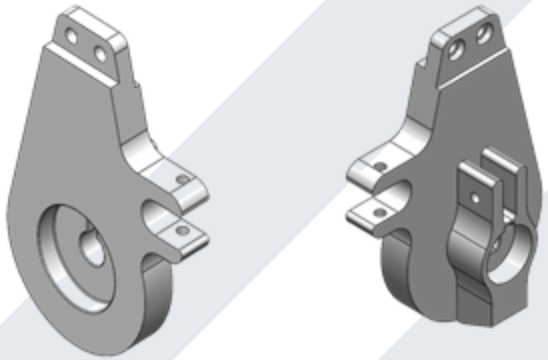
V2 – Dual Plate Design

Suspension Sub-Assembly

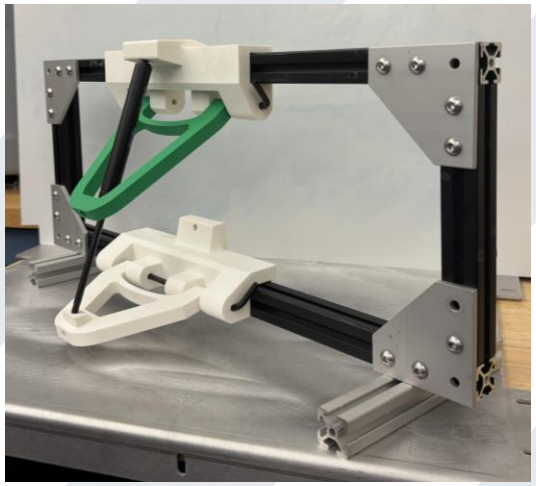
- The SolidWorks model is the primary mockup for dimensioning
- Prototype mock-up was used to verify sizing and relations of components outside of SolidWorks
- Upper
  - Upper mounting bracket
    - White PETG 3-D printed
  - Upper wishbone
    - 6061 Aluminum
  - Ball joint
    - 5/16" -18 threaded insert
  - Shocks
    - 20-lbf
- Lower
  - Lower mounting bracket
    - White PETG 3-D printed
  - Lower wishbone
    - 6061 Aluminum



SolidWorks Model for Complete Suspension System

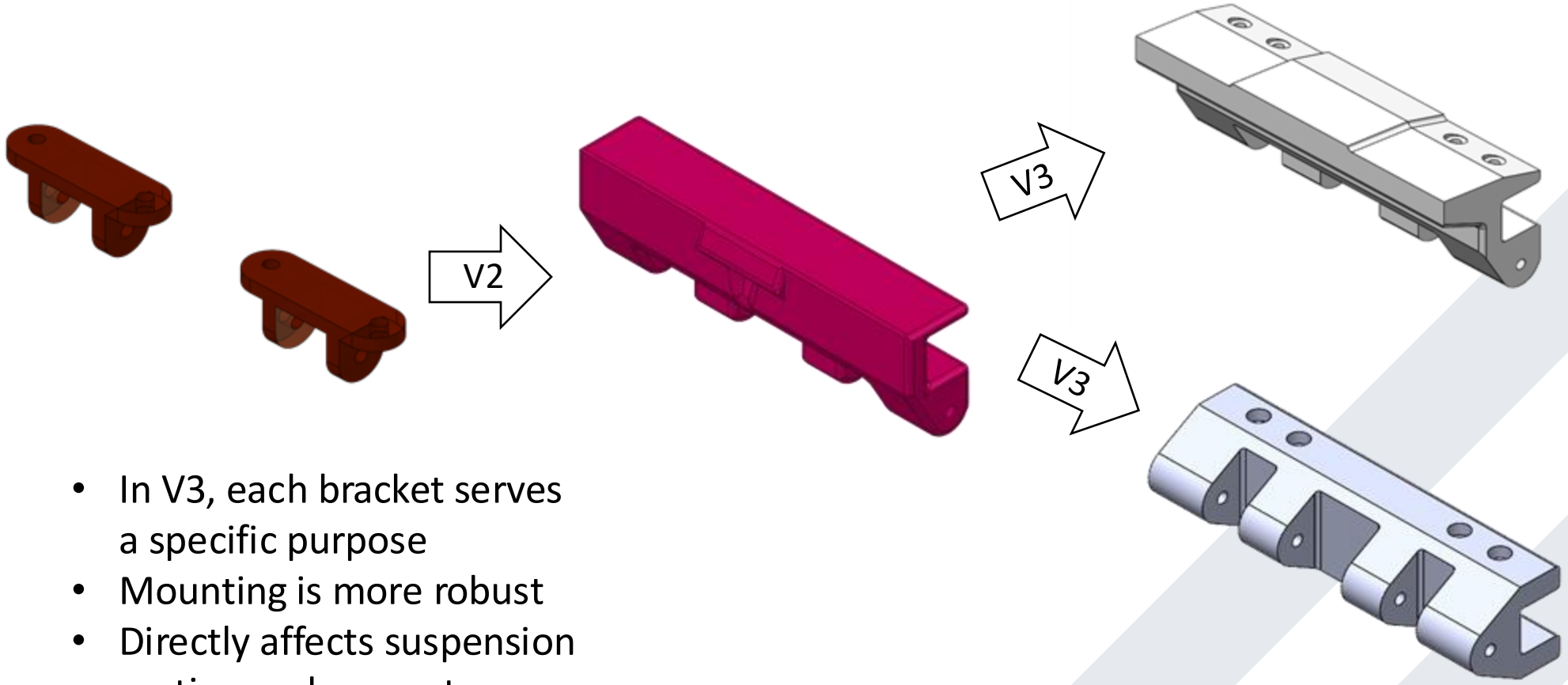


Motor Hubs Final Version



Prototype Mock-up

Wishbone Mounting Brackets



Upper Wishbone Mount

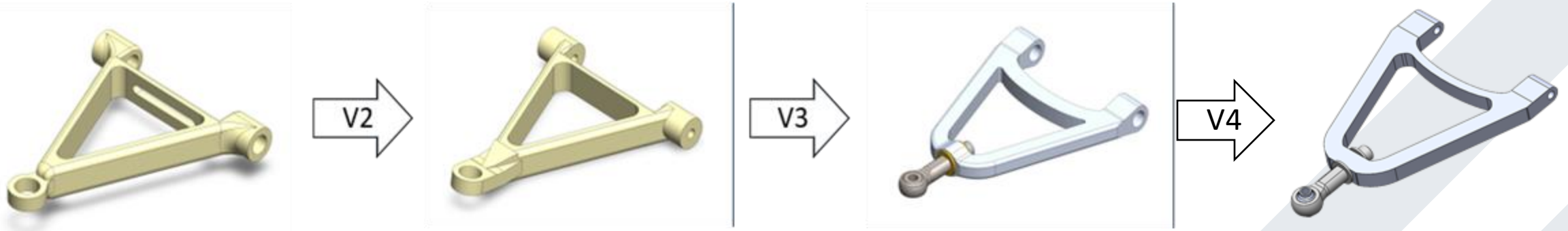
Lower Wishbone Mount

- In V3, each bracket serves a specific purpose
- Mounting is more robust
- Directly affects suspension motion and geometry

- V1: Initial two-bracket design
- V2: Monolithic bracket
- V3: Unique bottom and top brackets reinforced

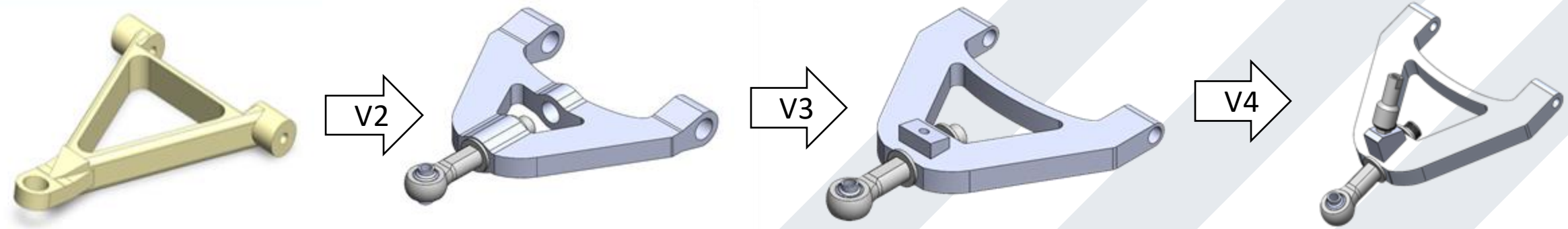
Wishbone Updates

TOP



- Each iteration reflected the manufacturing technique planned
- Over time, a simpler, more cost effective design was determined
- V4 for top and bottom each prioritize geometry best for water jet cutting
- V4 would be cut from a single ½” 6061 aluminum sheet (12" by 24")

BOTTOM



MAE Electronic team Goals

The goal for the MAE team's electronic work is to lay the foundation for future teams to inherit a simple moving vehicle.

Requirement before semester end:

- Forward and backward motion
- Speed control and feedback
- Platform stability

Steps to reach the goals:

- Establish simple motor control (forward backward with a power supply)
- Develop a throttle control and a "speedometer" feedback
- Establish simple multi-motor control
- Learn about CAN Bus
- Employ CAN Bus system to code the control for 2 motors
- CAN Bus control 4 motors
- Develop serviceable connections to place control system onto the chassis

Electrical System Components

- CAN Bus
- Arduino
- CAN bus hub
- Motor controller
- BLDC electric motor 350W
- Power-supply
- Battery

Single Motor Control (Spring 24)

User Inputs

- Arduino IDE (Integrated Development Environment) serial monitor

Controllers:

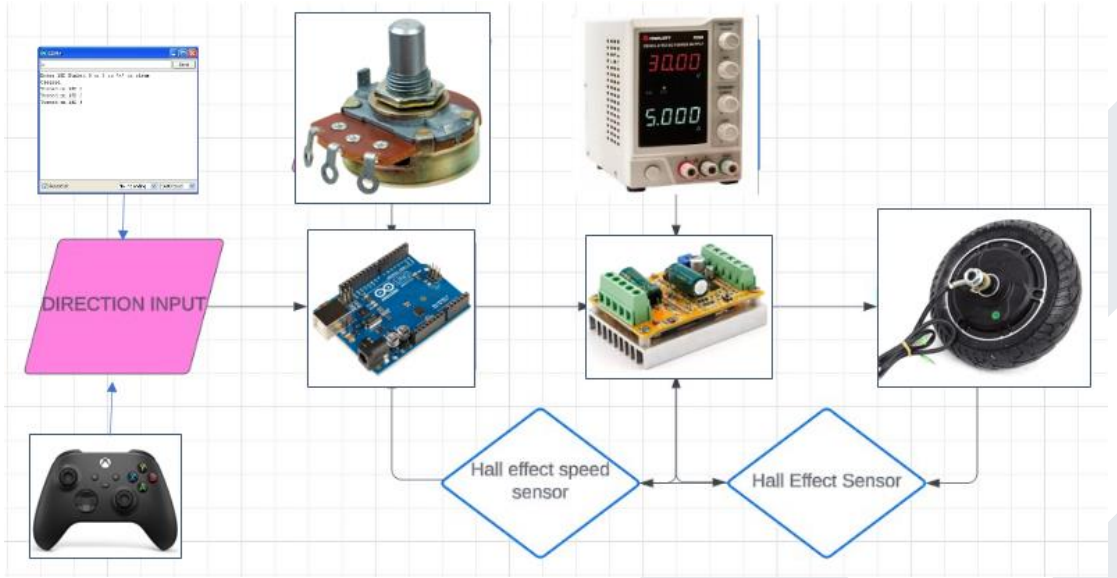
- Arduino Uno Rev 3 Micro Controller
- Potentiometer for speed throttling (5 mph requirement)
- BLDC motor controller with Hall feedback sensor

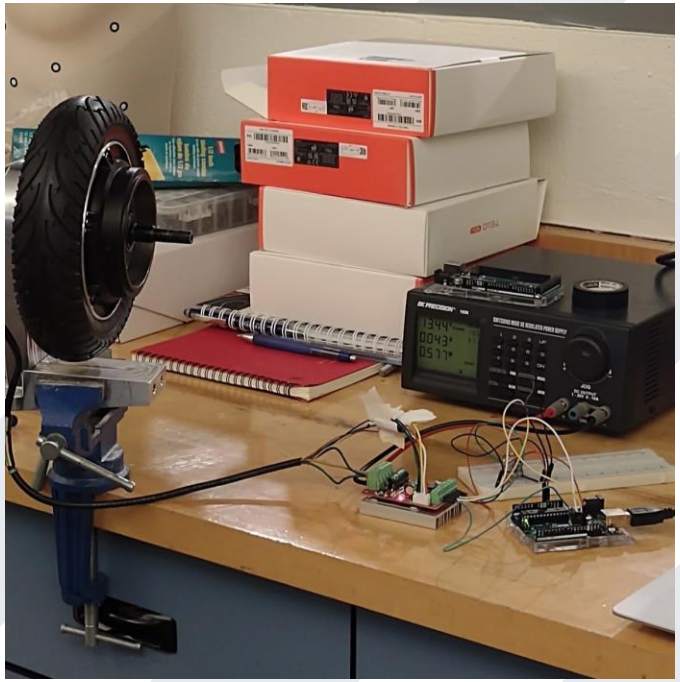
Motor:

- Hoverboard BLDC hub driven motors (Rising Sun 24v motor)

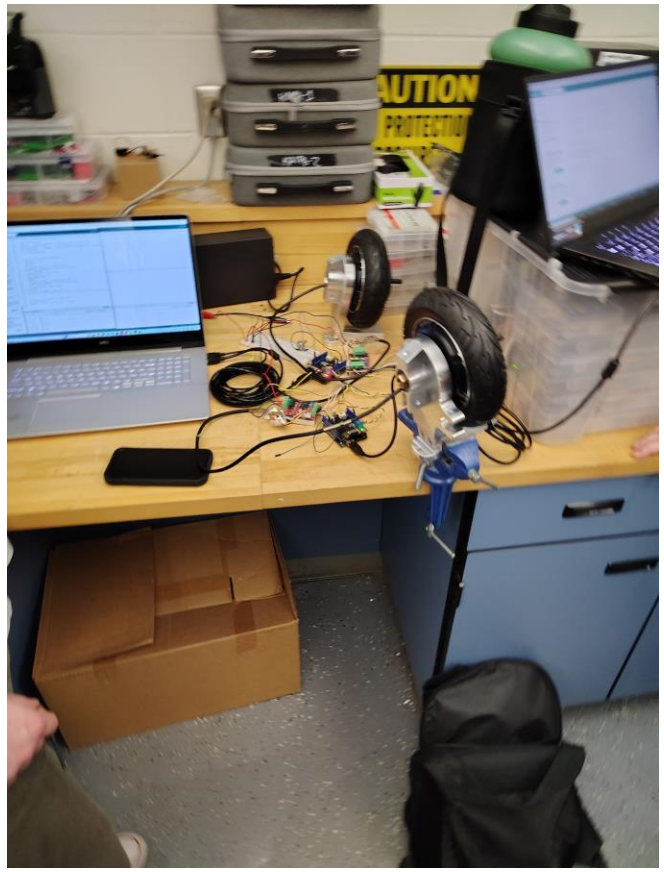
Power:

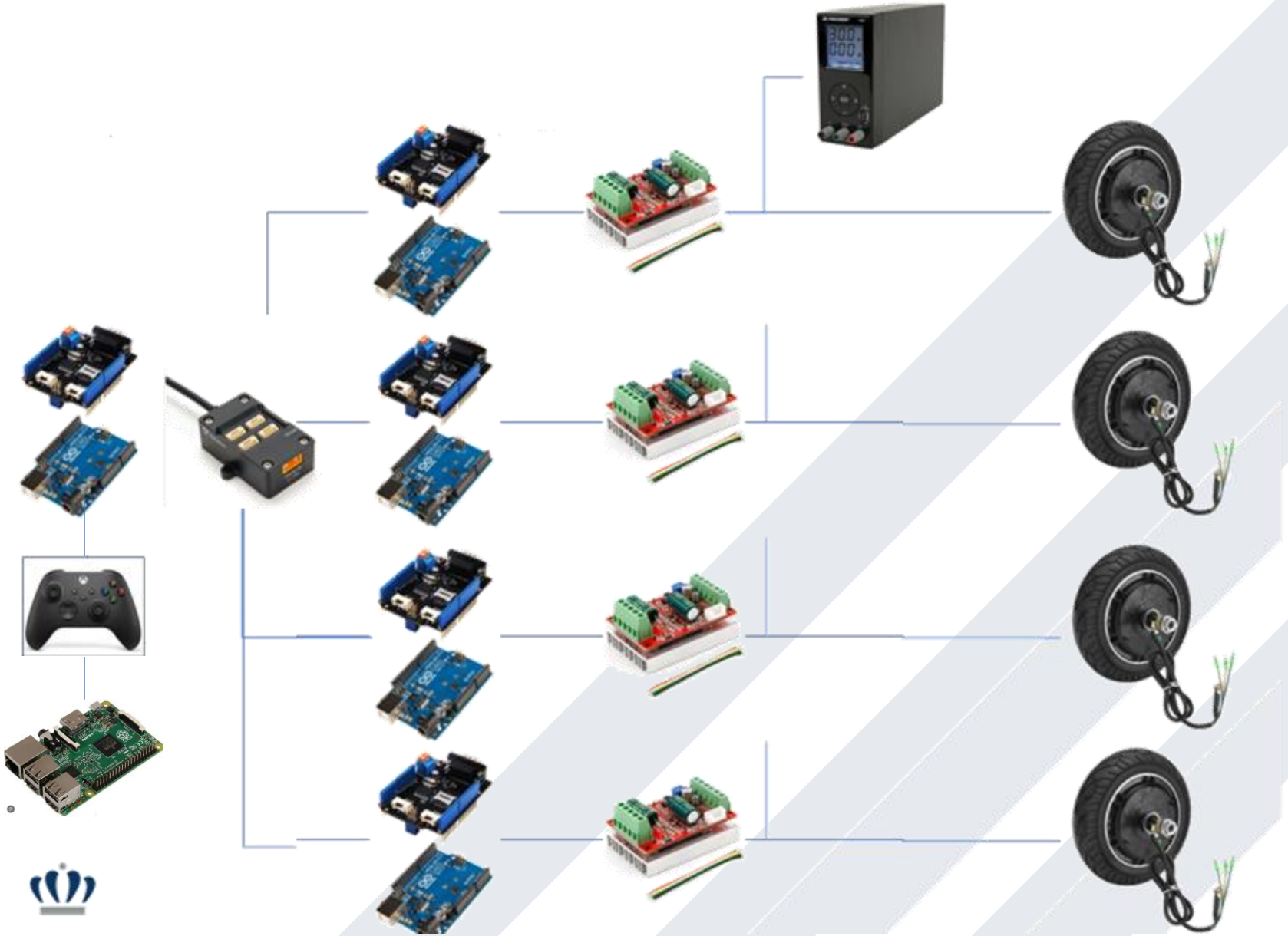
- Power supply (Run at 12-15v, less than 1 amp)





Multi-motor control





Engineering Standards

Mechanical and Structural Design Standards:

- **ISO 2768-1:1989** - *General Tolerances for Linear and Angular Dimensions*
  - This standard is essential for ensuring that parts such as the wishbone suspension and motor hub assemblies maintain proper dimensional accuracy and tolerances in manufacturing, which is crucial for ensuring the integrity and fit of mechanical parts. **[Motor Hub and Wishbone Suspension]**
  - Tested and ensured the wishbone suspension and motor hubs for solid clearance through SolidWorks so there's no issue when machining.
- **ASTM B221M** - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  - Outlines the procedures for testing the mechanical properties of those materials, ensuring their strength and suitability for load-bearing components like the wishbone or hub.**[Deck Plate / 80-20 Chassis]**
- **ASME Y14 -** *Drawing Standard Series*
  - *Used with all SolidWorks sketches and model drawings*
- **IGVC Standards**
  - Design **[Ground Vehicle]**
  - Length **[3-7ft]**
  - Width **[2-4ft]**
  - Height **[Max 6 ft]**
  - Propulsion **[Onboard – Battery]**
  - Payload **[20lb Cinder Block 16" x 8" x 8"]**

Engineering Standards

Material Standards:

- **ASTM B209-14** - *Standard Specification for Aluminum and Aluminum-Alloy Plate*
  - Ensures that the aluminum plate meet specific mechanical properties and quality standards, important for maintaining structural integrity and reducing vibration effects. **[Deck Plate]**
  - Ensured the deck plate could withstand forces up to 4x gravity
- **ASTM D638-14** - *Standard Test Method for Tensile Properties of Plastics*
  - 3D-printed components, this standard applies to the testing and validation of polymer parts, such as those made with nylon or other materials used in the hub or suspension system. **[Prototypes/Wishbone/Mounts]**

Engineering Standards

Testing and Prototyping Standards:

- **ASTM E1559-09** - *Standard Guide for Sampling Strategies for Additive Manufacturing (AM) of Materials*
  - Using 3D printing for rapid prototyping, this standard provides guidelines for ensuring that the materials and parts produced through additive manufacturing meet required tolerances, strength, and durability. **[Prototypes/Wishbone/Mounts]**

- **ASTM F2792-12a** - *Standard Terminology for Additive Manufacturing Technologies*
  - This standard defines terms and methods used in 3D printing, helping to ensure clear communication and consistency when discussing design parameters and testing methods for 3D-printed components. **[Prototypes/Wishbone/Mounts]**

THANKS
Any questions?

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