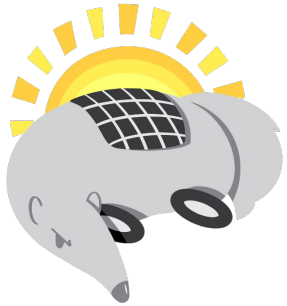


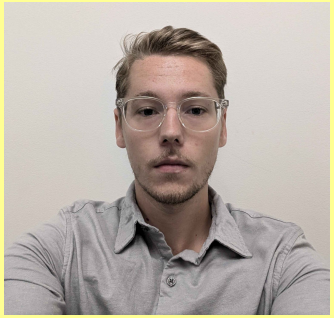
ZotSun
Solar Racing

Preliminary Design Review
Front Suspension

Sebastian Caballero, Tiffany Gao, Quan Nguyen,
Patrick Revives, Nicholas Wilson

Team Introduction

Patrick Revives



Nicholas Wilson

Quan Nguyen

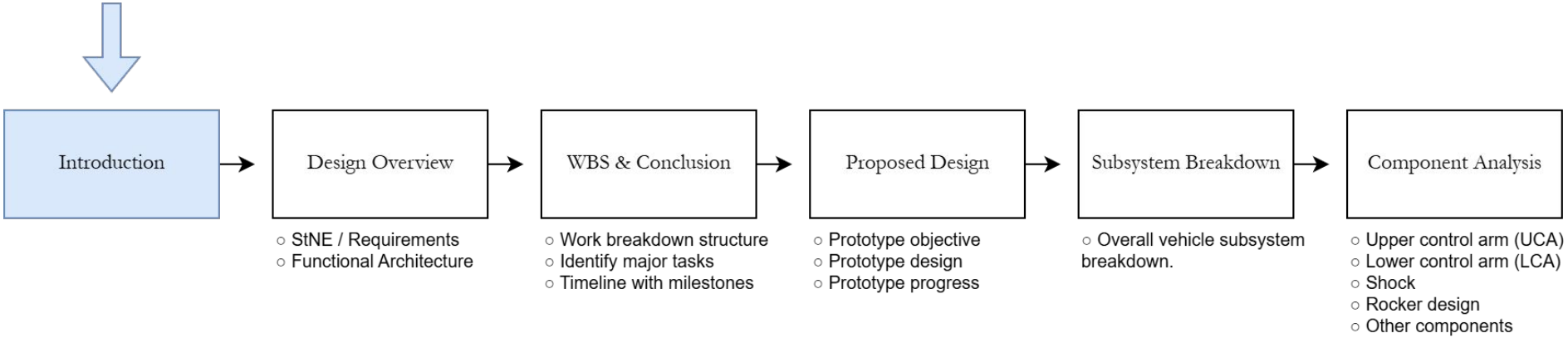
Tiffany Gao

Sebastian Caballero

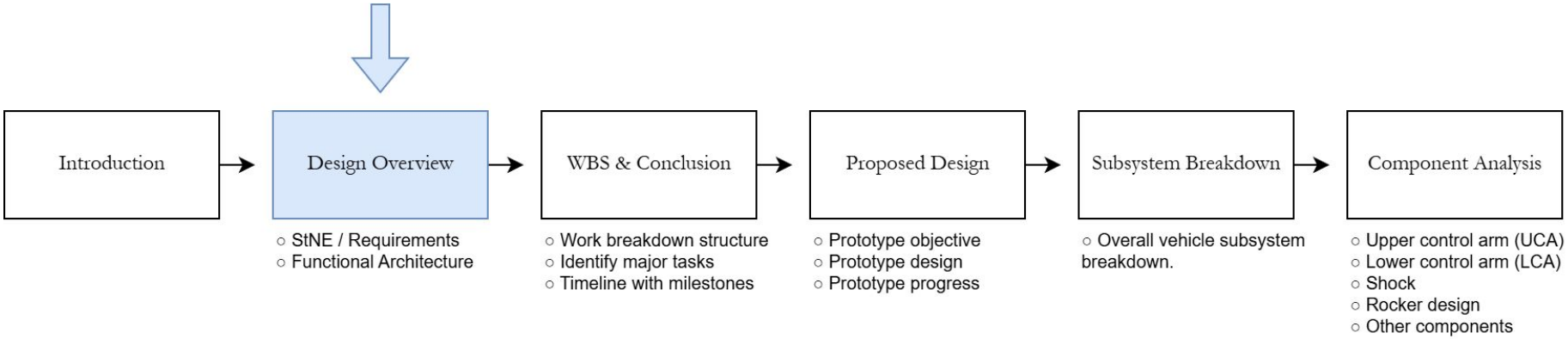
Introduction: Presentation Goals

Preliminary Design Review for ZotSun Front End (Suspension, Steering, Braking)

- Presentation divided into six sections
- Current section shown in blue.



Design Overview



Overview: Problem Definition of Vehicle

Problem:

- Vehicle propulsion generates greenhouse gases -
  - Directly (as in an ICE)
  - Indirectly (e.g. to generate electricity to run an EV).
- Most vehicles are too inefficient to be powered directly from green sources, such as solar.
- Therefore, drivers need an inexpensive, eco-friendly alternative to ICE and *conventional* EV propulsion.

Solution:

- A vehicle sufficiently efficient at ~40 mph, able to be powered by a solar array no greater than 4.000 m2 (per regulation 8.1.B).

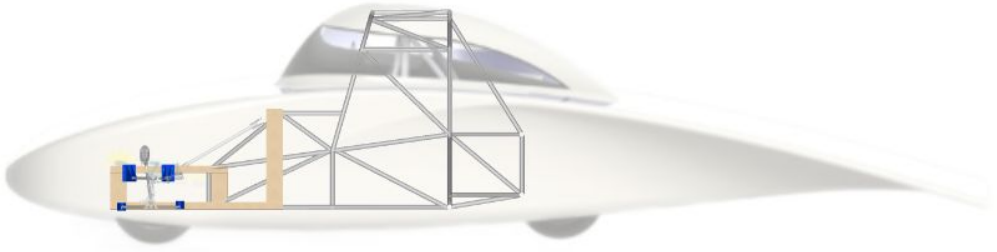
Overview: Problem Definition of Prototype

Sub-problem:

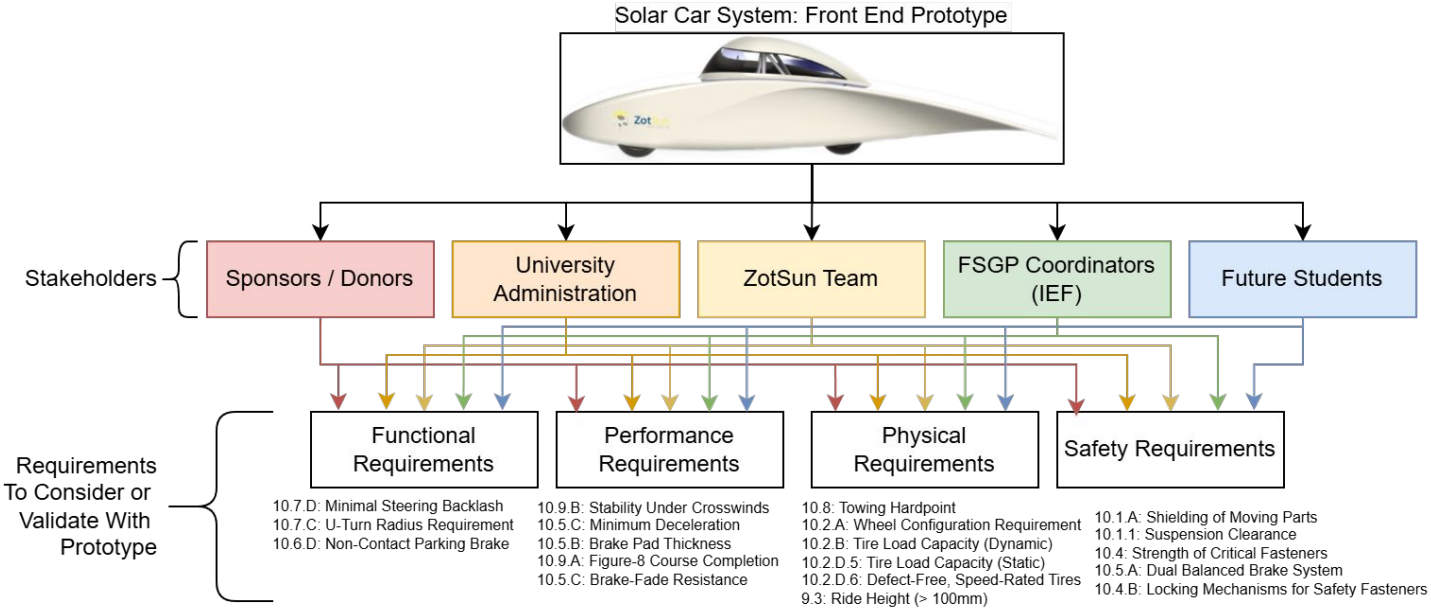
- Design using exclusively CAD, CAE, and mathematical analysis can be fallible or used fallibly.
- An inexpensive model of the proposed solution must be constructed: i.e. a prototype.

Sub-solution:

- A prototype for the front end of the vehicle, which includes critical subassemblies that may interfere with each other:
  - Chassis
  - Brakes
  - Steering
  - Suspension

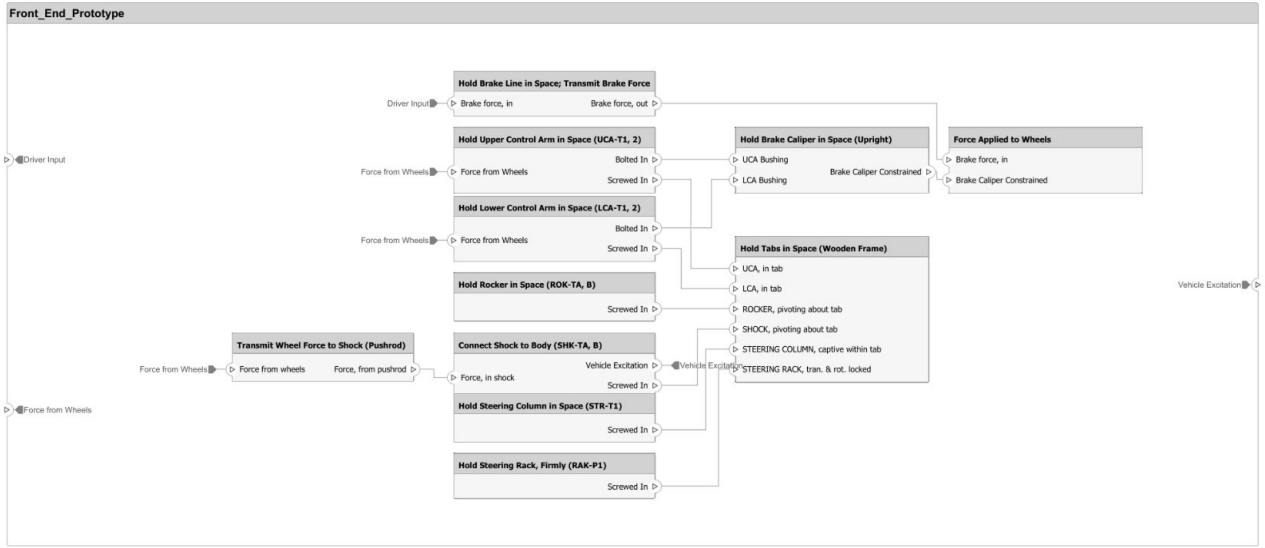


Overview: Requirements



- A spreadsheet (link) is compiled with over 41 relevant requirements for the vehicle. A naming scheme is applied to these requirements.
- The above figure shows a subset of those requirements which we will validate using the prototype or consider during development.

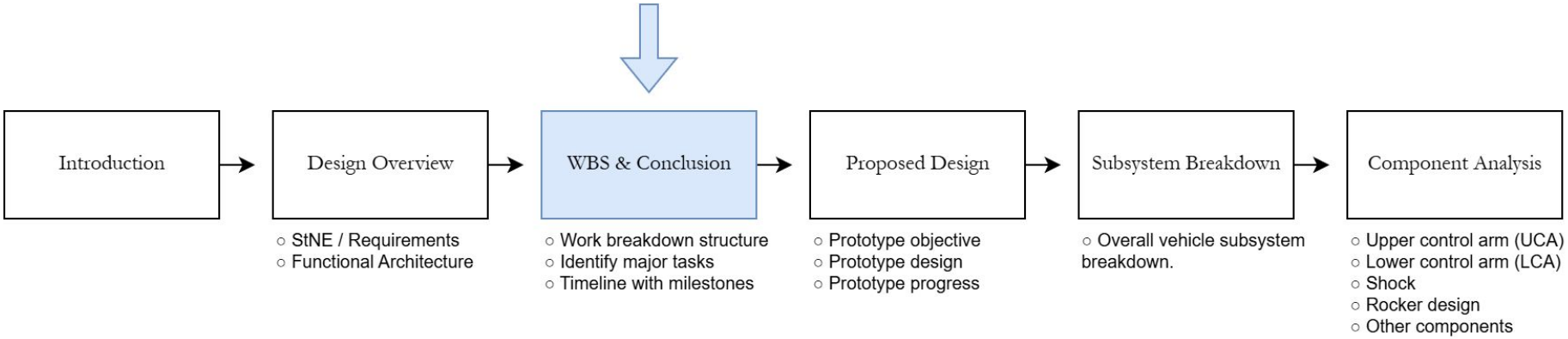
Overview



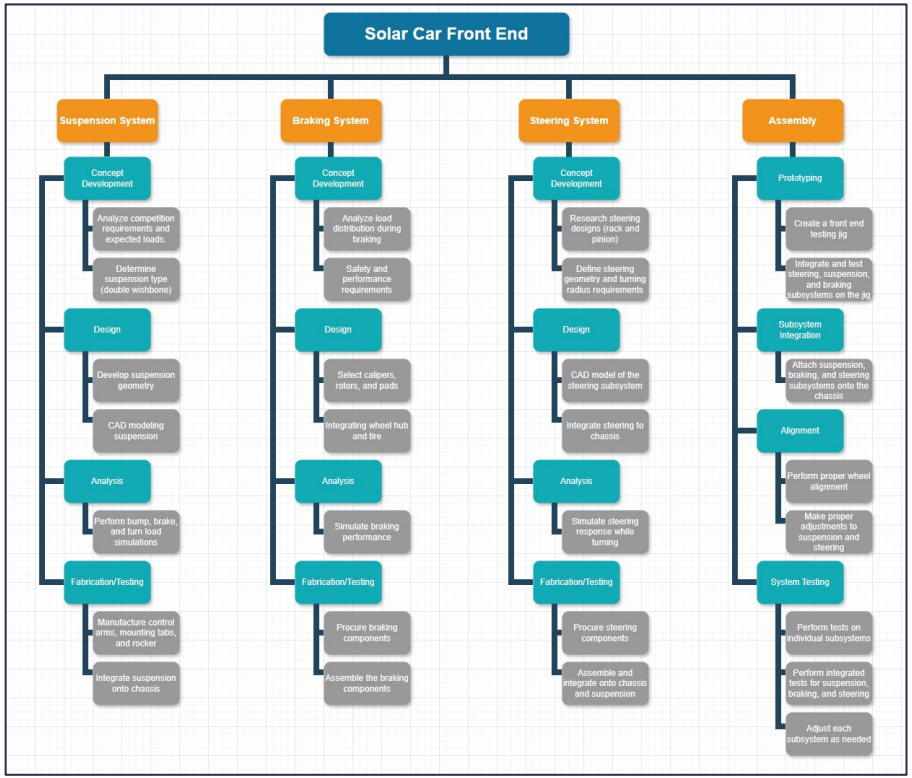
- A functional architecture of the prototype.
  - Parenthesis indicate the part ID or part name associated with the function.
  - The function of mounting tabs and the wooden frame are indicated.

ZotSun Solar Racing

Work Breakdown

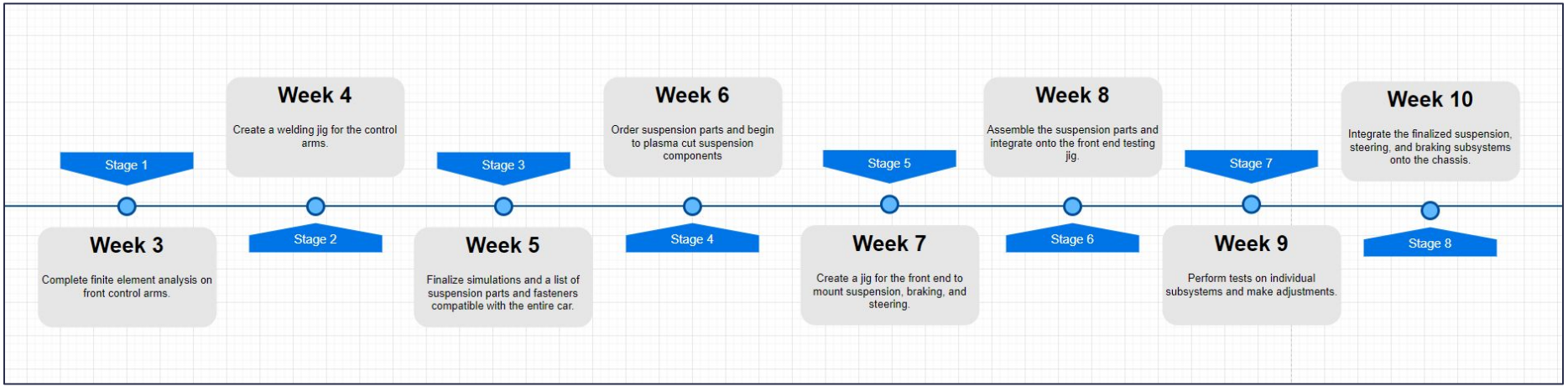


Work Breakdown Structure



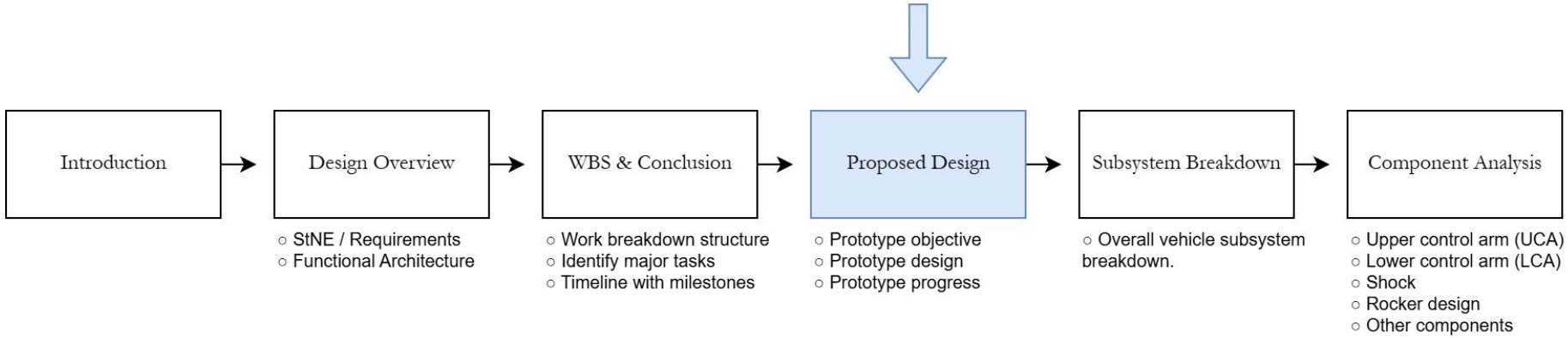
ZotSun Solar Racing

Work Breakdown Structure



ZotSun
Solar Racing

Proposed Design



Proposed Design

- The team’s objective is to design and develop a fully functional front-end assembly that integrates steering, suspension, and braking into a cohesive system. This assembly will be mounted onto a custom designed wooden jig that serves as a testing platform to simulate real-world conditions. The jig will allow for detailed evaluation of the assembly's performance through testing, providing opportunities for fine-tuning key parameters such as steering geometry, suspension alignment, and braking efficiency.

Proposed Design

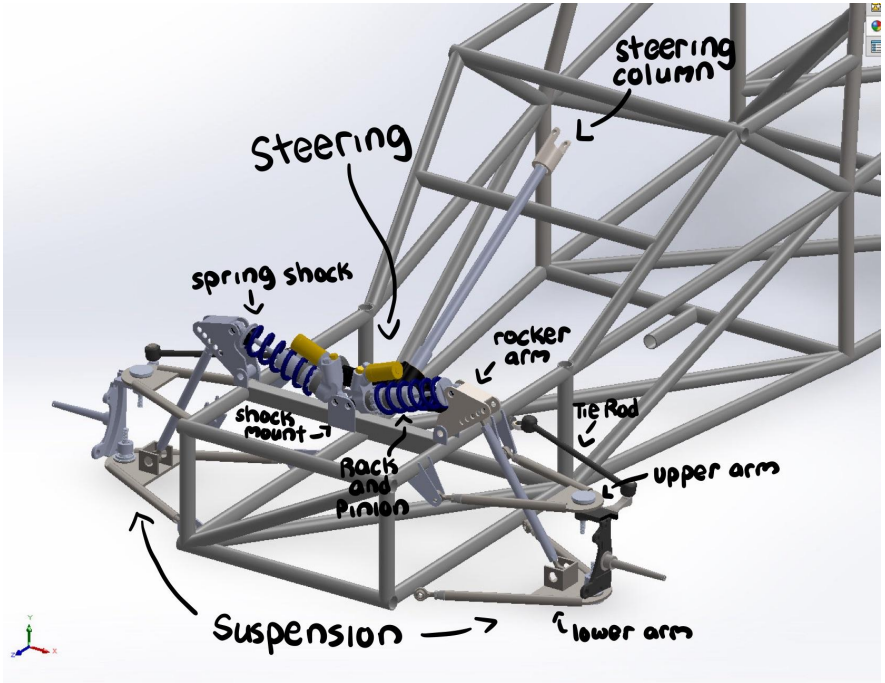


Figure 1: CAD model of front end

Proposed Design

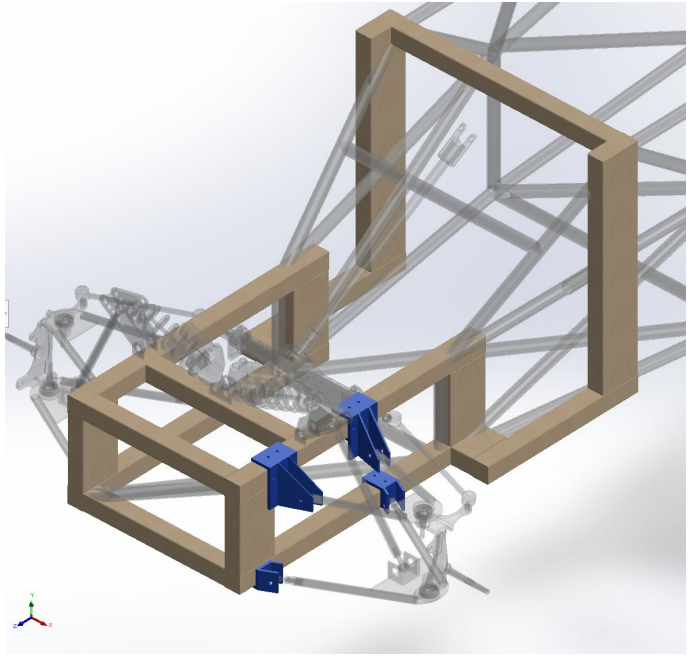


Figure 2: CAD model of wooden jig and mounting tabs

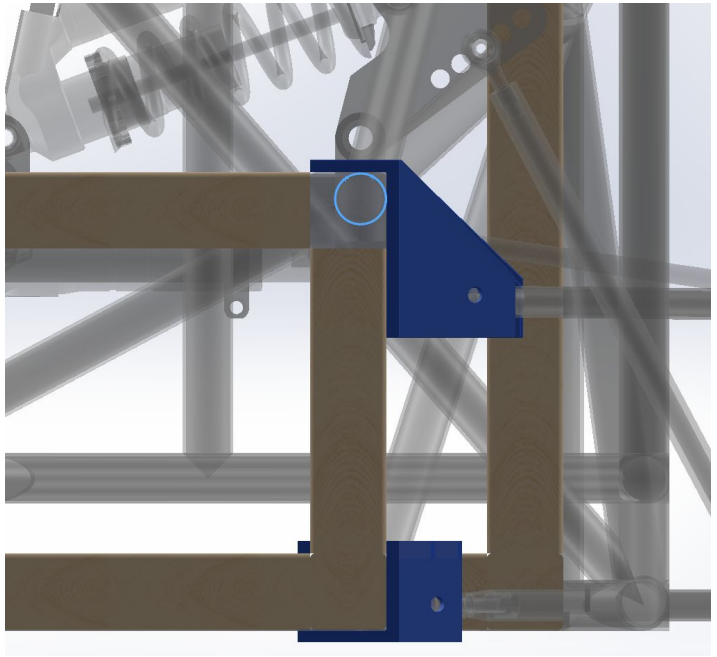


Figure 3: Side view of the upper and lower wishbone mounts

Proposed Design

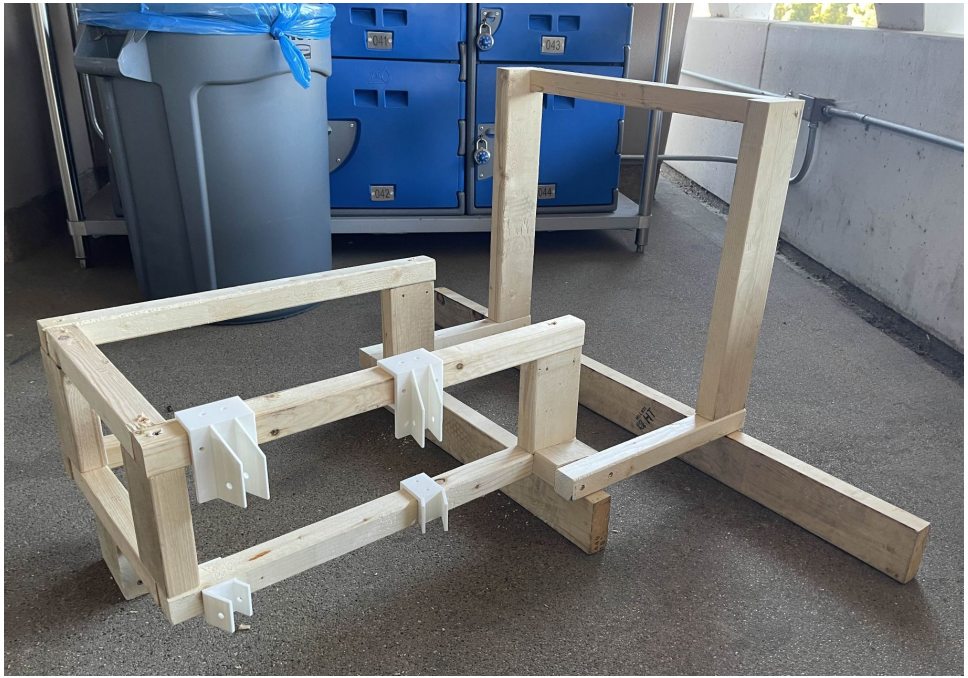


Figure 4: Physical Wooden Jig with Mounts

Proposed Design

Figure 5: Front View

Figure 6: Top View

Subsystem Breakdown

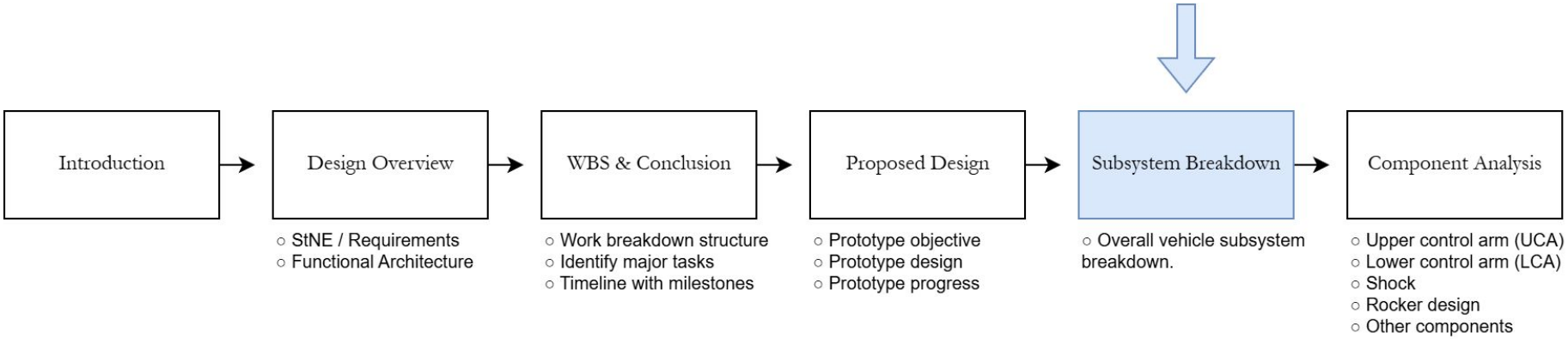


Table of Subsystems

Subsystem	Form	Function
Suspension	Overall Form: Suspension System Relevant Components: Springs, Dampers, Control Arms, Rocker Arms	Function: Improve stability Subfunctions: Support vehicle weight, control oscillations, maintain wheel alignment, transfer motion to inboard components
Steering	Overall Form: Steering System Relevant Components: Steering column, rack and pinion, tie rods	Function: Enable vehicle direction control Subfunctions: Allow driver to control vehicle direction, transmit driver input to steering mechanism, convert rotational motion to linear motion
Braking	Overall Form: Braking System Relevant Components: Brake pedal, upright, brake calipers and rotors	Function: Decelerate and stop the vehicle Subfunctions: Initiate braking process, apply force to brake pads, convert kinetic energy to thermal energy via friction

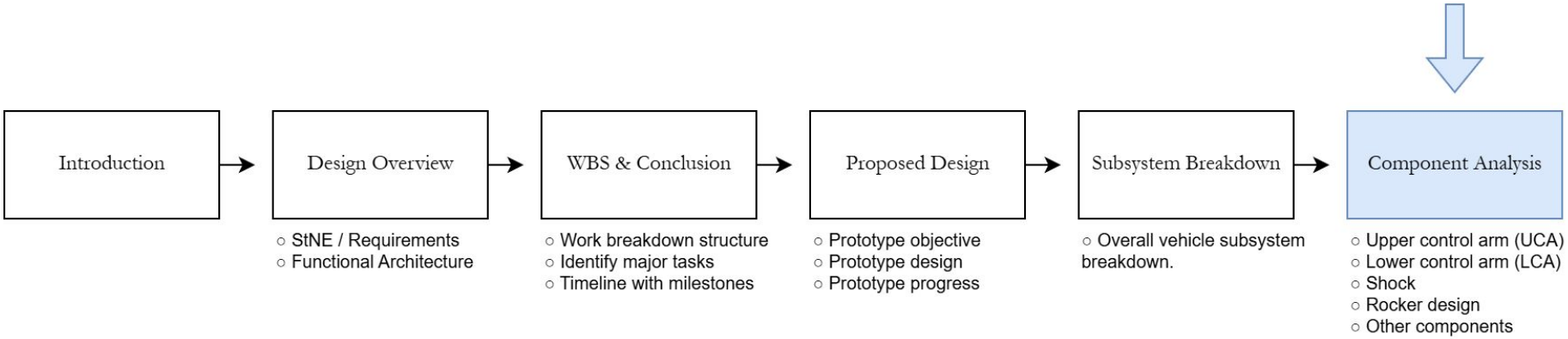
Table of Subsystems Cont.

Aerobody	Overall Form: Body shell Relevant Components: Nose, Tail, Side Panels	Function: Reduce Air Resistance Subfunctions: Deflect airflow, Minimize turbulence
Chassis	Overall Form: Frame Relevant Components: Frame Rails, Mounting Points, Cockpit	Function: Support Vehicle Structure Subfunctions: Provide rigidity, attach components, driver safety
Human Interface	Overall Form: Control Panel Relevant Components: Steering Wheel, Accelerator Pedal, Brake Pedal	Function: Driver Control Subfunctions: Direction control, speed control

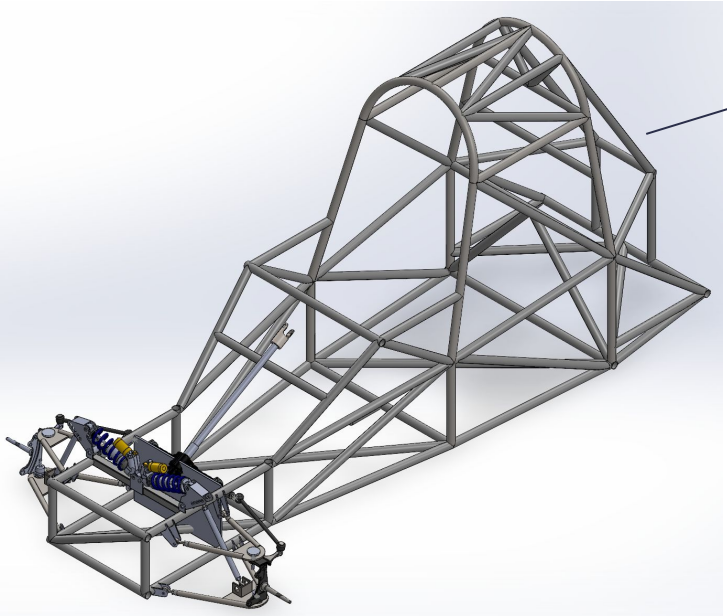
Table of Subsystems Cont.

Battery	Overall Form: Battery Pack Relevant Components: Cells, battery enclosure, Battery Management System	Function: Energy Storage Subfunctions: Store energy, Physical/thermal protection, Regulate charge/discharge
Motor	Overall Form: Electric Motor Relevant Components: Rotor, Cooling system	Function: Provide Drive Power Subfunctions: Generate torque, Maintain Optimal Operating Temperature
Solar	Overall Form: Solar Array Relevant Components: Solar cells, array mount	Function: Generate electricity Subfunctions: Convert sunlight, secure panels

Component Analysis

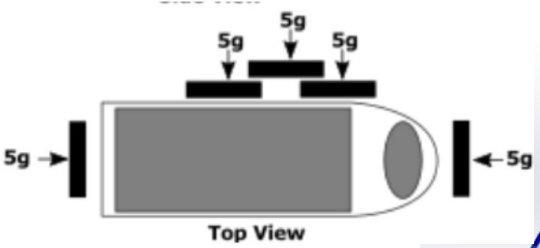


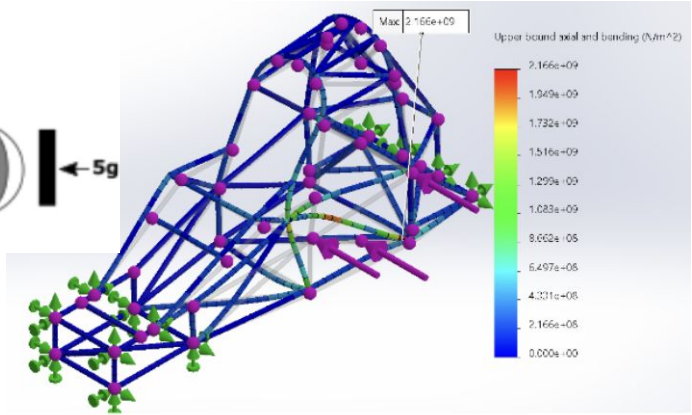
Components of the Design - Chassis



Chromoly Steel Property Values

Property	Value	Units
Elastic Modulus	2e+11	N/m^2
Poisson's Ratio	0.29	N/A
Shear Modulus	7.75e+10	N/m^2
Mass Density	7850	kg/m^3
Tensile Strength	800000000	N/m^2
Compressive Strength	2.16e+9	N/m^2
Yield Strength	434000000	N/m^2





Circular Tube Chassis with front suspension and steering components mounted. Changed last year's square tubing.

Max Stress: 2.166E9 N/m^2
Allowable Stress: 6.70E8 N/m^2
Max Deformation: 27.42mm

Side Impact Simulation

ZotSun Solar Racing

Components of the Design - Chassis Cont.

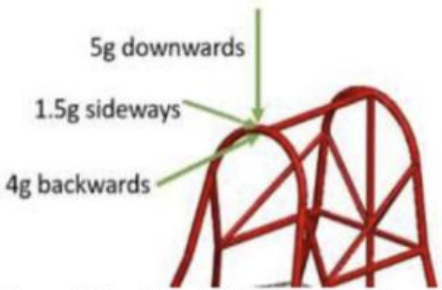
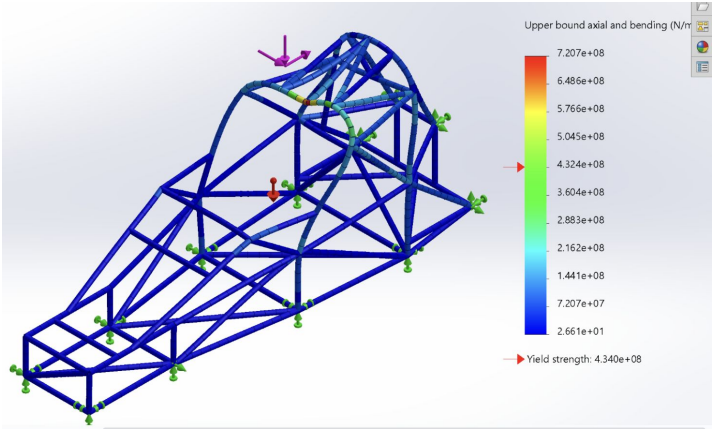
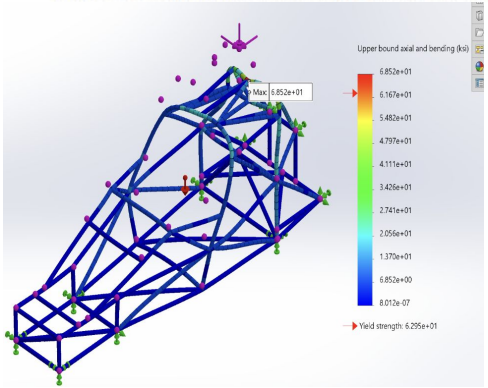


Figure 6 Combined Roll Cage Load Case (Front Hoop)

Max Stress: 7.207E8 N/m^2
Allowable Stress: 4.34E8 N/m^2
Max Deformation: 3.88mm



Front Roll Hoop Roll Simulation

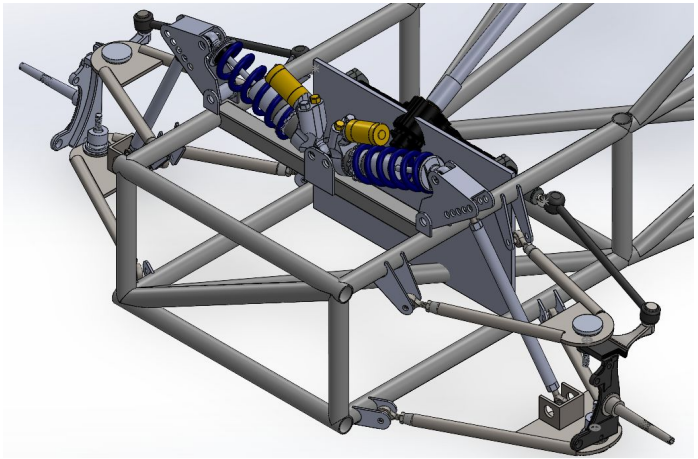


Rear Roll Hoop Roll Simulation

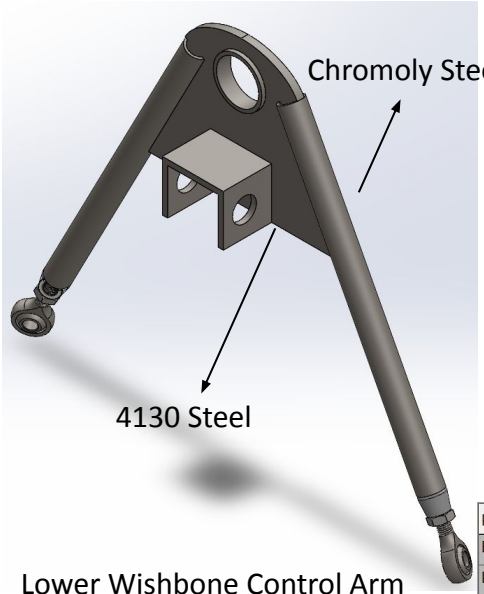
Max Stress: 7.207E8 N/m^2
Allowable Stress: 4.34E8 N/m^2
Max Deformation: 3.88mm

We believe that this yielding is caused by improper weld meshing in the CAD model. If still a concern, using a larger diameter tube for roll hoop.

Components of the Design - Front Suspension



Overlook of Suspension



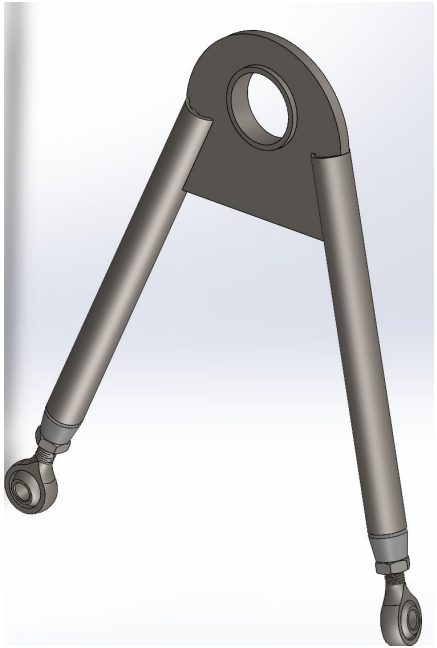
Lower Wishbone Control Arm

Last Year's Version

Larger Diameter Tubing to withstand greater forces. Secured to chassis with ball joint ends for more reliability, and smoother mobility. Double Wishbone system used for better handling and stability.

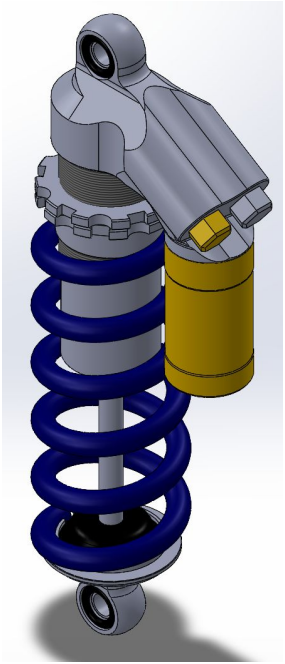
Property	Value	Units
Elastic Modulus	2.05e+11	N/m^2
Poisson's Ratio	0.285	N/A
Shear Modulus	8e+10	N/m^2
Mass Density	7850	kg/m^3
Tensile Strength	560000000	N/m^2
Compressive Strength		N/m^2
Yield Strength	460000000	N/m^2

Components of the Design - Front Suspension Cont.



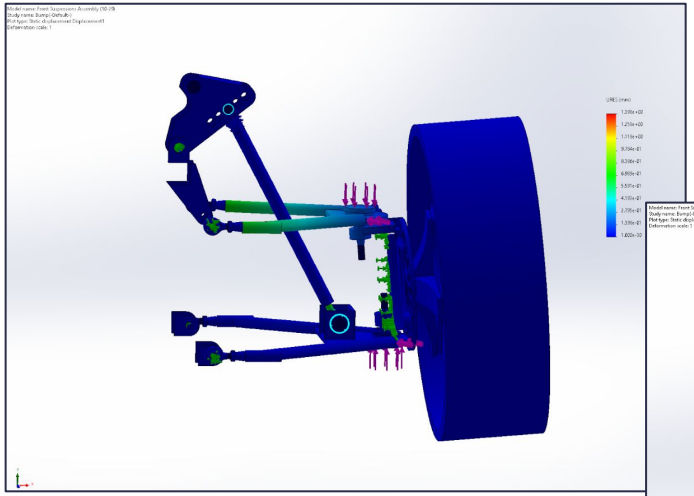
Upper Wishbone Control Arm

Same Materials a Lower, and iterated from last year's design for the same reasons.

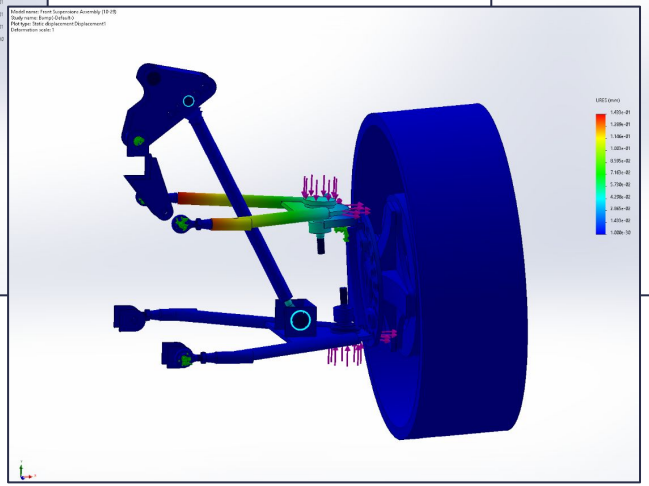


Off the shelf Spring and Damper Shock. 220mm in length and has 550lb weight capacity, each.

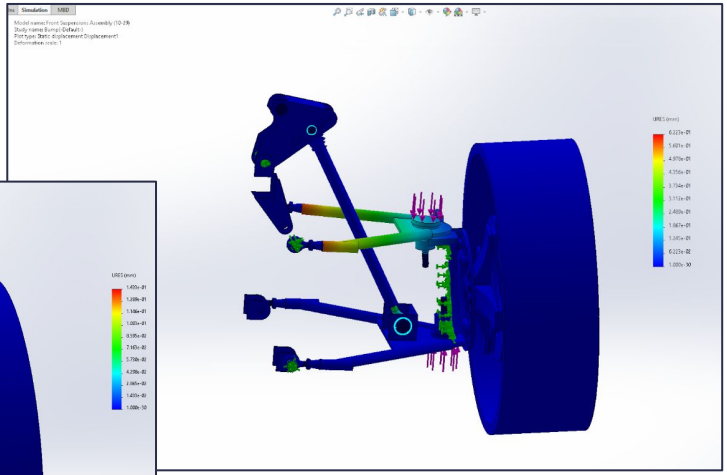
Components of the Design - Front Suspension Cont.



Braking Simulation

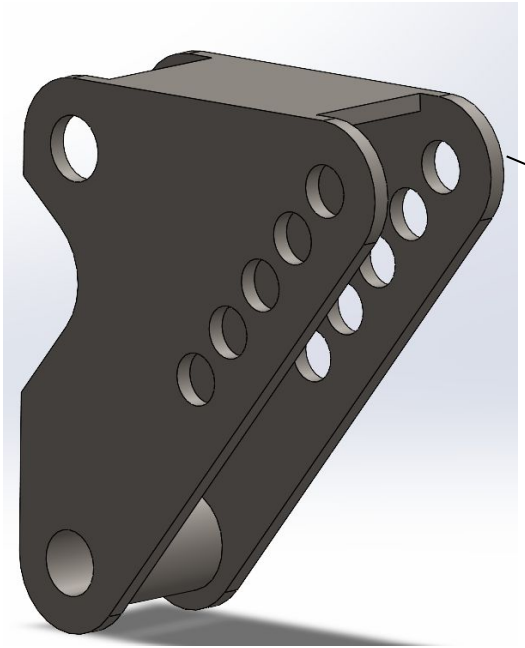


Cornering Simulation



Bump Simulation

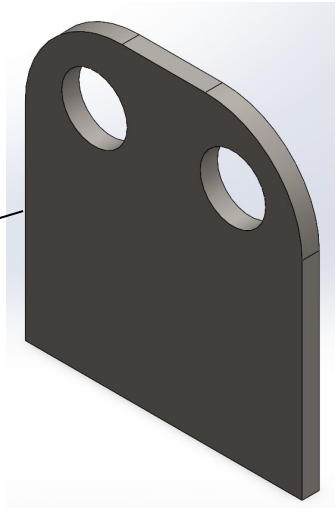
Components of the Design - Front Suspension Cont.



Rocker Arm

4130 Steel

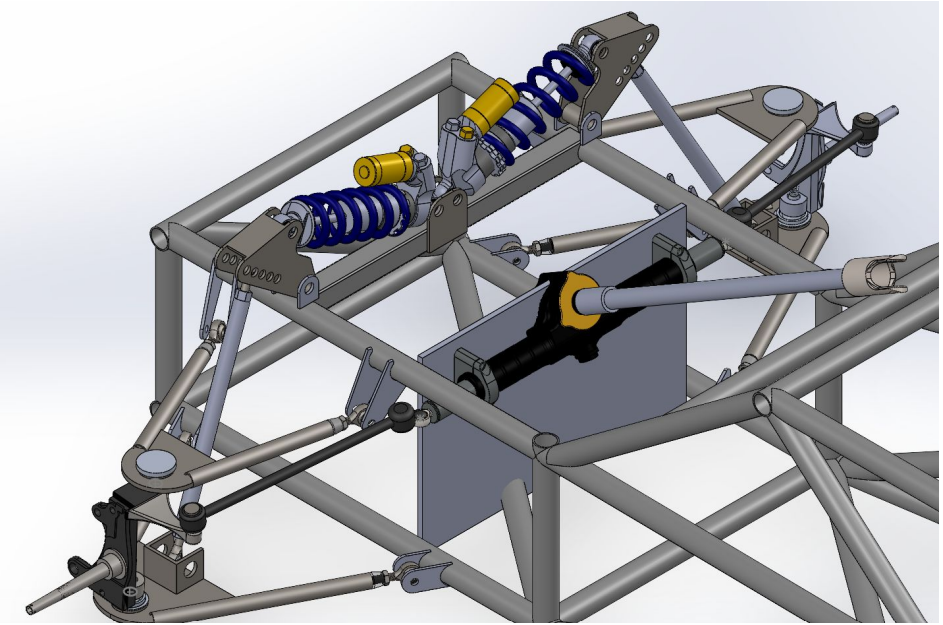
Property	Value	Units
Elastic Modulus	2.05e+11	N/m^2
Poisson's Ratio	0.285	N/A
Shear Modulus	8e+10	N/m^2
Mass Density	7850	kg/m^3
Tensile Strength	560000000	N/m^2
Compressive Strength		N/m^2
Yield Strength	460000000	N/m^2



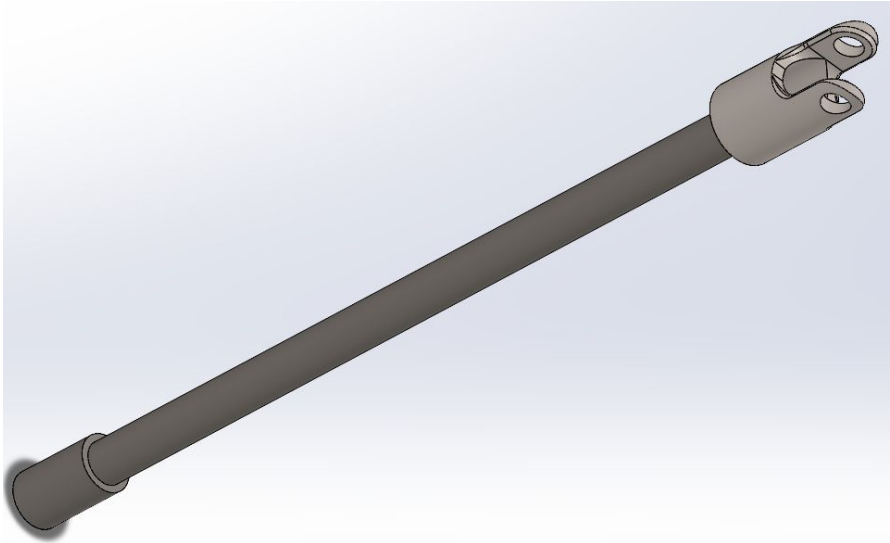
Shock Mount

Plasma cut 4130 sheet steel, welded together to make Rocker Arm, and mount. Best method for custom application as it is cheap and easy to implement. Skeletonized to reduce weight but keep strength.

Components of the Design - Steering



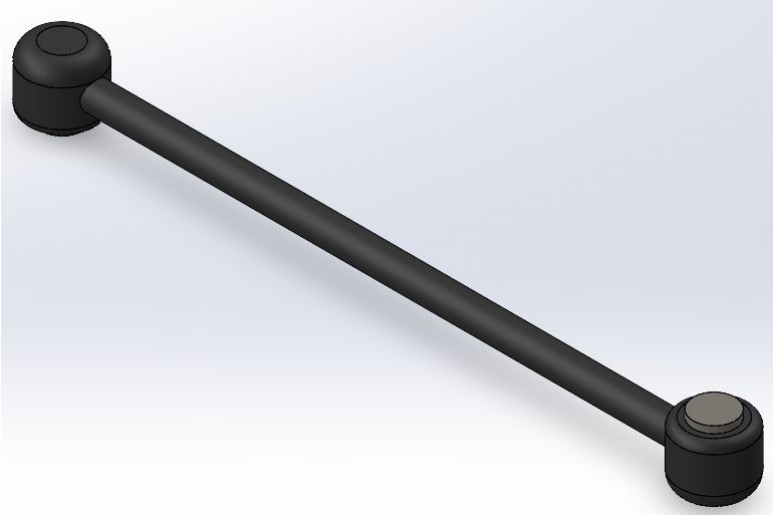
Steering Overview



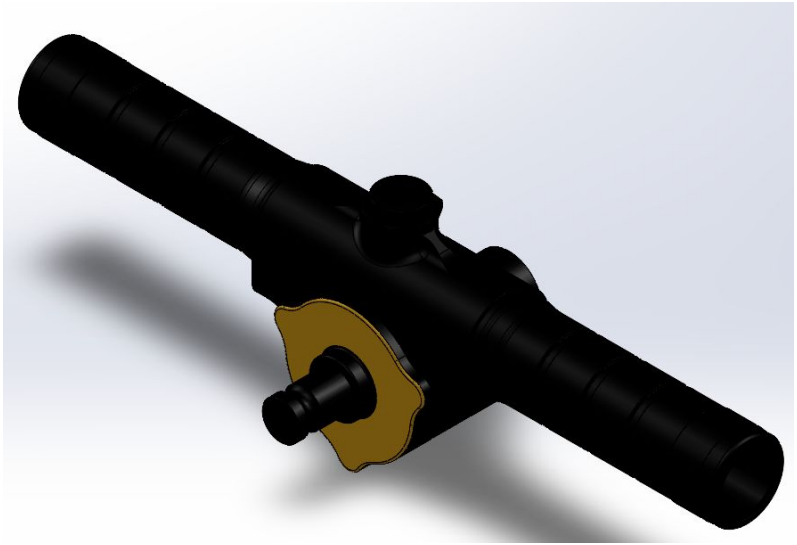
Steering Column

Custom Steering Column to account for unique angle and limited space in chassis.

Components of the Design - Steering Cont.



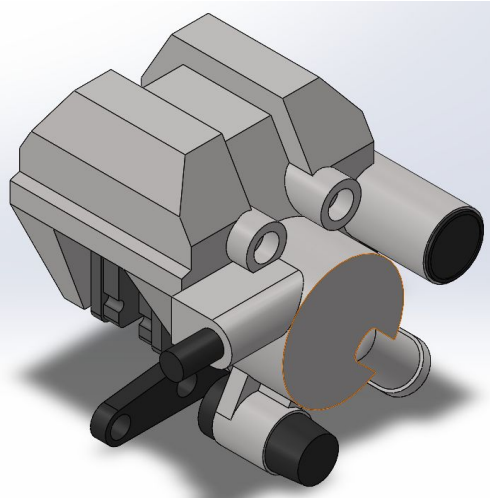
Off the Shelf Tie Rod



Off the Shelf Rack and Pinion

Off the Shelf Parts chosen for time restraint purposes as well as precision in manufacturing.

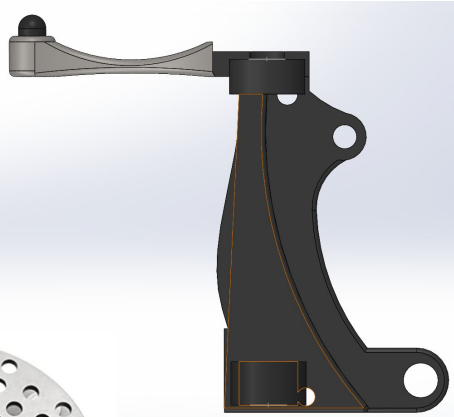
Components of the Design - Braking



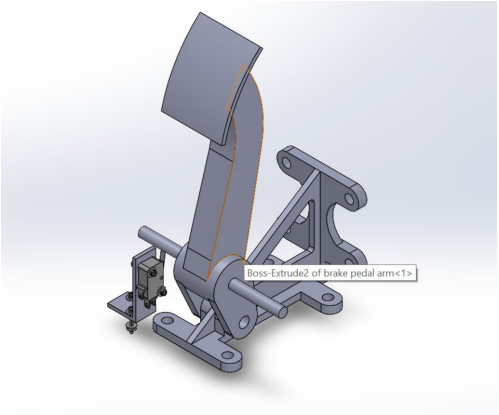
Yamaha Banshee 350 Brake Caliper

Used for a high performance ATV that weighs 400 lbs, capable of speeds up to 70mph

Yamaha Banshee Brake Rotor



Upright



Off the shelf brake pedal

Brake actuator is currently being redesigned by braking subteam.

These parts were picked for ease of implementation and to decrease the manufacturing time of our project as a whole

Concerns

- Manufacturing of upper and lower control arms
- Brakes
- Mounting angle of knuckle
- Wheel alignment
- Strength of rod end
- Possible rocker interference
- Integration of all sub-assemblies