NAU
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SAE Baja

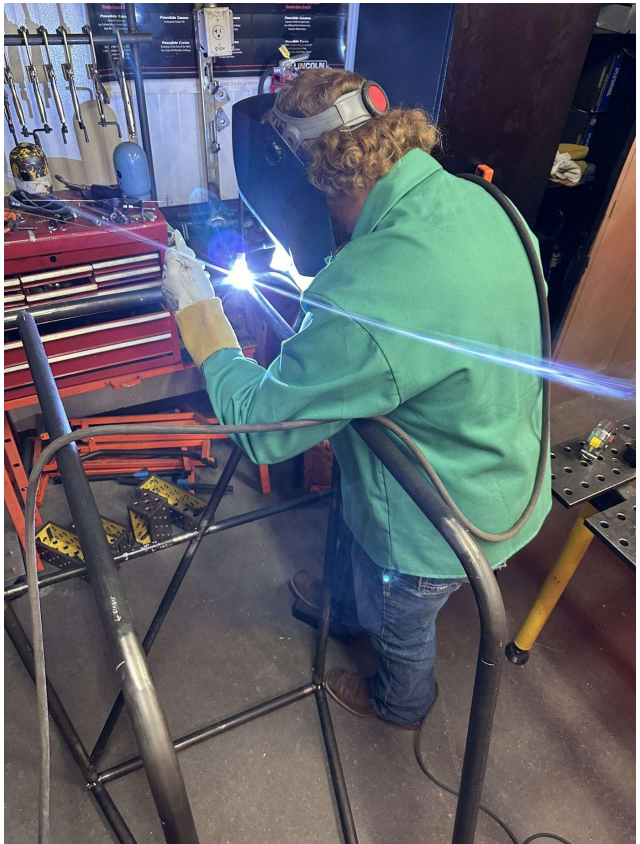
Chassis Team
2024-2025

Physical Prototype

CA

Questions

- How will the CAD translate to actual fabrication?
- What designs have to be changed to comply with manufacturing methods?
- How will other components integrate?



CA

Methods/Manufacturing

- Bent the tube with the tube bender from center out.
- Coped at an angle defined by the drawing and what we had already bent.
- Tacked the components according to specs.

Wyatt

Answers

- Tube bending die size was slightly larger than originally expected.
- Springback of the tubing is around 5 deg so bends have to be changed accordingly.

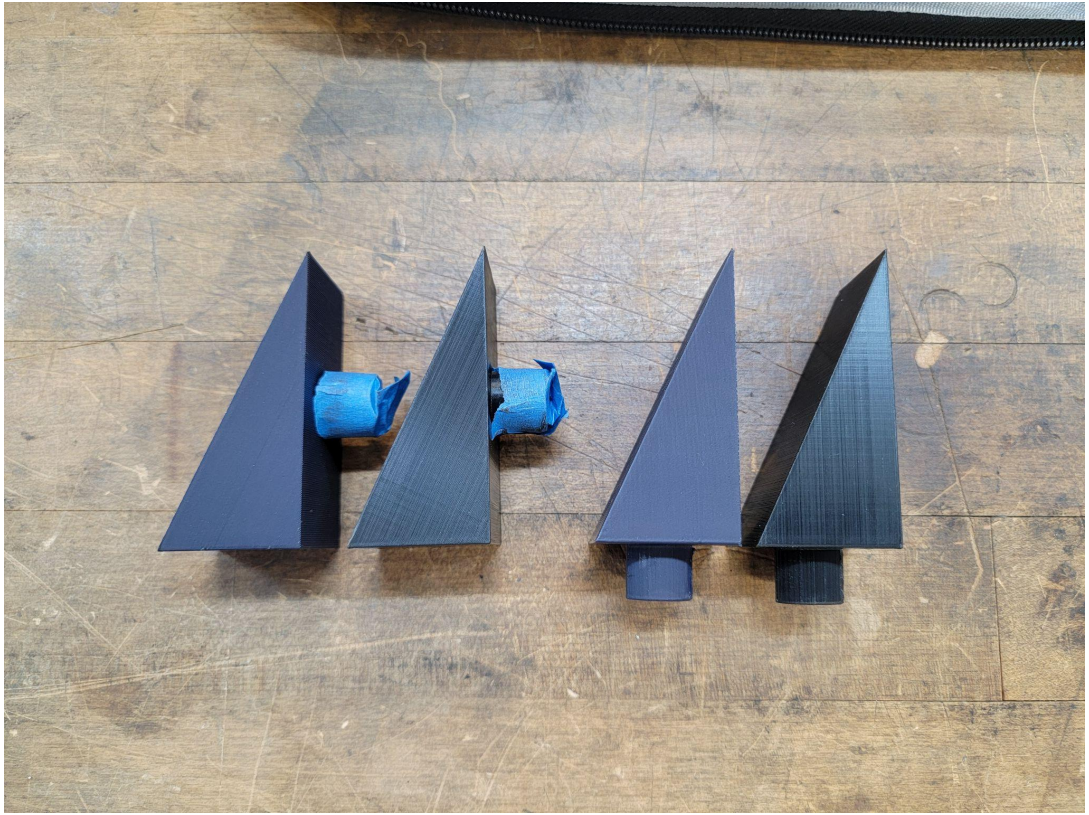
Wyatt

Inform the Design

- The rear roll hoop and overhead member were slightly changed to better adhere to manufacturing methods.
- Secondary members have to be manufactured differently than primary members.

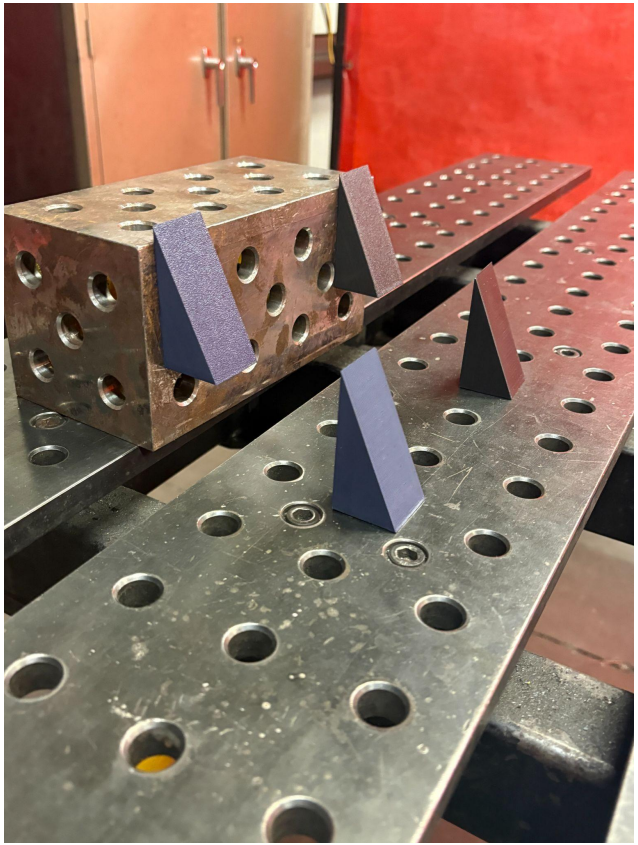
Ryan

Jig Prototype



Questions

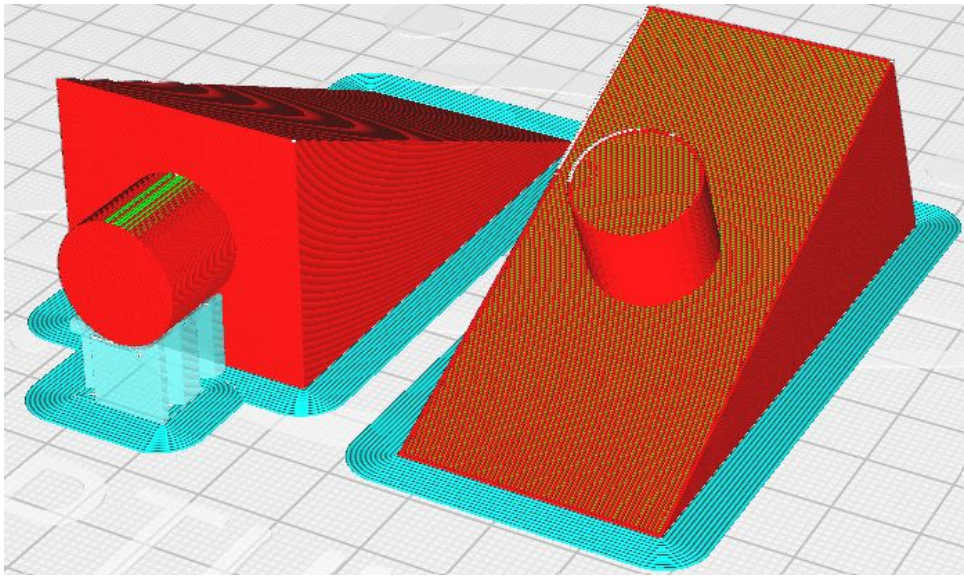
- How can the team ensure that the rear hoop member to the desired angle?



Ryan

Methods

- Designed in Solidworks to be placed in the welding table and act as a wedge for the leaning of the hoop.
- 3D printed



Ryan

Answers

- After tacked it was ~15° degrees on both sides.
- This was a satisfactory result for the team.

Wyatt

Inform the Design

- B.3.2.6 in the rulebook says the it must be between 0-20 degree incline from vertical.
- As a result of using the jigs, the hoop sits at a declination angle that is in compliance with the rule book.

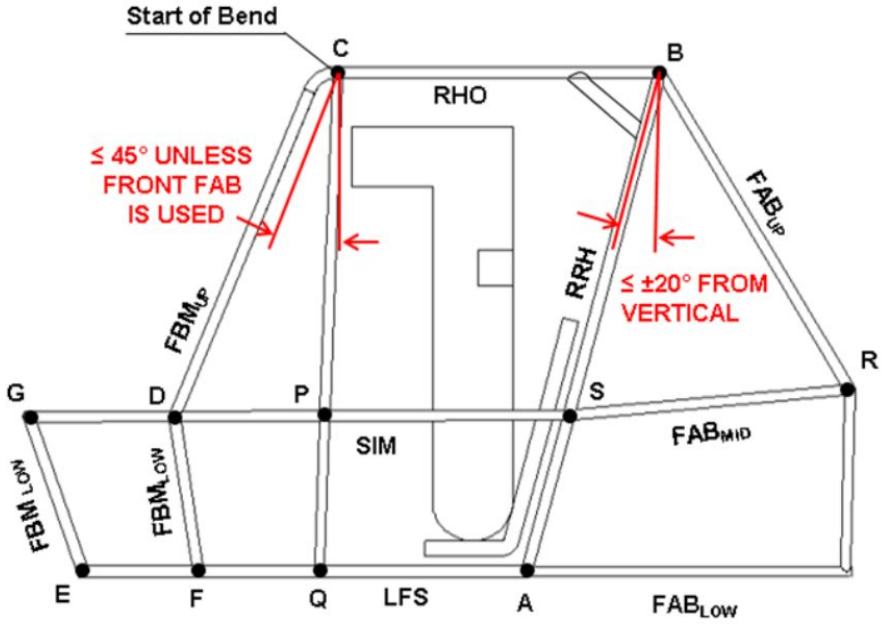


Figure B-22: Roll Cage, FBM

Wyatt

Thank You

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Prototype 2

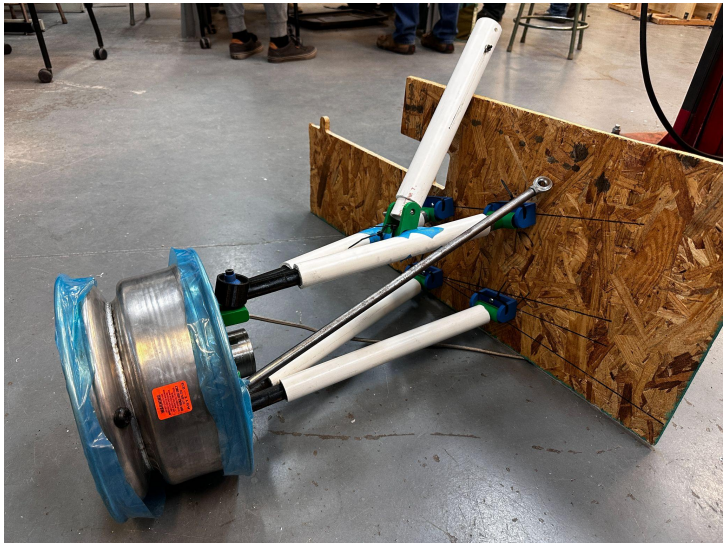
2024-2025 SAE Baja
Suspension, Steering and Brakes

David Polkabla Jr.
Taylor Hewitt
Steering, Brakes

Ryan Key
Ryan Latulippe
Oliver Husmann
Brennan Pongratz
Suspension

Front Suspension/Steering Prototype

- Analyzing current measurements, clearance, tie rod uptravel clearance, approximate travel, fit and finish.



Methods/Manufacturing

- 3D printing
  - **Knuckle**
  - **CA to frame mounts**
  - **CA to knuckle ball joint cup**
  - **UCA to shock mount**
  - **Misalignment spacers**
  - **Rear brake mount**
- PVC Pipe for control arm members
- 3D print control arm components press fit into PVC.
- Steel tube cut to spec to emulate a tie rod.
- Ball joints, hub, CV axle cup, wheel

Front Suspension/Steering Prototype

Questions:

- Does the wheel have clearance around the knuckle and brakes?
- Does the prototype display any binding issues?
- What is the estimated travel?
- Does hardware fit as expected?

Front Suspension/Steering Prototype

Answers:

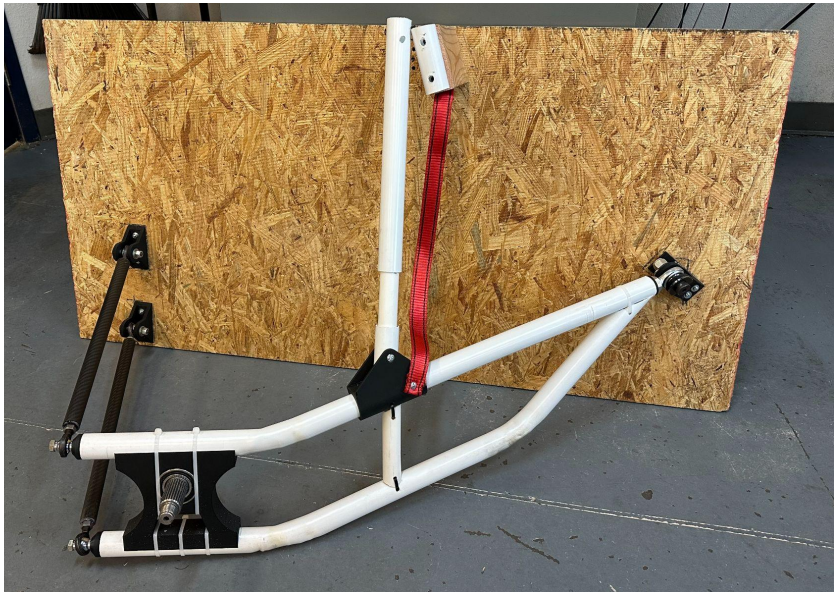
- Yes, there is enough clearance around the knuckle and brakes for the wheel to rotate freely.
- Yes, there was a slight binding issue with the control arm cups, the angle looking head on is too aggressive.
- The estimated travel is approximately 14 in based on control arm orientation.
- Hardware fits as expected.

Front Suspension/Steering Prototype

How did this inform design:

- Control arm cup angles from head on needs to be adjusted to address binding on the knuckle.
- Suspension travel meets our goals.
- Current control arm angles are correct to get our travel of over 12 in.
- Selected hardware works.

Rear Prototype - Trailing Arm Assembly



Ryan K.

Rear Prototype - Trailing Arm Assembly

Questions:

- **Are the link lengths correct for the geometry?**
- **Are limiting straps a viable solution for limiting the downtravel?**
- **Are the shock mounts, angle, and position adequate?**

Manufacturing:

- **3D printed press-fit link ends, bearing housing, mounting brackets.**
- **PVC pipe bent and coped, model shock created with correct eye to eye and travel lengths.**
- **Hardwear from previous year and around shop.**
- **Spare bearings pressed into housing to support splined cv axle end.**
- **Carbon fiber camber links**
- **Flat Nylon limit strap**

Ryan K.

Rear Prototype - Trailing Arm Assembly

Answers:

- **The link lengths are correct for the geometry.**
- **The limiting straps work well for limiting the downtravel and protecting the shocks.**
- **The current shock geometry is usable.**

Moving Forward:

- **Link sizes and mounting geometry are finalized, FEA was used to design the central support and will be utilized to remove more material for further weight savings.**
- **Mounting for the limit straps can be incorporated into shock mounts/other mounting options.**
- **With geometry and mounting working out, the manufacturing process can continue.**

Ryan K.

Brake Prototypes

Front Prototype

Rear Prototype

Questions

Front Brakes

- Will the actual caliper have clearance once the knuckle is attached to the hub and tire?

Rear Brakes

- Will there be any interference between the rear brake caliper and rotor once installed?

Methods/Manufacturing

Materials

- Rotors were cut out of mild steel by a waterjet from Harshco.

- Bolts and nuts were bought from mcMaster Carr

Answers

Front Brakes

- The caliper has plenty of clearance and will easily be able to clamp to the rotor.

Rear Brakes

- The brake mount 3D printed for the prototype ensures that there will be no interference between the caliper and rotor.

Inform The Design

Front Brakes

The front calipers are attached to the knuckle opposite of the tie rod mounts. This spot was the most optimal position for the calipers as it allows full engagement of the calipers and gives no interference between the calipers and the rims.

Rear Brakes

By manufacturing a mount to attach the caliper to the rear gearbox casing, we can ensure that the caliper correctly lines up with the rotor so that the brake system will function properly.

Who was responsible for what

David Polkabla

- 3D printing for suspension components, assembly of front suspension/steering prototype.

Ryan Key

- Manufacturing and assembly of all components for rear suspension assembly.

Ryan Latulippe

- Manufacturing and assembly of control arms for front suspension/steering prototype.

Oliver Husmann

- Assembly of knuckle components for front suspension/steering prototype.

Brennan Pongratz

- Manufacturing of knuckle components for front suspension/steering prototype.

Taylor Hewitt

- Design and assembly of both rotors integrated with both the suspension/steering assembly and the rear gearbox assembly.

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Drivetrain Prototype 2

Rear Gearbox

What question is being asked with the prototype?

- How do the new dimensions work with the gears?
- How do the bearings fit within the casing

The methods/manufacturing used for prototype?

- 3D printing, screws, zip ties, and cardboard.

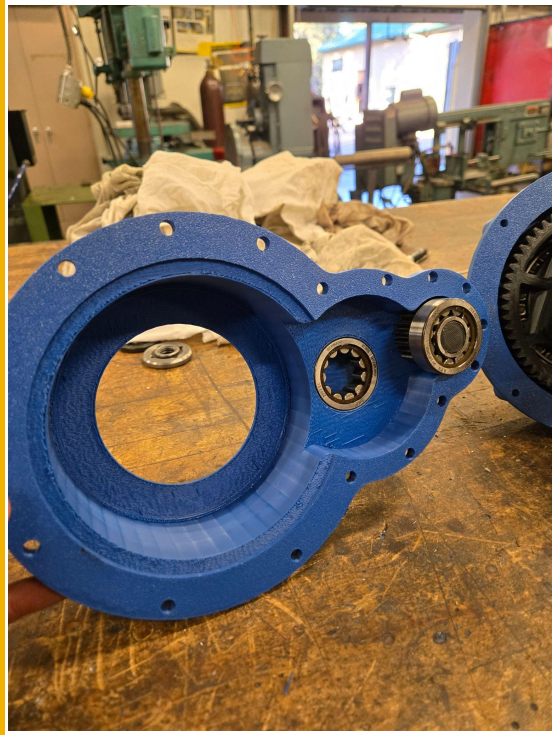
Answer to questions:

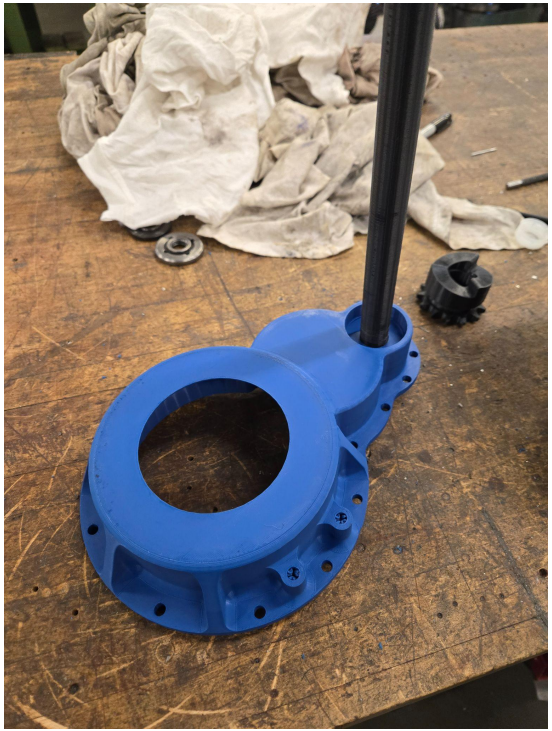
- The new dimensions work but might need to be adjusted once made.
- The bearings mostly fit well except the tapered bearings.

How did the answer inform the design?

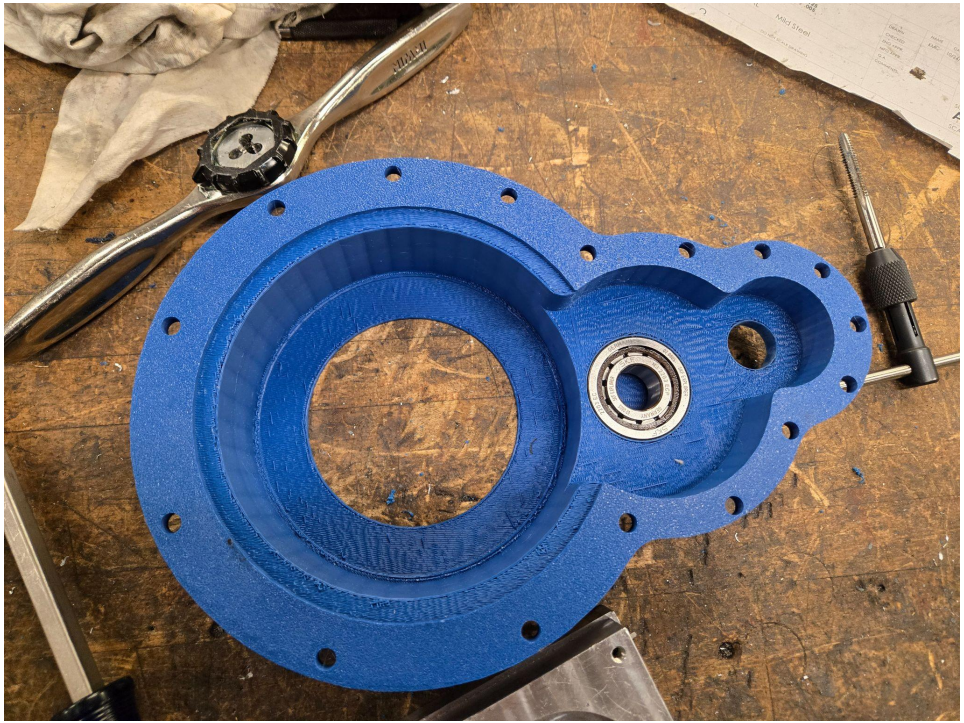
- Each bearing will need to be measured to ensure quality and then the casing will change accordingly.

Rear Gearbox Pictures





Rear Gearbox Pictures



4WD

What question is being asked with the prototype?

- 1) Is there enough clearance between the chain and the housing?
- 2) Is there enough clearance between the CV boot and the housing?
- 3) Does the bearing ordered satisfy design requirements?
- 4) How is the chain drive moving across the vehicle?

The methods/manufacturing used for prototype?

- The prototype was mostly 3D printed. Bearings were added to the 3D printed assembly as well.

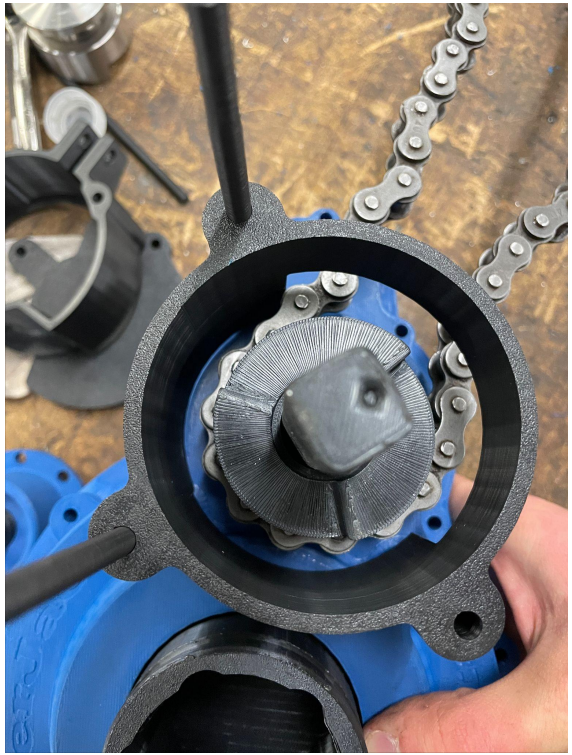
Answer to questions:

- 1) Yes, there is enough clearance between the chain and the housing.
- 2) Yes, there is enough clearance between the CV boot and the housing.
- 3) No, the bearing does not satisfy the design requirements.
- 4) Solidworks displays how the chain will move across the vehicle.

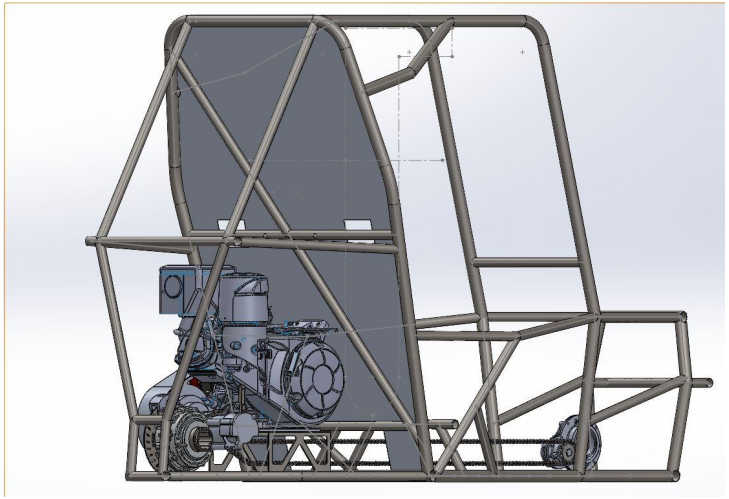
How did the answer inform the design?

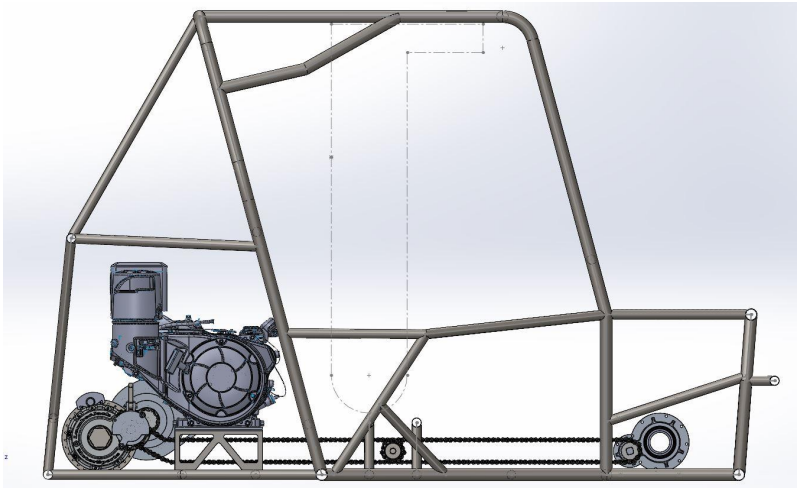
- Prototype shows that the diameter of the entire dog box can be made smaller.
- Instead of a cylindrical bearing, two deep grooves will be used instead to take axial loads in both directions.
- Virtual prototype shows that a chain drive can be ran across the vehicle with no interference and complies with SAE HROE and PPE rules.

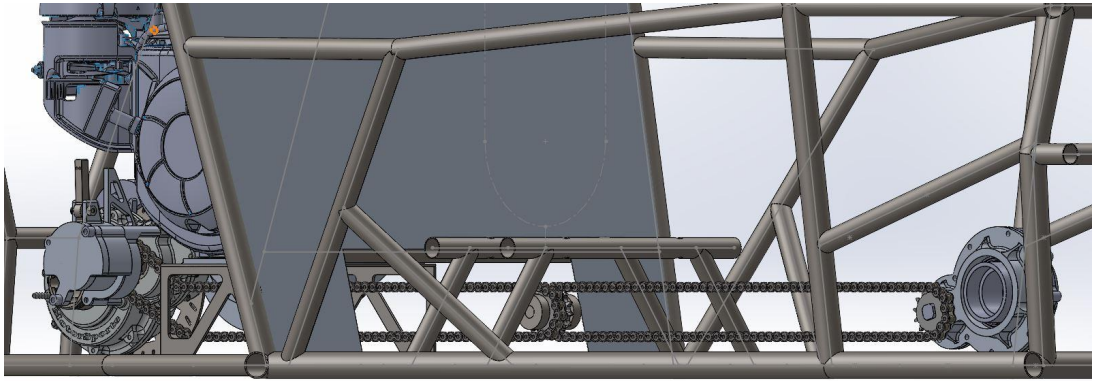
4WD Pictures



4WD Pictures







Front Gearbox

What question is being asked with the prototype?

- 1) Do the bearings fit in their respective places?
- 2) Does any more clearance need to be added to fit the bearings gears and shafts into the casing?

The methods/manufacturing used for prototype?

- The prototype was mostly 3D printed. Bearings were added to the 3D printed assembly and the casings were zip tied together.

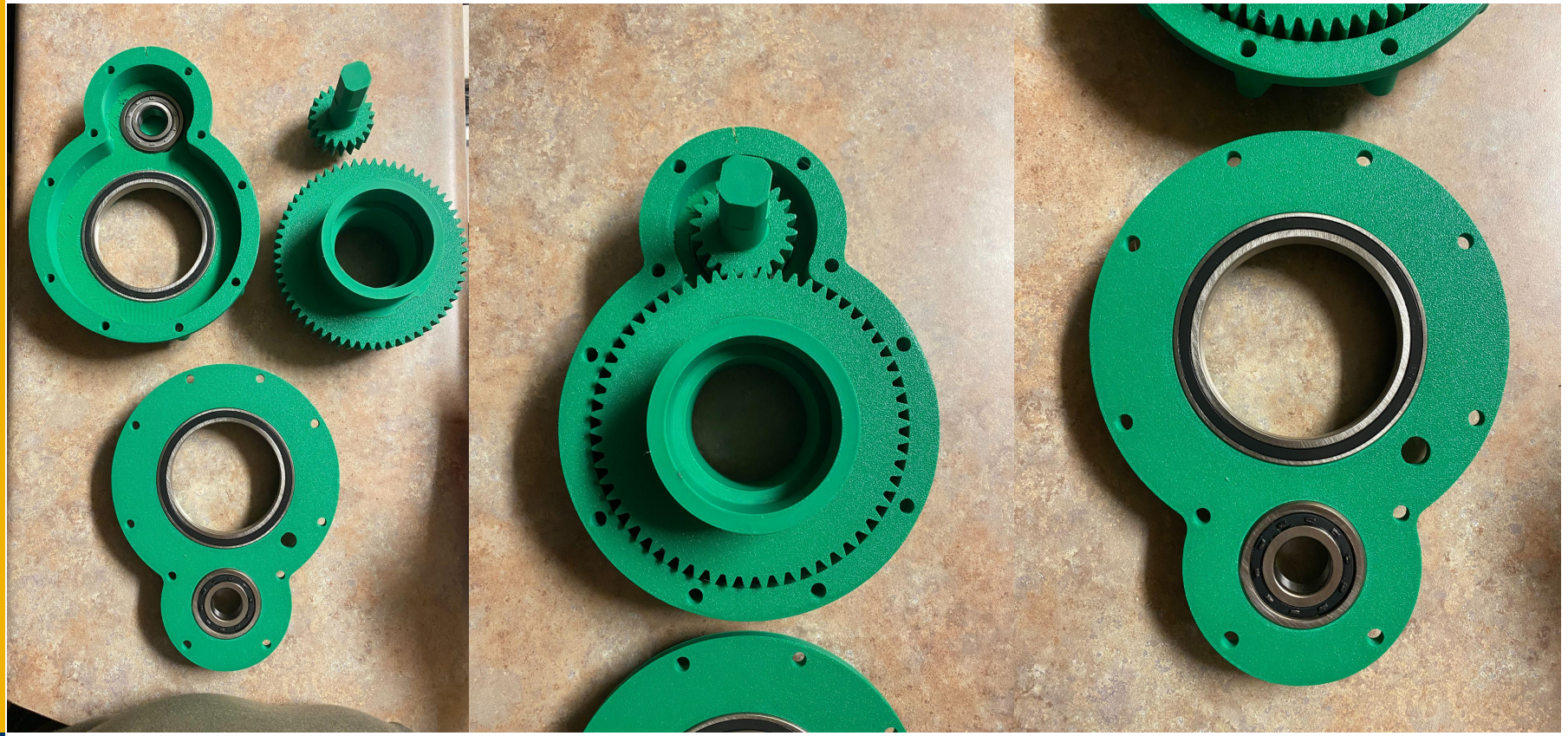
Answer to questions:

- 1) The bearings fit tightly into their places, dimensions were rough with 3D printing tolerances.
- 2) More clearance is needed between the gears and the casing so no rubbing occurs.

How did the answer inform the design?

- The answers above show that the casing will function well, and all components that need to fit into the gearbox will fit.

Front Gearbox Pictures



CV Cup

What question is being asked with the prototype?

- How the CV cup fits to the sprag bearing?
- How the sprag bearing fits to the drive shaft?
- How the CV cup meshes with the CV Axle?

The methods/manufacturing used for prototype?

- 3D printing
- Press fitting

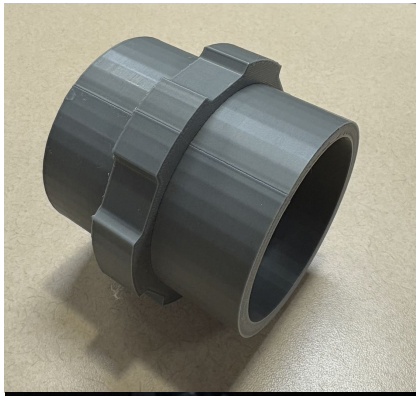
Answer to questions:

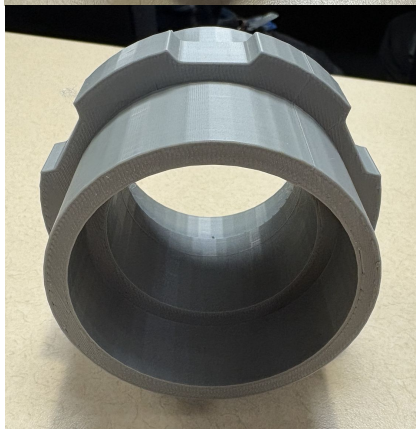
- The CV cup will press fit to the sprag bearing and the sprag bearing will press fit to the drive shaft, the measurements confirm this and physical testing will be performed once we have the sprag bearings.
- The CV cup perfectly meshes with the CV axle.

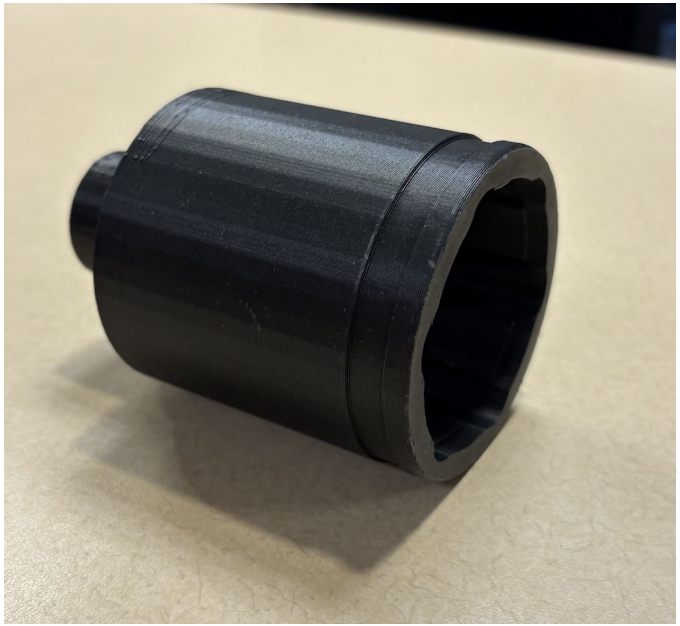
How did the answer inform the design?

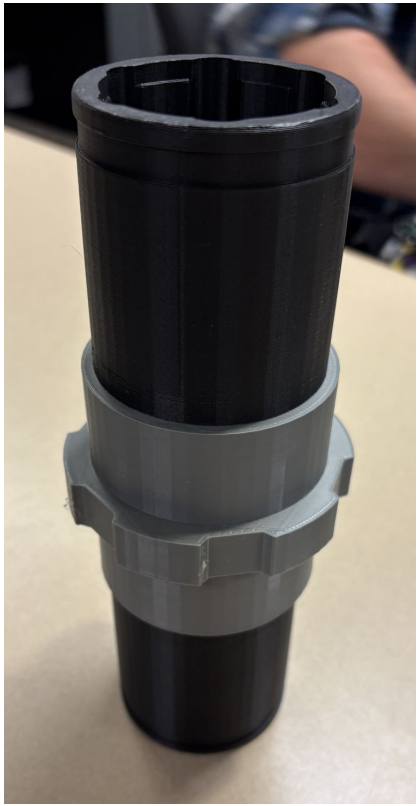
- The answer informed that the table driven features of the CV cup are good as of now but can be iterated upon as design features change in order to better accommodate design needs and symmetry of the final assembly.

CV Cup Pictures









Rear Hub

What question is being asked with the prototype?

- How does the rear hub fit together with the wheel and trailing arm, as well as how the rear hub fits on the axle.

The methods/manufacturing used for prototype?

- 3D printing, designed in solidworks, and put on the real axle.

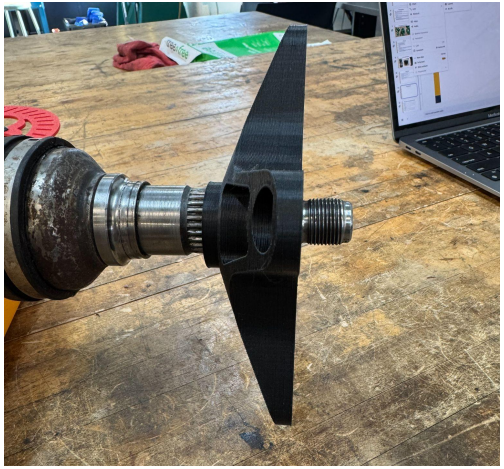
Answer to questions:

- The hub fits and allows for ideal suspension travel.

How did the answer inform the design?

- The real rear hub can start to be manufactured, and there is an extra quarter inch of spline.

Hub Pictures



Who was responsible for what

Dylan Carley:

- The design and assembly of the gears to the shafts and the casing for the rear gearbox.

Matthew Dale:

- Design of the hubs to ensure fitment across suspension and drivetrain components

Rowan Jones:

- The design and assembly of the gears, shafts, and casing for the front gearbox.

Ethan Niemeyer:

- The design and fitting of the CV cup-shaft-cup

Seth Scheiwiller:

- The design of the shafts and dimensions needed to withstand high cycle fatigue

Nolan Stomp:

- The design of the jaw clutches and dimensions of intermediate shaft needed