

Pi Tau Sigma 2024 Technical Challenge

PLA Car Bumper Design



Objective: Design a front bumper made of PLA for a model car which minimizes force felt on the car and total mass

Design Constraints:

- Design must mount to provided car body (see CAD and drawings in appendix)
- Design must be made of PLA (PLA+ prohibited)
 - For material clarifications, email ptstechchallenge@umich.edu
- Design must fit in within bounding box of dimensions 19.5 cm x 15.5 cm x 10.5 cm
- 1" of clearance between bumper and track (bottom of wheels)

Chapter Participation:

- Pre-Convention (larger prizes!)
 - One team per chapter
 - Can print own bumper
 - Can send STL file to ptstechchallenge@umich.edu to have ready at convention
 - Indicate chapter in subject line
 - File must be sent by 2/1 to allow for time to prints
 - Specify infill, wall thickness, and layer thickness settings in the email with the file
 - One page Design Summary due on February 14th containing an image of design, justification of design, and 3D print settings used
 - Verbal presentation of design choices to judges (shape and settings)
- At Convention
 - Teams of 4 created from combining students from different chapters
 - Given 3D printed arms to connect to car (see Appendix)
 - 1 hour to construct bumper out of office and craft supplies
 - Must still meet volume constraint

- Verbal presentation of design choices to judges

Competition Round Procedure:

- Bumper weighed on scale and mass recorded
- Bumper volume constraint verified
- Bumper affixed to front of car
- Car released down 30 ft track, reaching speed of 10 mph, collides with wood wall at end of track runout
- Accelerometer placed on car measures force upon impact
- Teams will present their design decisions to the judges (3 min maximum)
- Presentation scored according to rubric found in scoring

Scoring:

- Performance: 60%
 - $1 / (\text{Maximum force (from accelerometer)} * \text{mass of bumper (from scale)})$
- Presentation: 40%
- Total score will be a weighted average of performance and presentation components

Prizes

- Announced January 2024

Summary of Deliverables:

- Bumper before convention
 - Self-printed
 - Design Summary by 2/14
 - Verbal presentation at convention following trial
 - Printed at Michigan
 - STL file with print settings emailed by 2/1
 - Design Summary by 2/14
 - Verbal presentation at convention following trial
- Bumper at convention
 - Bumper fabricated in given time slot
 - Verbal presentation at convention following trial

Questions? Email ptstechchallenge@umich.edu.

Appendix:

Car CAD:

[Solidworks Assembly File](#)
[Step File of Assembly](#)

Car Drawings:

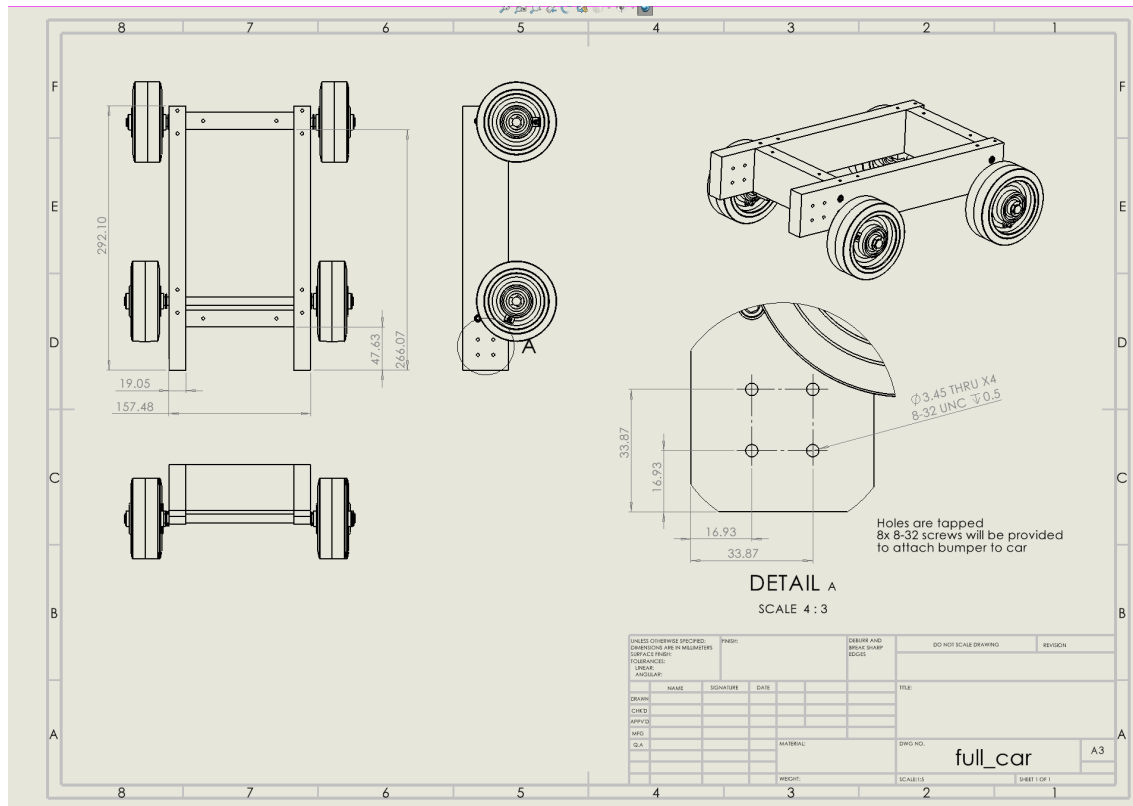
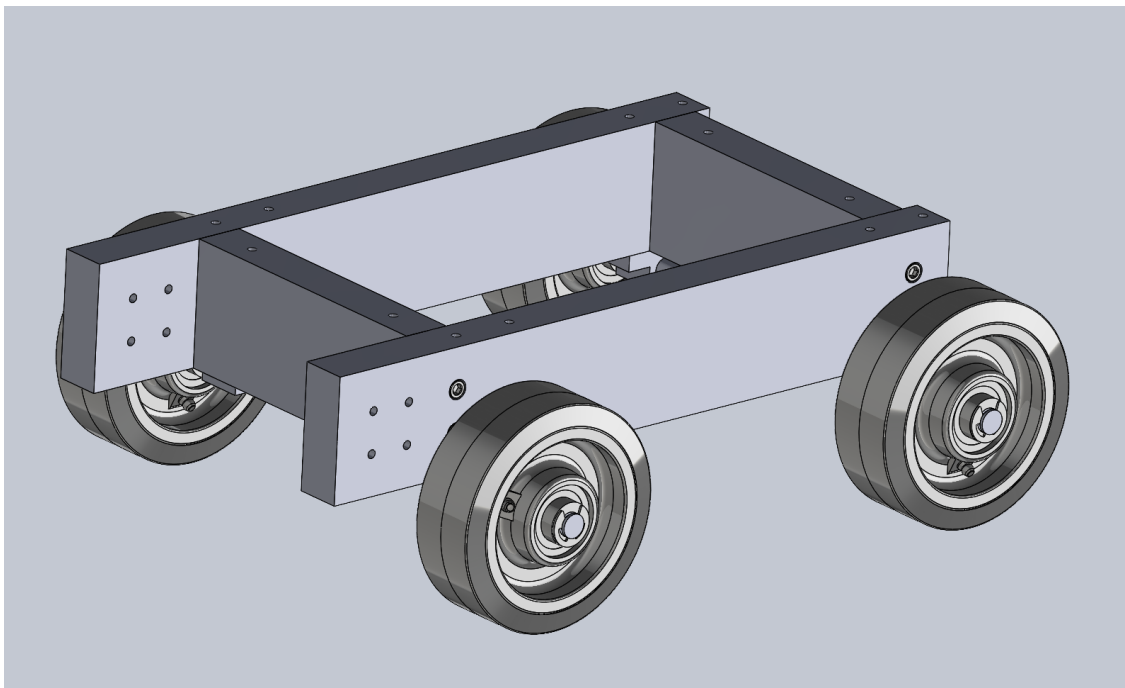


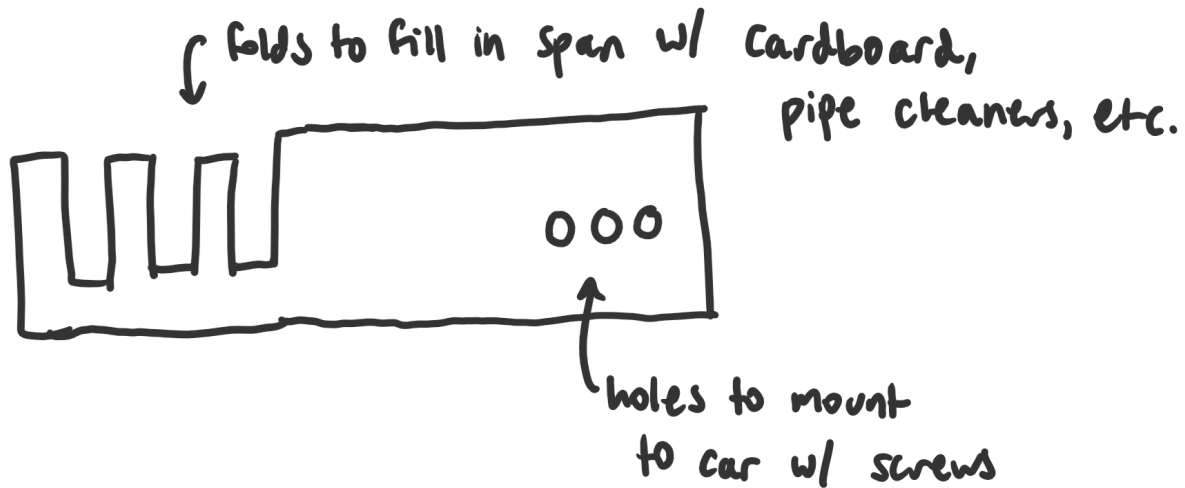
Image available [here](#)

Isometric View of Car (excluding plate with accelerometer, battery, and computer).



Screws to mount the bumper to the car (through the provided holes) will be provided on competition day.

Arm for Day-of Bumpers



Car BOM (provided on day of competition)

All components sourced from McMaster Carr

Part Description	Part #	Quantity
Side-Mount External Retaining Rings, for $\frac{3}{8}$ " diameter shaft	97431A20	8
Rubber Wheels	2439T41	4
Aluminum Stock, 2" x $\frac{3}{4}$ " Rectangular	8975K78	3 ft
Steel Socket Head Screw, 8-32 UNC, $\frac{1}{2}$ " length	91251A194	20
Steel Socket Head Screw, 8-32 UNC, 1 $\frac{1}{4}$ " length	91251A201	8