NAU
NORTHERN
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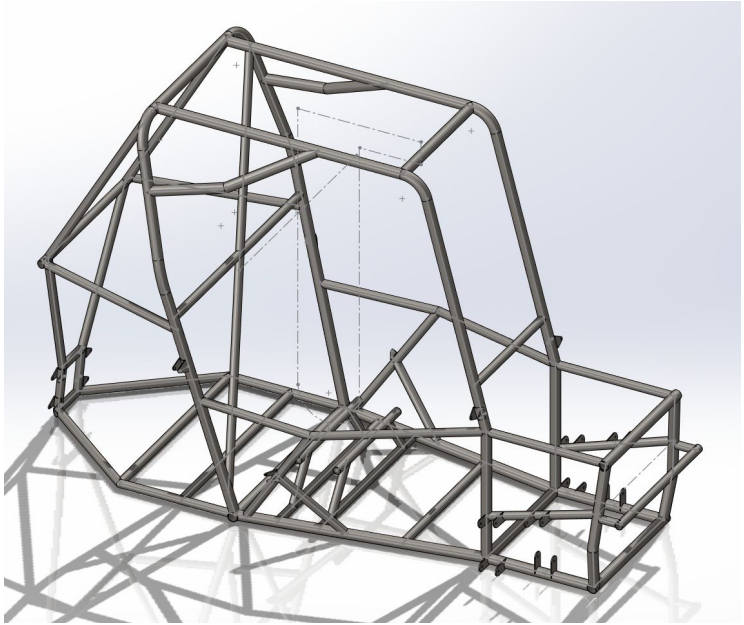
SAE Baja

Chassis Team
2024-2025

Physical Prototype



Questions

- How does will the driver fit into the cockpit?
- How will other subteams integrate in with the frame?
- How will the coping angles and bends of the frame look like?

Methods/Manufacturing

- Took 1.25” PVC piping and cut to length.
- Coped at the angle defined by the drawing.
- Heated up with the heat gun and bent to angle. defined by the drawing
- Taped the joints together.

Wyatt

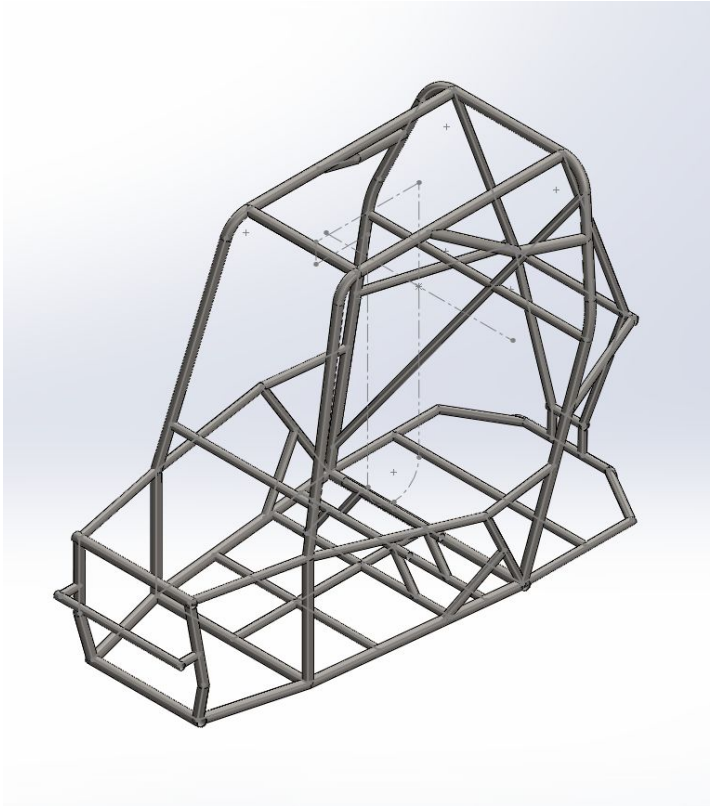
Answers

- The driver has plenty of room and is to spec per SAE rulebook.
- Front end is too large and chunky.
- Suspension will need different angles for mounting.

Wyatt

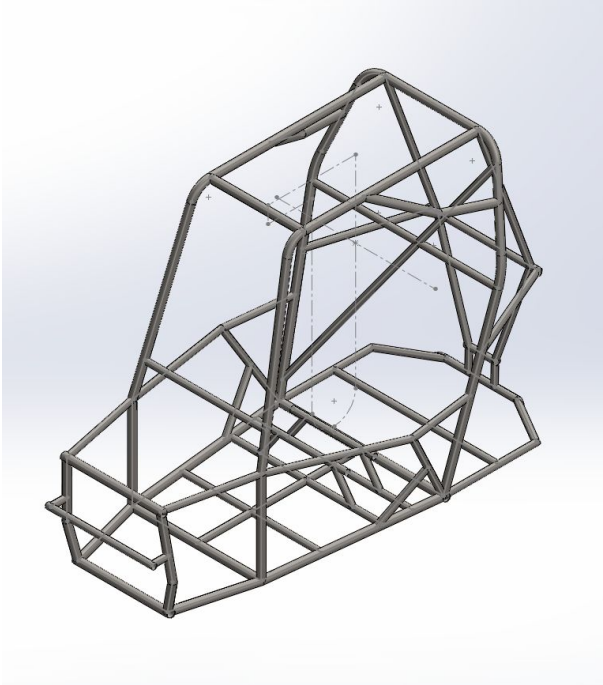
Inform the Design

- Front Toe box was made smaller when inboard brakes was scrapped.
- Front toe box was angled outwards for suspension integration.
- The entire frame width was made smaller.

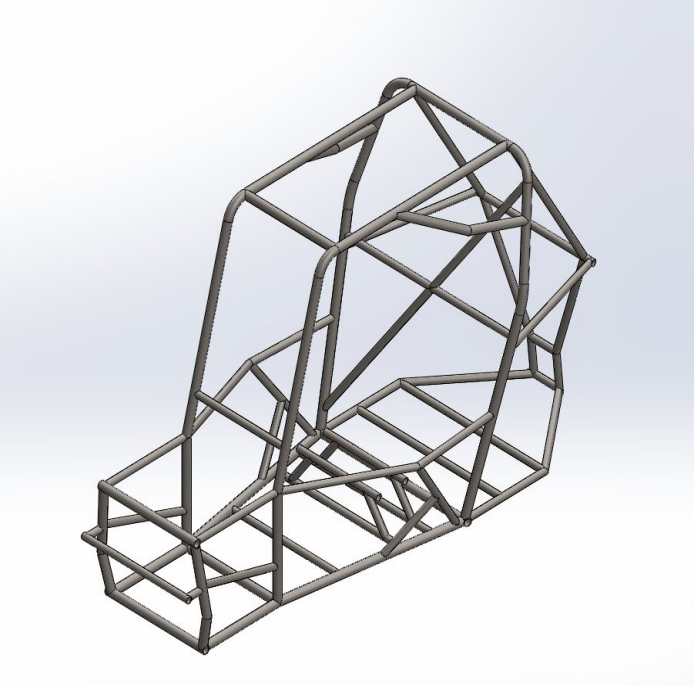


Ryan

After Prototyping



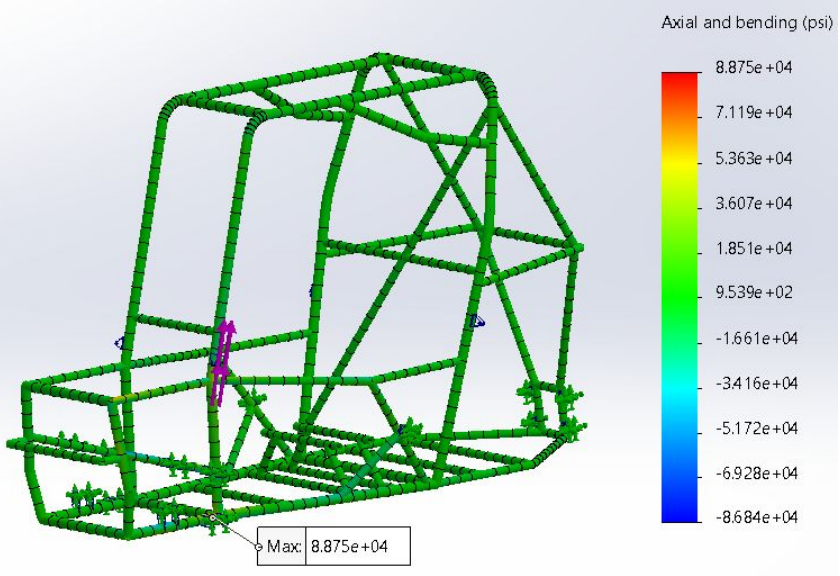
Before

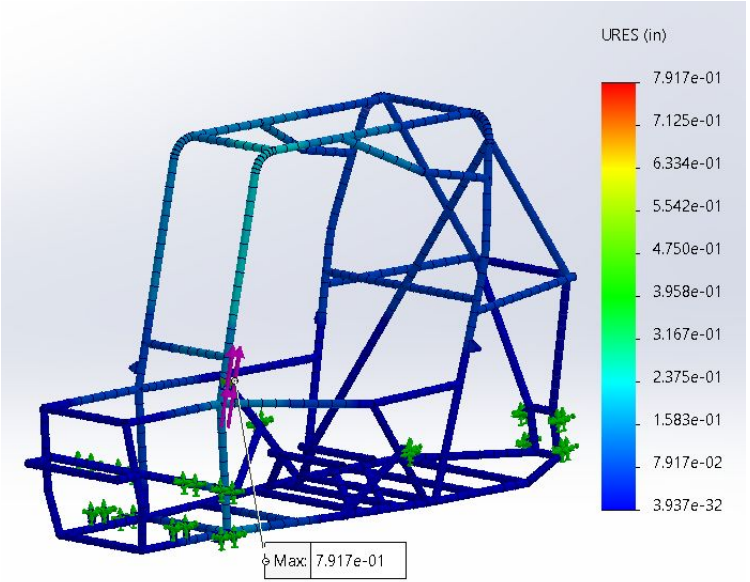


After

Ryan

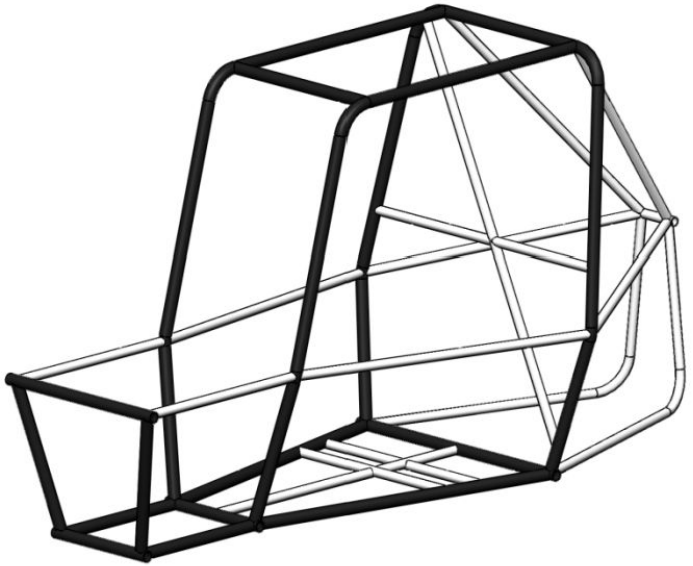
Virtual Prototypes FEA





Questions

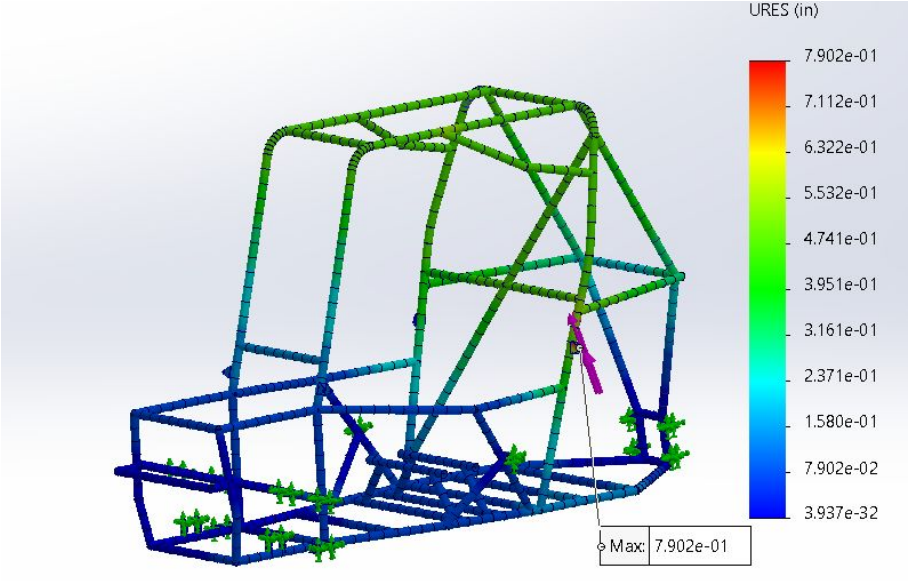
- Where can we expect to see deformation?
- How critical will the deformation be to the frame overall?
- Will the driver be safe?



Ryan

Methods

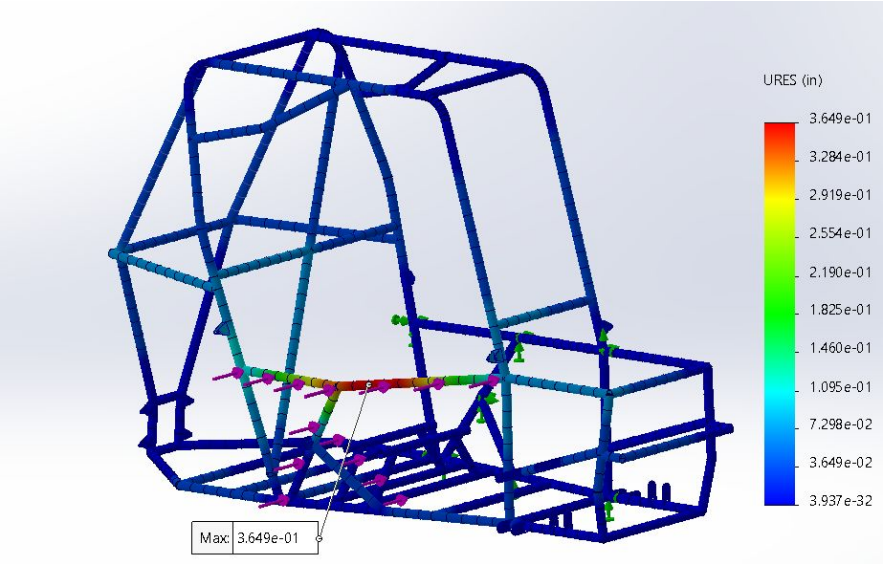
- Using the simulation tool in SolidWorks.
- Applied forces to the applicable members and mounts in a “worse case scenario situation”.
- Set fixed geometry.



Ryan

Answers

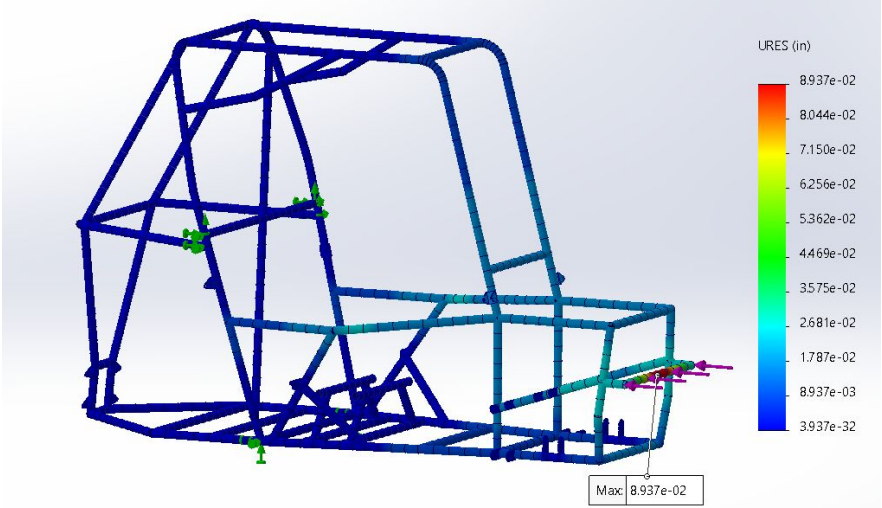
- Minor deformation is experienced in a head to head, rear end, and side impact collisions.
- Suspension mounts need reinforcement
- Driver will be safe upon impact.



Wyatt

Inform the Design

- No major changes to structural members need to be made.
- Suspension mounts need revision for better support



Wyatt

Thank You

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Drivetrain Prototype 1

Rear Gearbox

What question is being asked with the prototype?

- How do the gears fit with the shafts?
- How do the shafts fit within the casing?

The methods/manufacturing used for prototype?

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

Answer to questions:

- The gears fit snug on the shafts.
- The shafts appear to fit well given that there isn't bearings in the assembly yet.

How did the answer inform the design?

- The answer validated my design, telling me that I am on the right track and should be able to start machining soon.

Rear Gearbox Pictures

Front Gearbox

What question is being asked with the prototype?

- The main question that was being answered was do the gears mesh well and does the center to center in the prototype allow for successful meshing. The bearing placements and retainments, or where the bearings will sit in the design, was also assessed in this prototype.

The methods/manufacturing used for prototype?

- The prototype was mostly 3D printed with cardboard spacers used to allow for proper fitment of the shafts. The prototype was modeled completely in SOLIDWORKS.

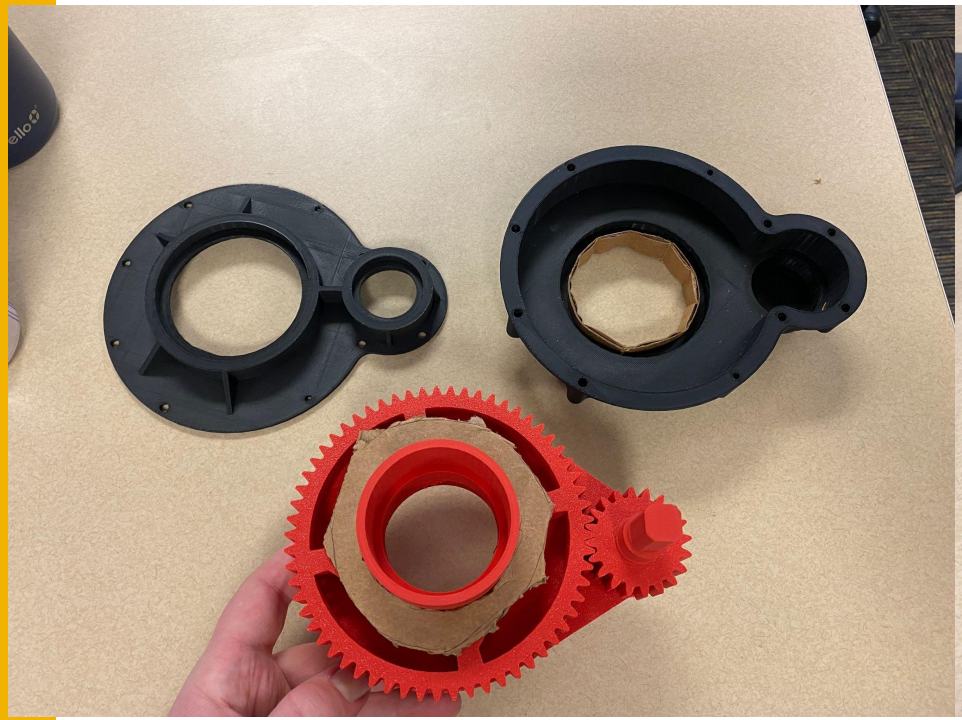
Answer to questions:

- Both questions asked above were answered with this prototype. The gears meshed well, proving their center to center was a good fit. The bearing retention method employed in this prototype also proved successful, and the bearings themselves will be integrated into the second prototype.

How did the answer inform the design?

- The answers given above will allow for further iterations of the front gearbox to be made. These iterations will include more refined bearing placements and retention ribbing, reducing the size of the ribbing, as well as reducing weight in the large side of the front gearbox. The prototype also showed the best places to add support filets to maximize strength.

Front Gearbox Pictures



CV Cup

What question is being asked with the prototype?

- How the CV cup fits to the rear gearbox
- How the CV cup fits to the brakes
- How the CV cup meshes with the CV Axle

The methods/manufacturing used for prototype?

- 3D printing
- Press fitting

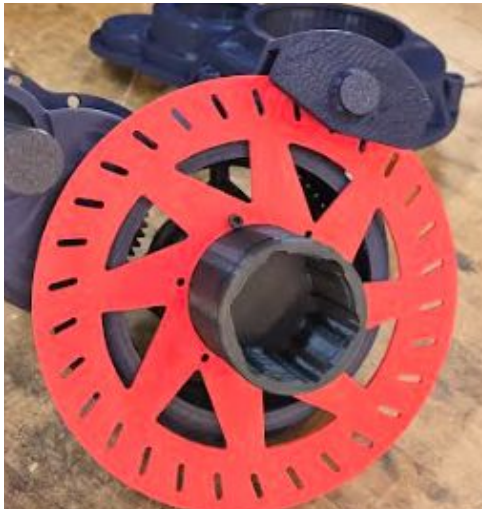
Answer to questions:

- The CV cup fits great to both the brake disc and rear gearbox, but the table driven planes of the extrusions must be tweaked in order to better accommodate symmetry within the design
- 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 need to be adjusted to better accommodate design needs and symmetry of the final assembly.

CV Cup Pictures



Hubs

What question is being asked with the prototype?

- How does the hub fit together with the wheel, brakes, and suspension knuckle, as well as how the hub fits on the axle. The front hub was printed, along with a spacer and “axle spline” in one part just for prototyping. The real assembly will have a spacer and axle spline separate.

The methods/manufacturing used for prototype?

- 3D printing, designed in solidworks. Brake rotor attached with screws.

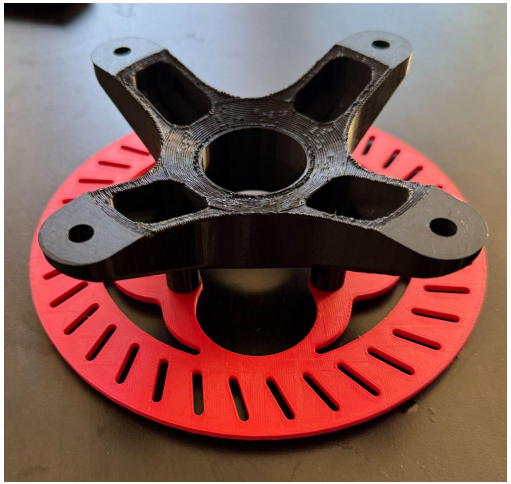
Answer to questions:

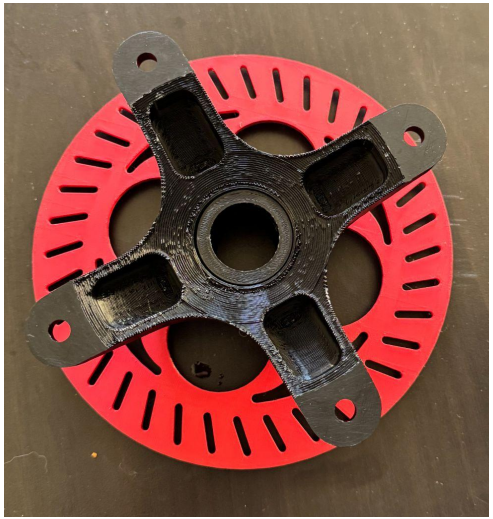
- The hub can be swept out a little less than originally thought, however the space left on the axle is less than originally thought.

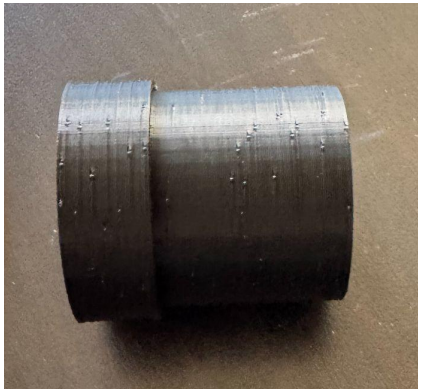
How did the answer inform the design?

- The hub was updated to reflect the findings, it was swept out a little less and spacing on the axle was accounted for.

Hubs 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

Prototype 1

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, steering angle, tie rod uptravel clearance, approximate ride height.

Methods/Manufacturing

- 3D printing
  - Knuckle
  - CA to frame mounts
  - CA to knuckle ball joint cup
  - Brake components
- 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.

Front Suspension/Steering Prototype

Questions:

- Are current measurements sufficient?
- What is the steering angle based on the current knuckle design?
- What is the estimated right height?

Front Suspension/Steering Prototype

Answers:

- **The current knuckle interferes with the actuation of the control arms.**
- **The steering angle with the current knuckle design could not be found due to the lower control arm cup causing inaccurate rotation of the knuckle.**
- **The estimated ride height is approximately 12in - 15in based on control arm orientation.**

Front Suspension/Steering Prototype

How did this inform design:

- **The current knuckle design needs alterations in the lower control arm cup area.**
- **The lower control arm cup needs to be adjusted to work with ball joints and knuckle design.**
- **Current control arm angles may be too aggressive for optimal travel, could result in undesired binding with the knuckle and cup.**

Rear Prototype - Trailing Arm Assembly

Ryan K.

Rear Prototype - Trailing Arm Assembly

Questions:

- Are the mounting bracket locations adequate?
- Are the link lengths correct for the geometry?
- Is there any binding/interference between parts?

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.

Ryan K.

Rear Prototype - Trailing Arm Assembly

Answers:

- The mounting brackets are in the proper locations.
- The link lengths are correct for the geometry.
- There was no substantial binding or interference with the chosen design.

Moving Forward:

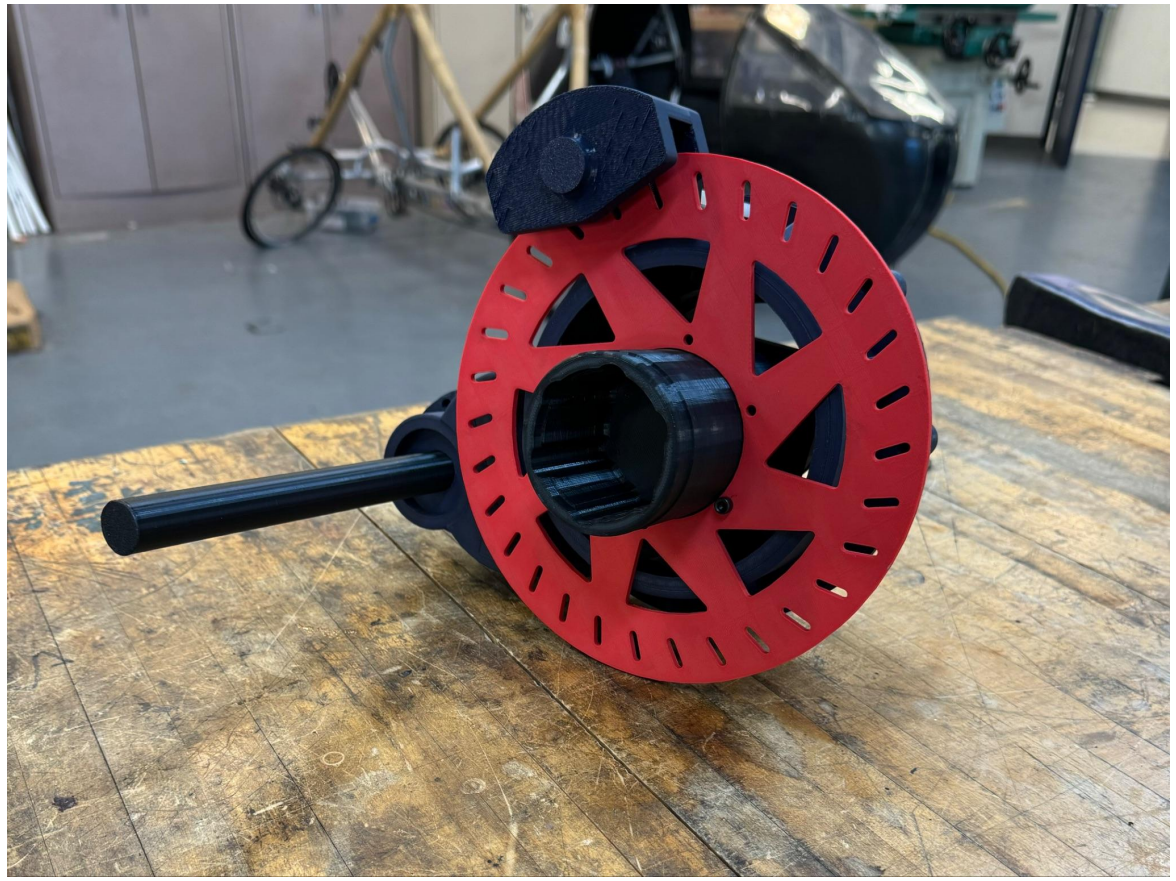
- Link sizes and mounting geometry are settled on, FEA and other testing can be used to determine exact bracing for trailing link, and camber link materials
- Shock mounting bracket can be slid along the trailing arm and used to model mounting locations on the frame to achieve desired travel and ride hight.

Ryan K.

Brake Prototypes

Front Prototype

Rear Prototype



Questions

Front Brakes

- Will there be interference between the caliper and the wheel?
- Where is the best position to install the caliper on the knuckle?

Rear Brakes

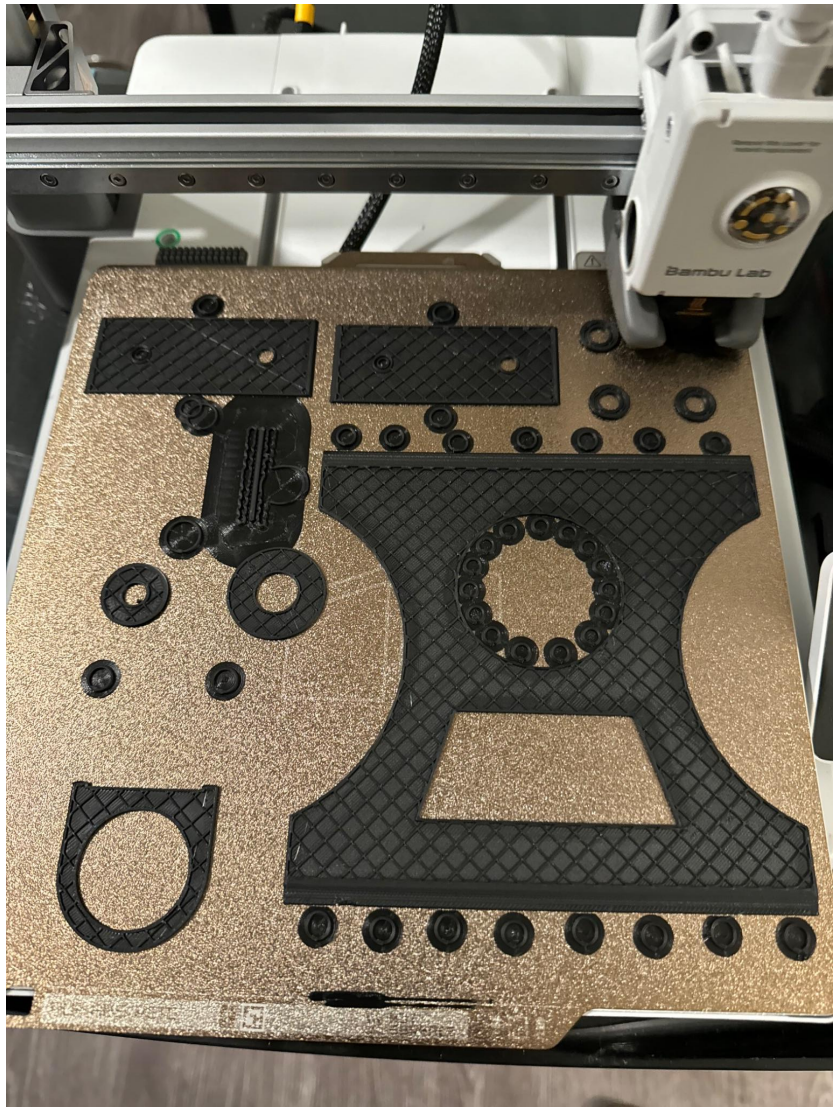
- How does the larger brake affect packaging for the rear gearbox?
- How can we attach the caliper to the rear gearbox?

Methods/Manufacturing

Materials

- Both rotors and calipers were 3D printed

- Bolts and nuts were bought from home depot



Answers

Front Brakes

The calipers and rotors will mount together with the knuckle with no interference when the wheel is in rotation.

The best position to mount the caliper on the knuckle is opposite of the steering mounts as it saves space on packaging.

Rear Brakes

The larger diameter does fit within the rear gearbox packaging and doesn’t cause interference.

The caliper will be mounted to the gearbox by using a caliper mount to ensure that the caliper can fully clamp the rear rotor.

Inform The Design

Front Brakes

The front caliper was integrated with the knuckle by making mounts on opposite of the tie rod mounts to save space with packaging.

This also ensures that the calipers will be able to fully engage with the rotors.

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 Hussman

- 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.