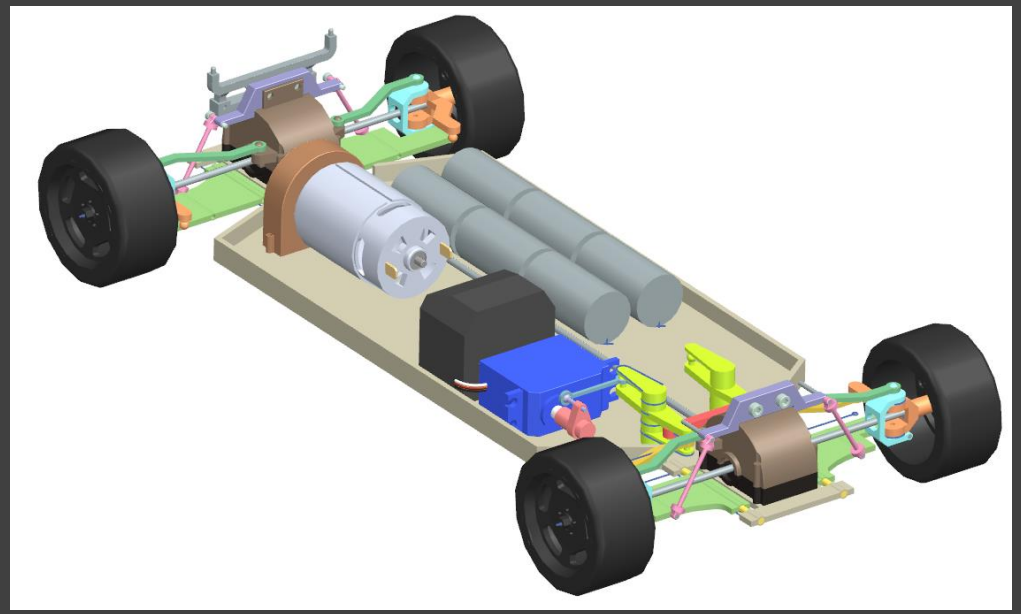
‘33 HOT ROD FINAL DESIGN

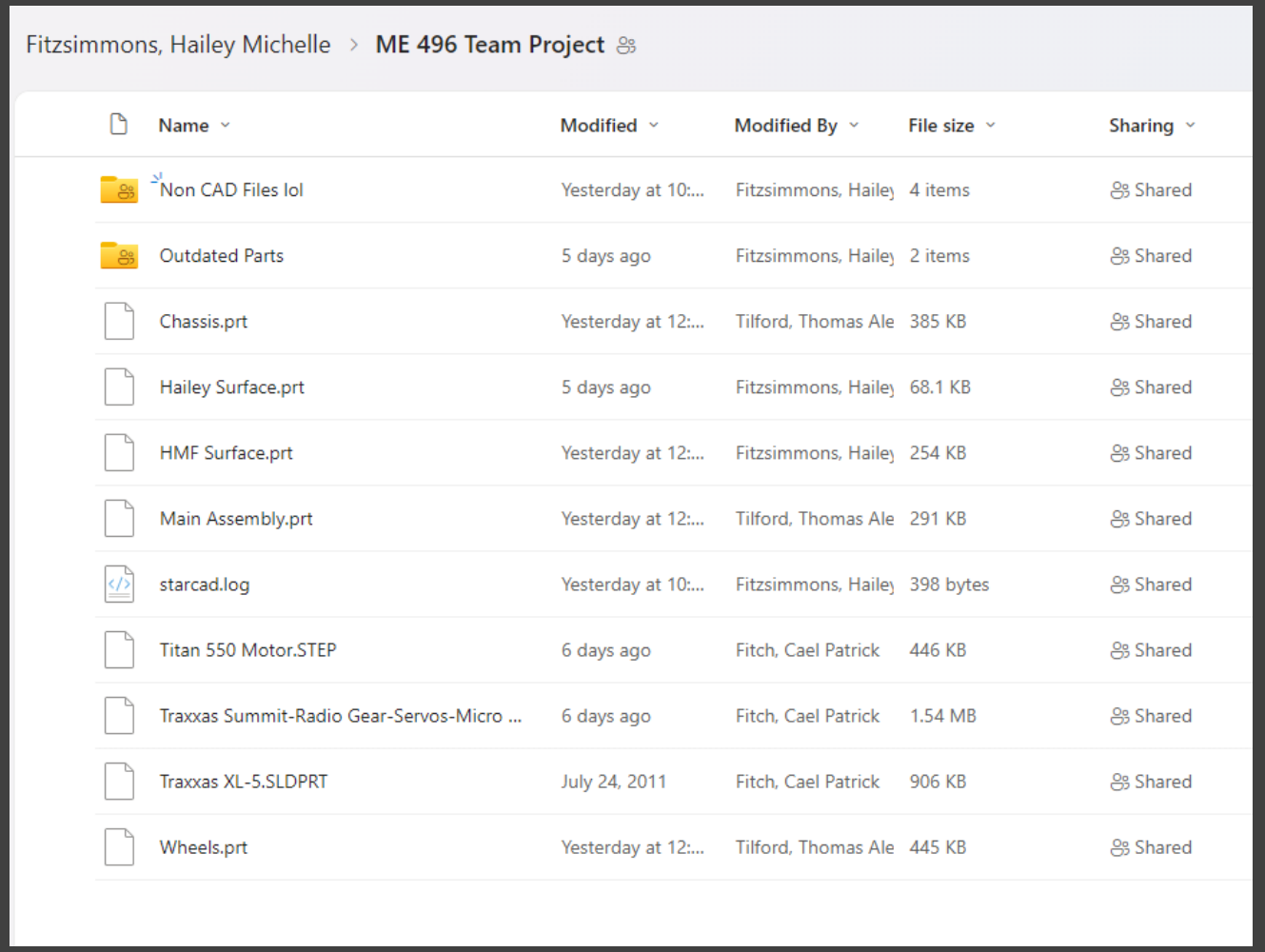
Fast and Furious: Cael Fitch, Hailey Fitzsimmons, Aditya Pimplikar, Thomas Tilford

1. Modeling and Parametrics



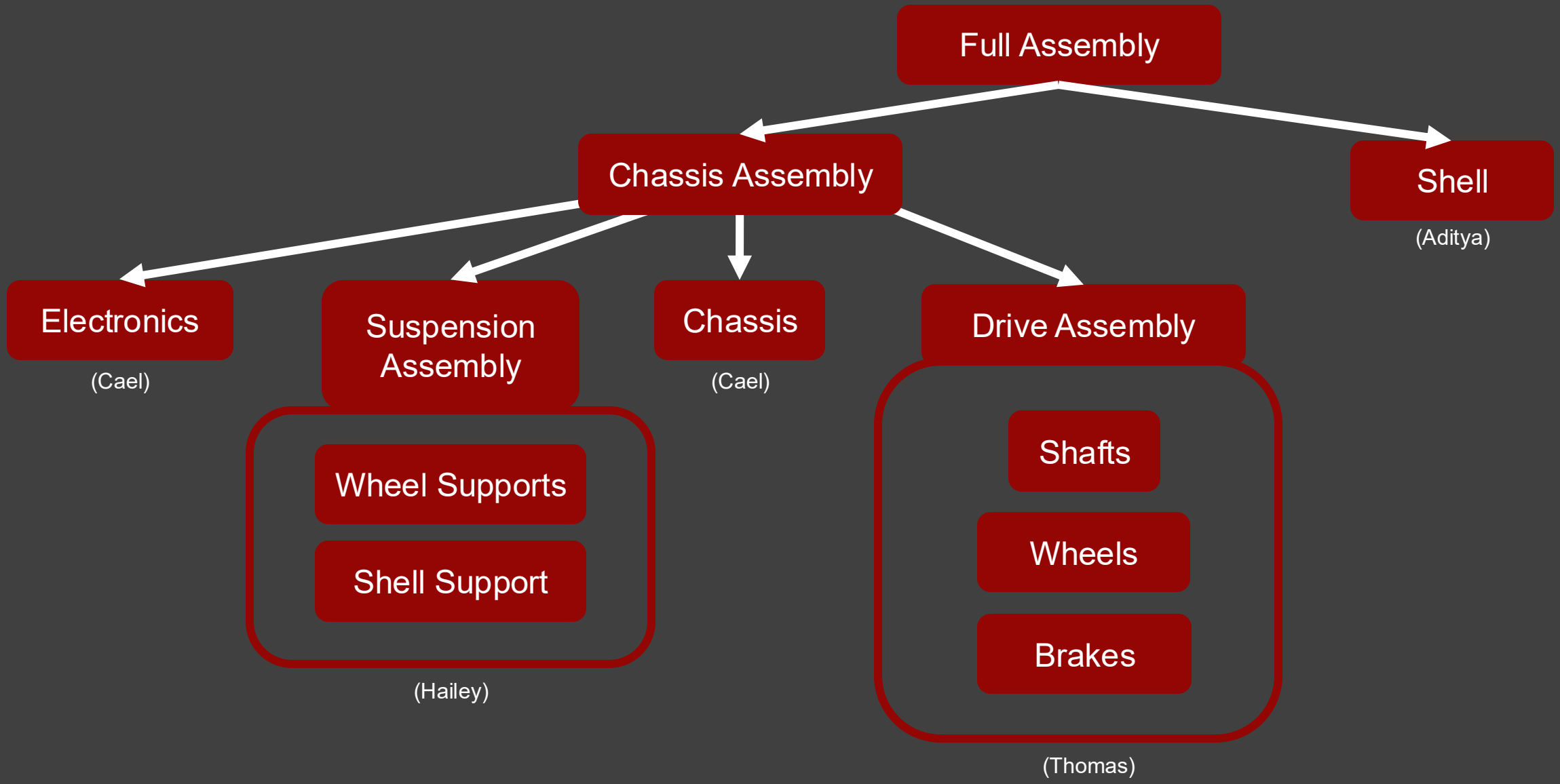
DATA EXCHANGE + COLLABORATION

- Communication through text message
- Semi-weekly meetings
- Individual work out of class
- Files shared through OneDrive
- Team alerted when file pulled out for editing



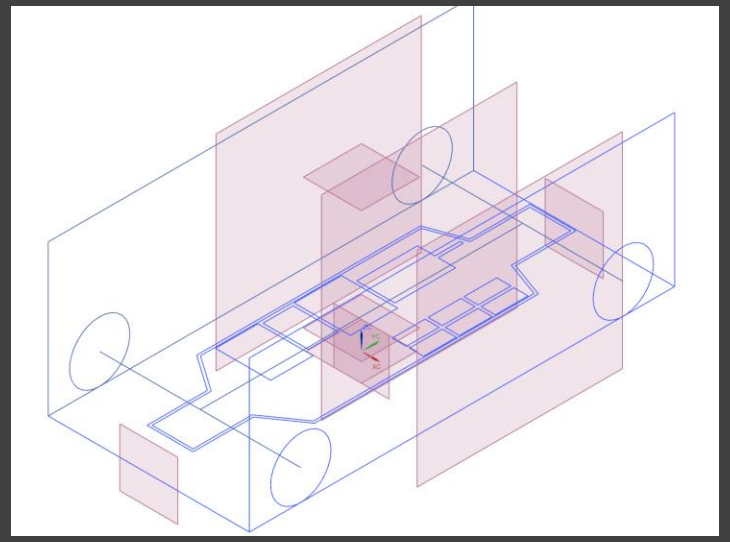
Name	Modified	Modified By	File size	Sharing
Non CAD Files lol	Yesterday at 10:...	Fitzsimmons, Hailey	4 items	Shared
Outdated Parts	5 days ago	Fitzsimmons, Hailey	2 items	Shared
Chassis.prt	Yesterday at 12:...	Tilford, Thomas Ale	385 KB	Shared
Hailey Surface.prt	5 days ago	Fitzsimmons, Hailey	68.1 KB	Shared
HMF Surface.prt	Yesterday at 12:...	Fitzsimmons, Hailey	254 KB	Shared
Main Assembly.prt	Yesterday at 12:...	Tilford, Thomas Ale	291 KB	Shared
starcad.log	Yesterday at 10:...	Fitzsimmons, Hailey	398 bytes	Shared
Titan 550 Motor.STEP	6 days ago	Fitch, Cael Patrick	446 KB	Shared
Traxxas Summit-Radio Gear-Servos-Micro ...	6 days ago	Fitch, Cael Patrick	1.54 MB	Shared
Traxxas XL-5.SLDPRT	July 24, 2011	Fitch, Cael Patrick	906 KB	Shared
Wheels.prt	Yesterday at 12:...	Tilford, Thomas Ale	445 KB	Shared

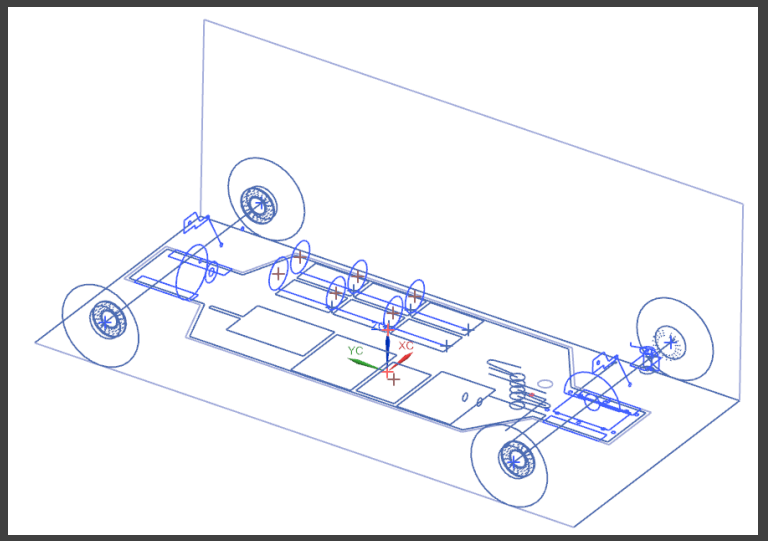
ASSEMBLY ORGANIZATION

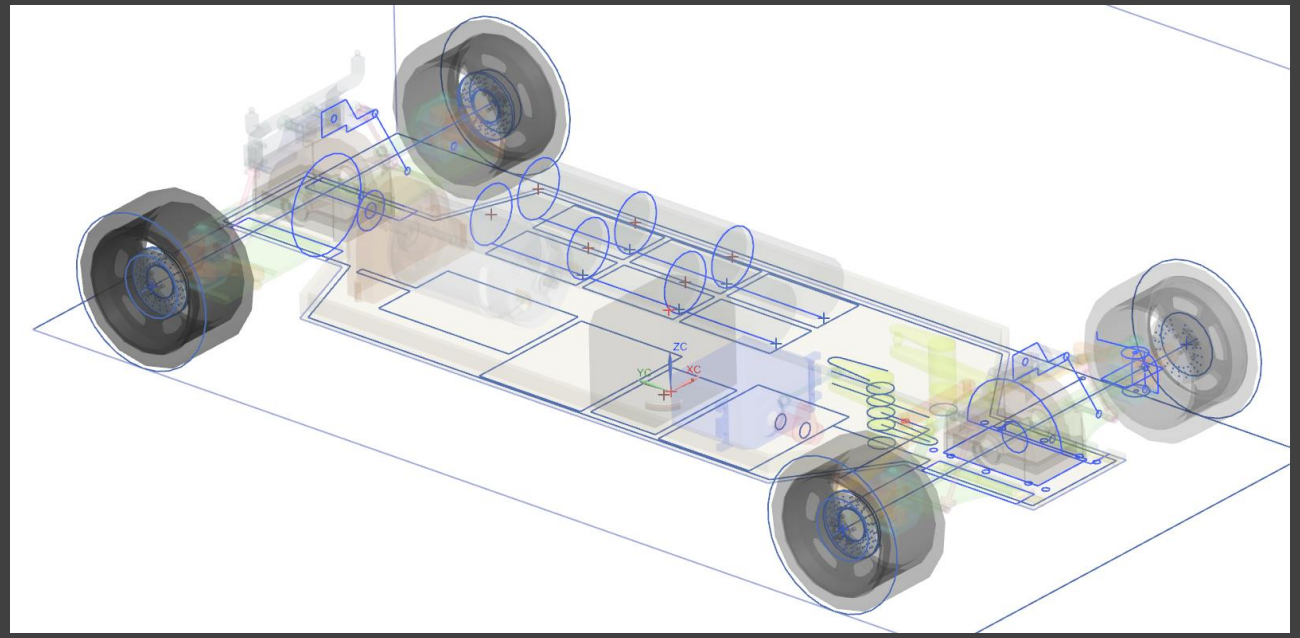


ASSEMBLY SKELETON

- Skeleton geometry for sketches
  - Body bounds
  - Wheel locations/axes
  - Midplanes
  - Chassis
  - Axles
  - Electronics
- Points/curves added to define key points on the shell

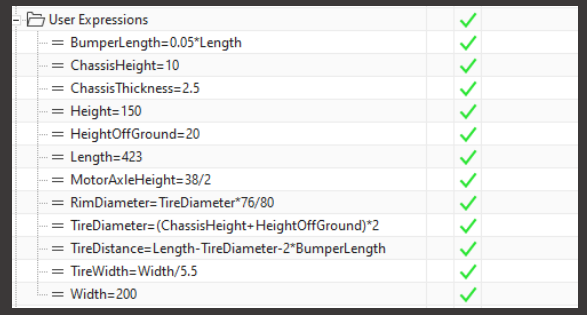


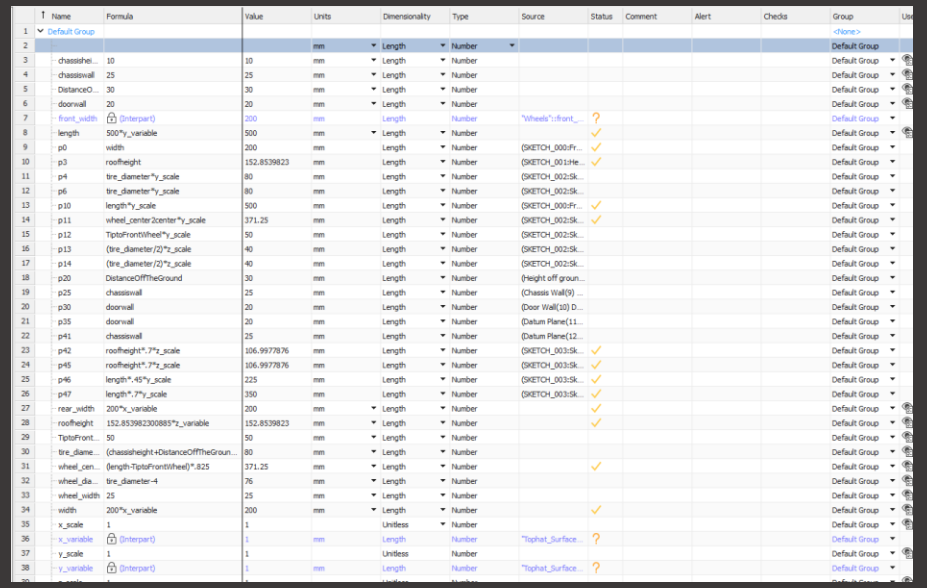


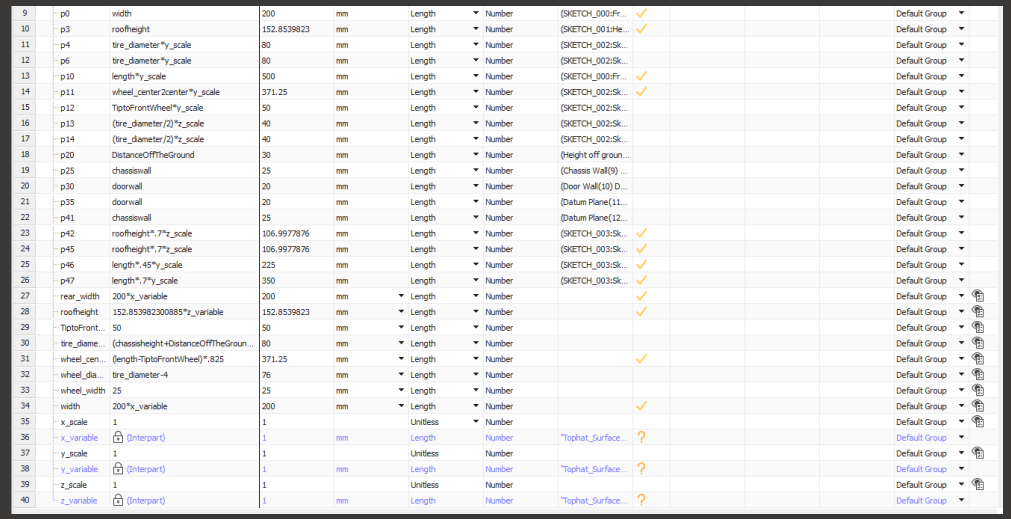


PARAMETRICS

- Core Parameters:
  - **Car Height (Z)**
  - **Car Width (X)**
  - **Car Length (Y)**
  - **Height of the Ground**
  - **Wheel Distance Apart**
- All skeleton and sub-assembly dimensions related to core parameters
- Sketches also aligned to skeleton geometry







PARAMETRICS – SCENARIOS

Original

Thinner Track

(Width Scale)

Low Clearance Bridge

(Height Scale)

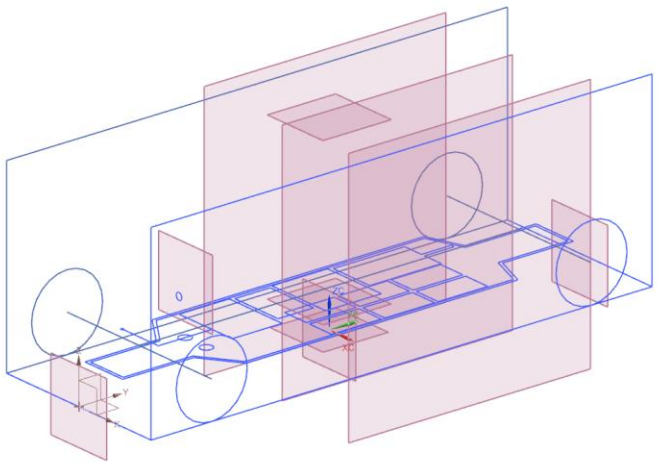
Small Parking Spot

(Length Scale)

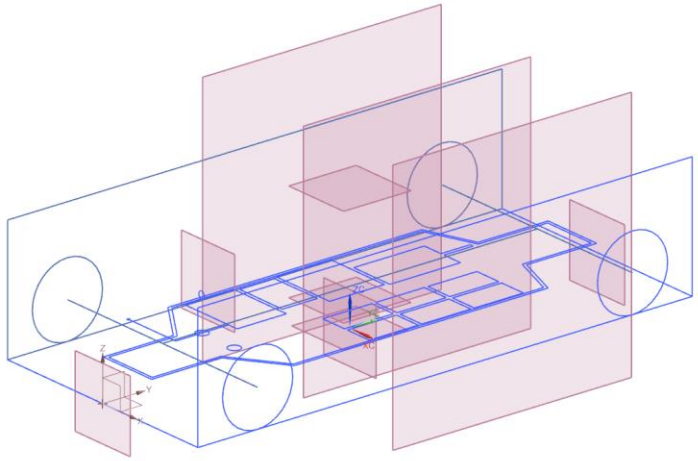
Default parametrics are the minimum bounds to still fit “hardcoded” components like electronics.

PARAMETRICS - SKELETON

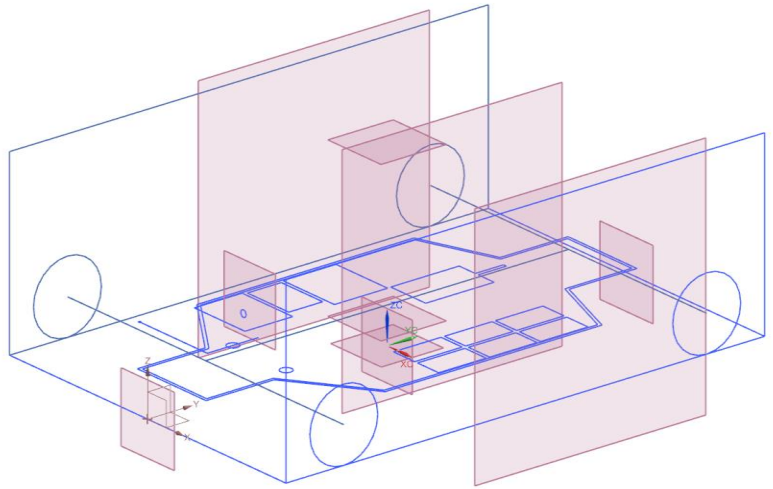
Thinner Track



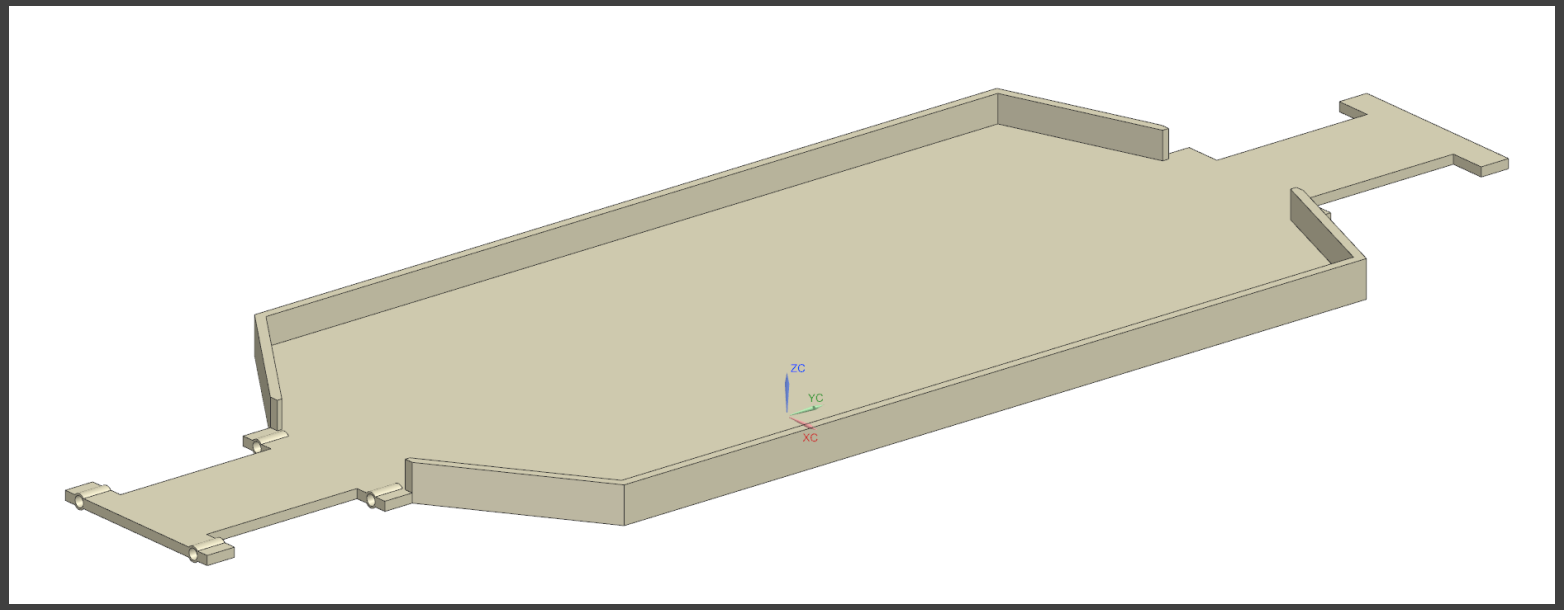
Low Clearance Bridge

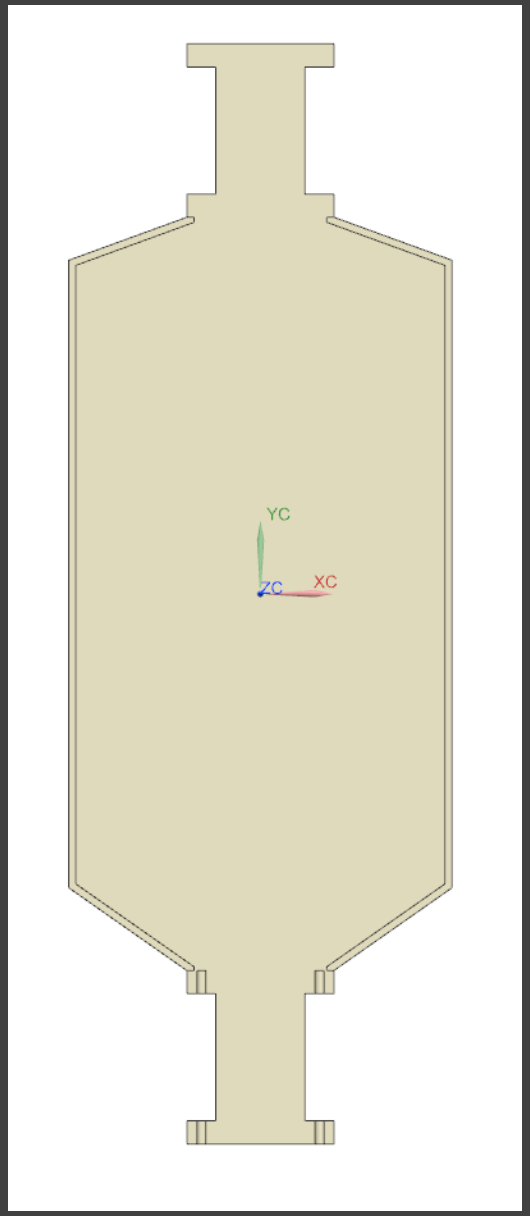


Small Parking Spot

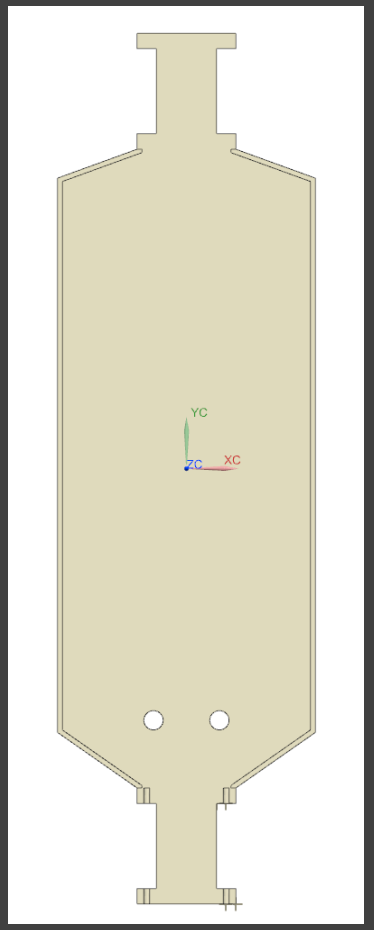


CHASSIS - MODEL

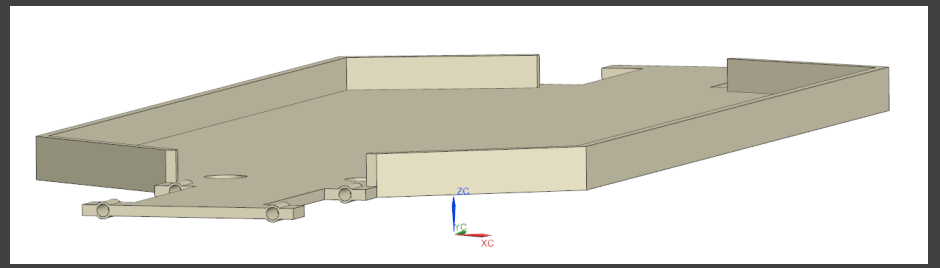




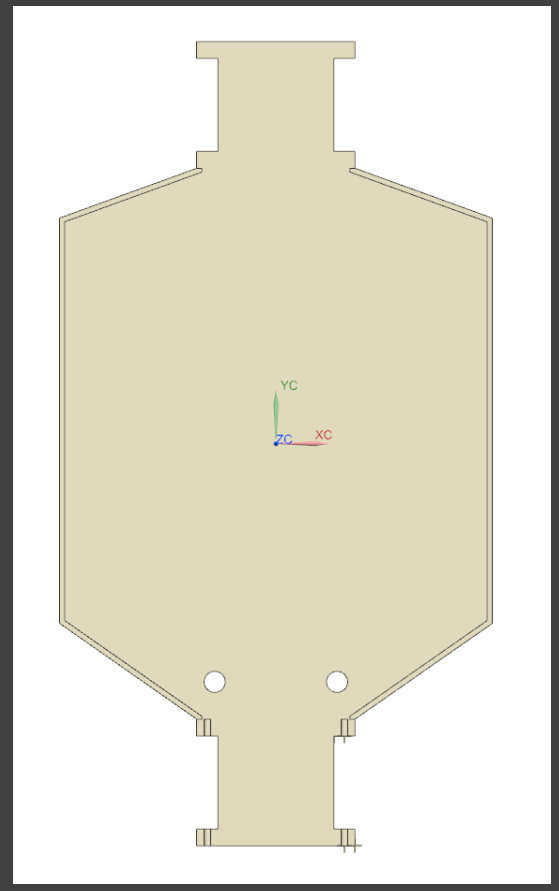
CHASSIS - PARAMETRICS



Thinner Track

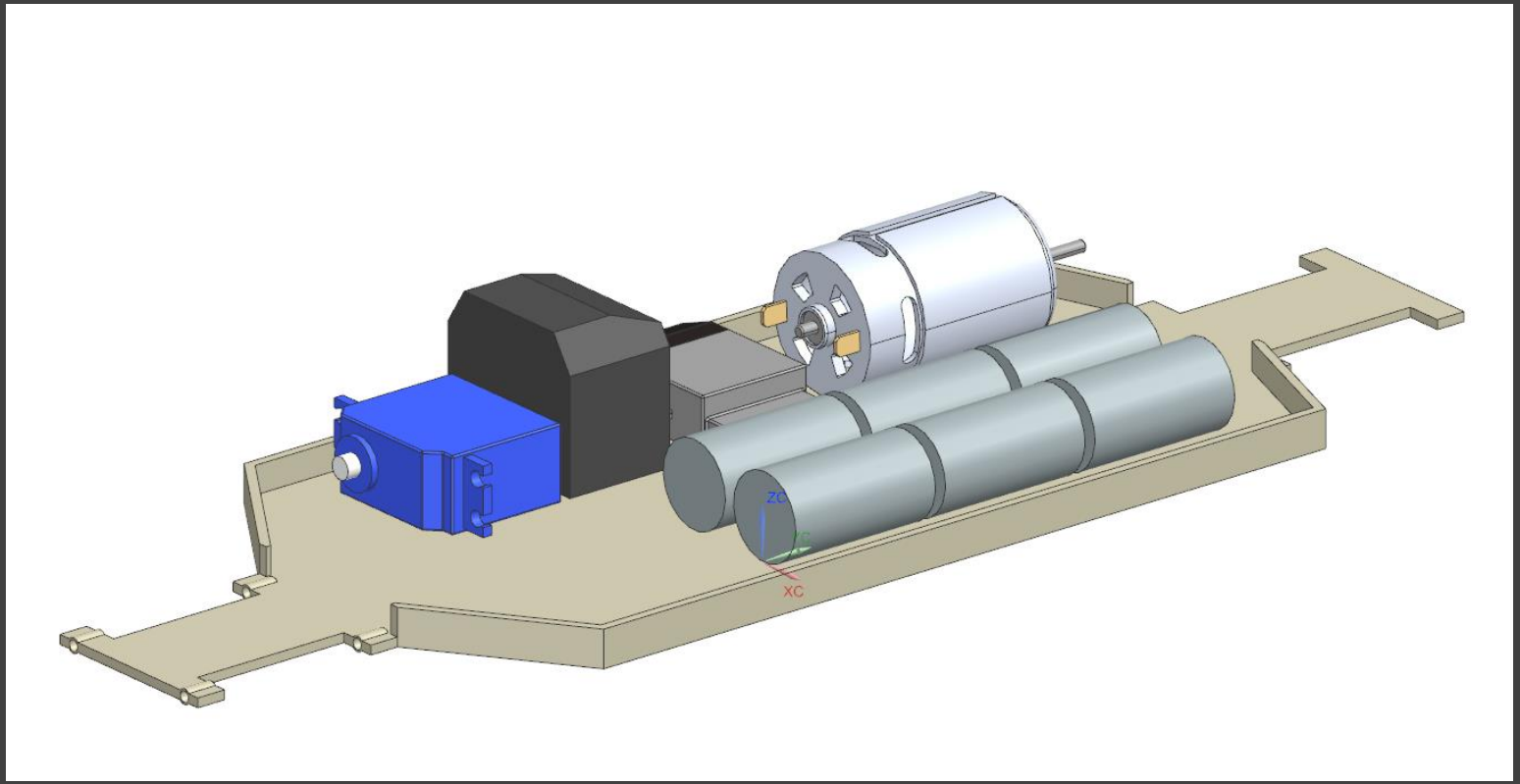


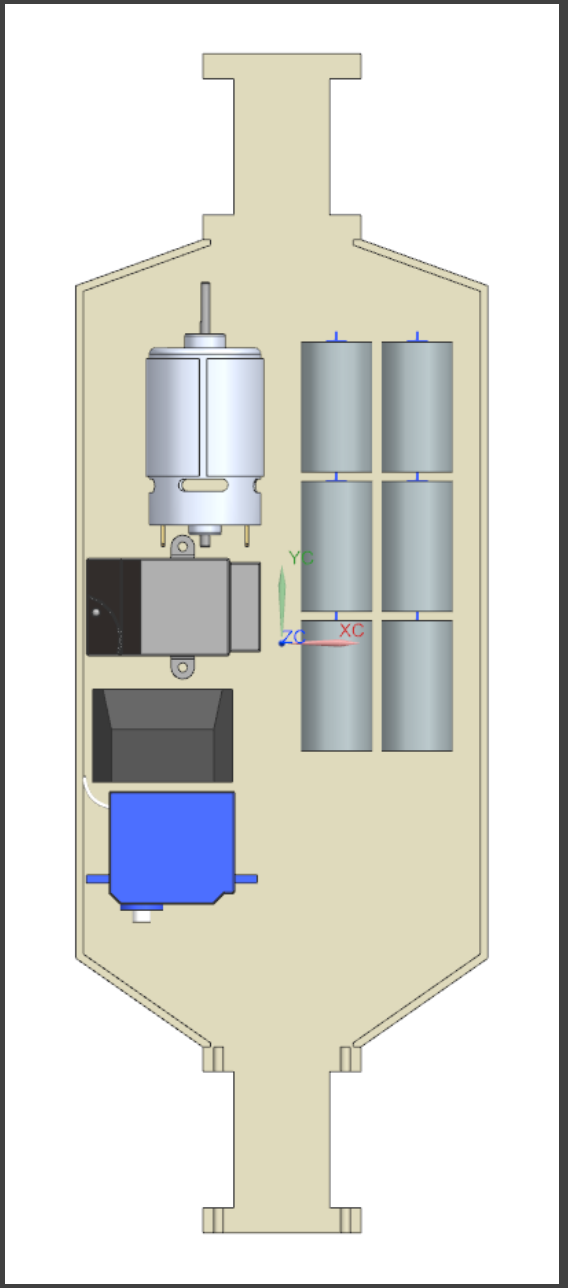
Low Clearance Bridge



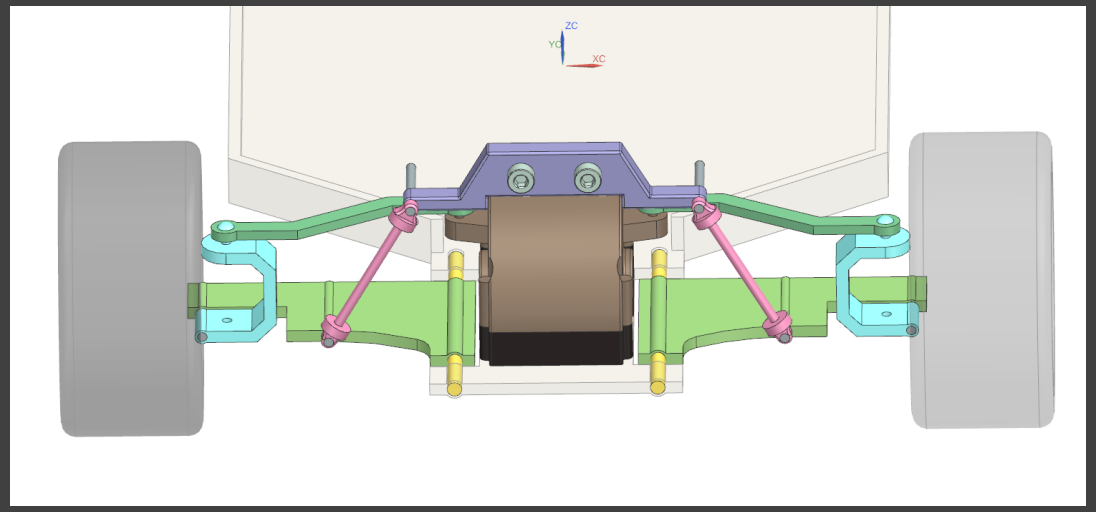
Small Parking Spot

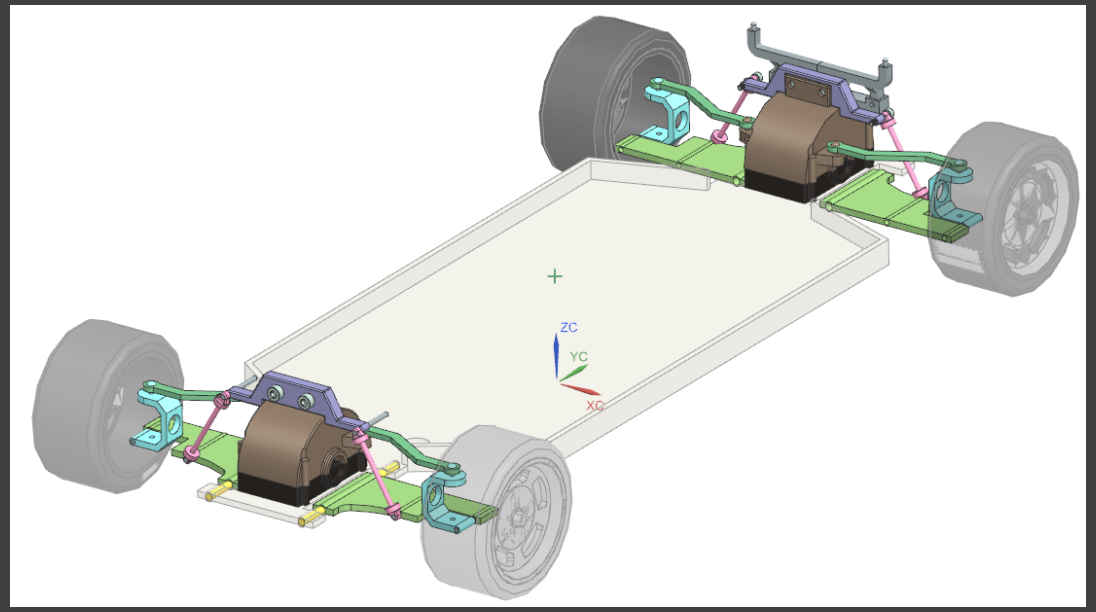
ELECTRONICS - MODEL

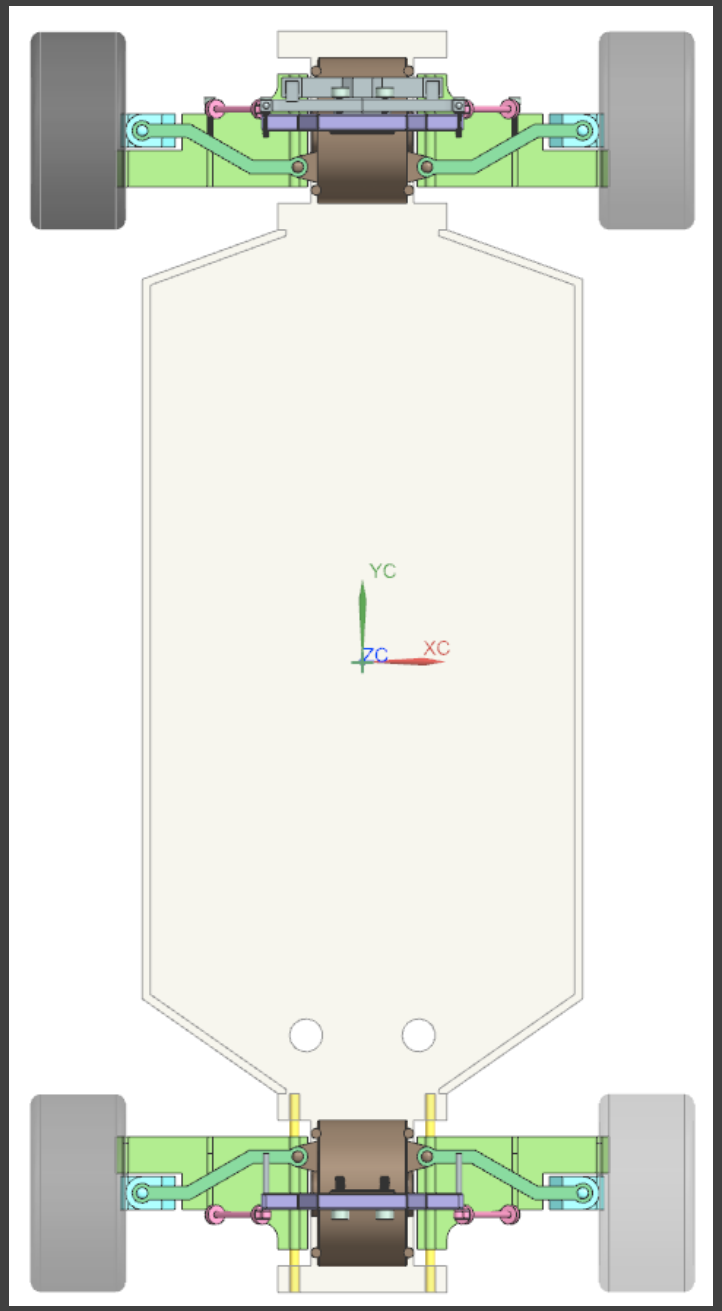




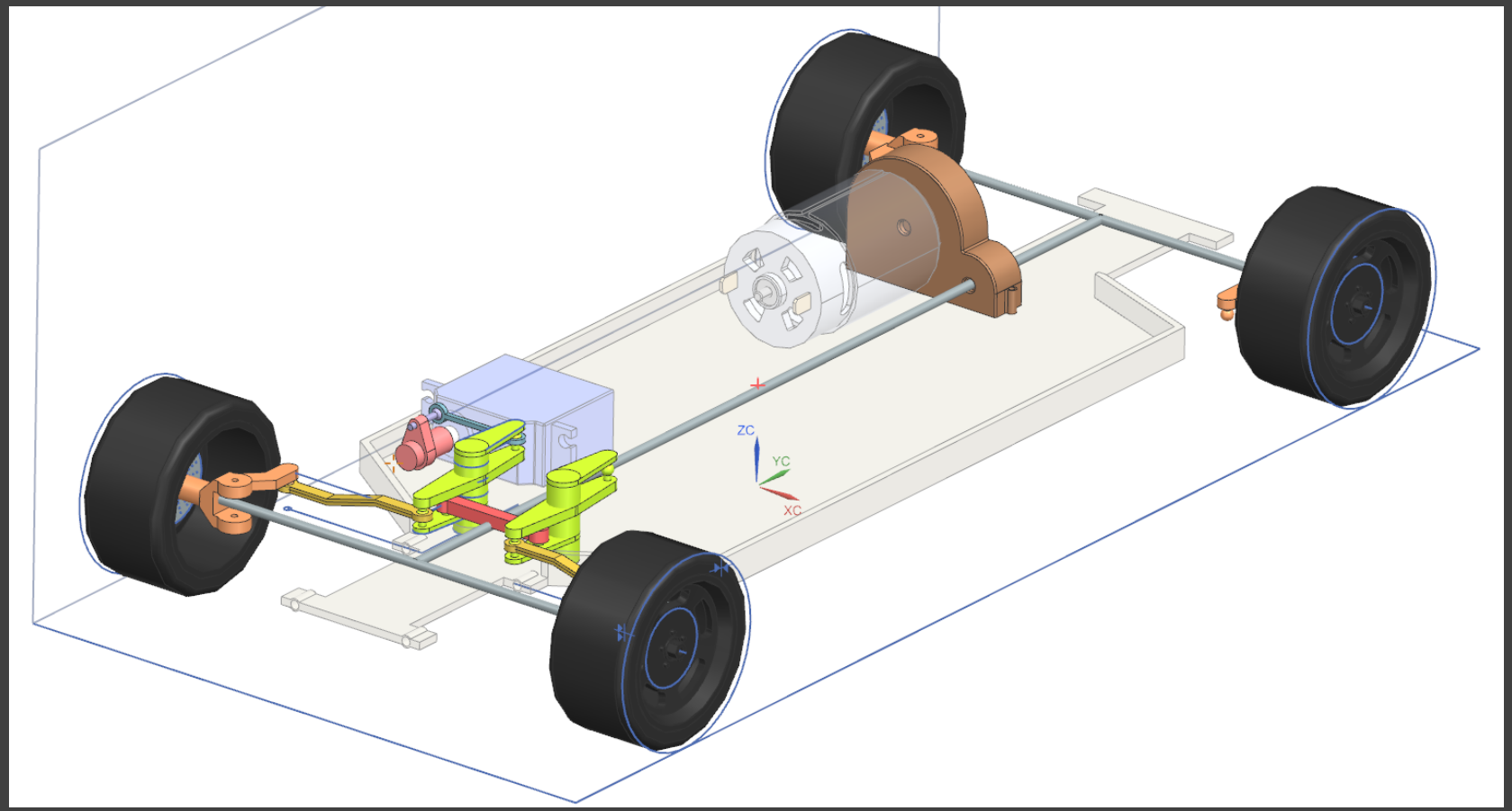
SUSPENSION - MODEL

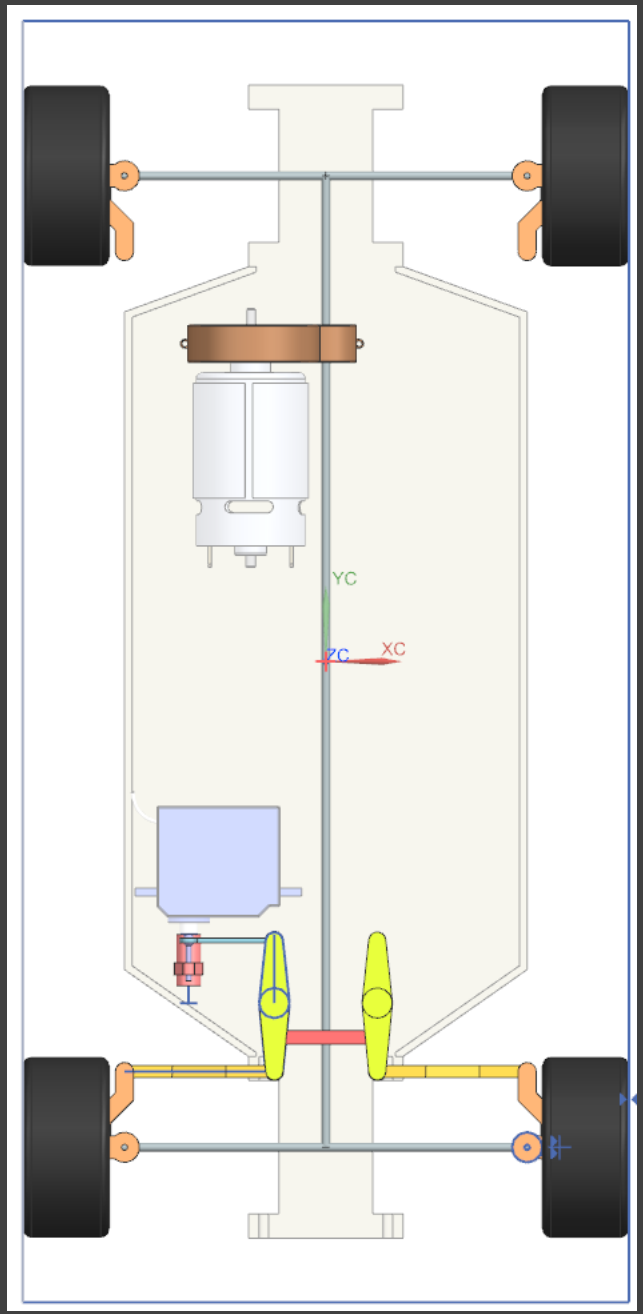




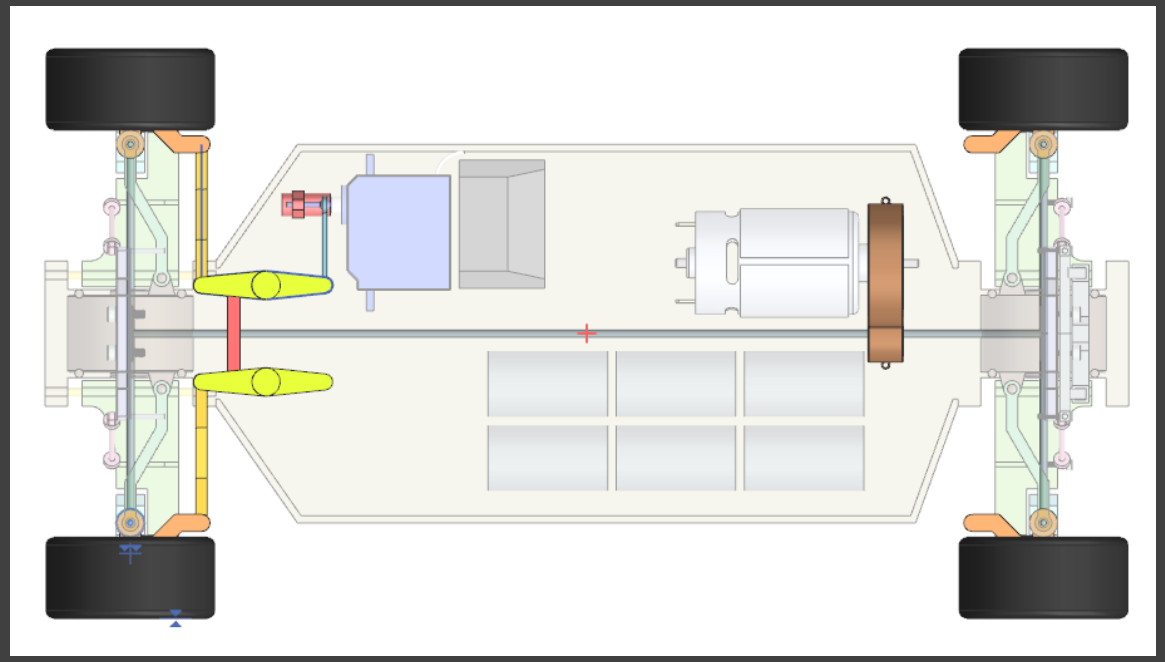


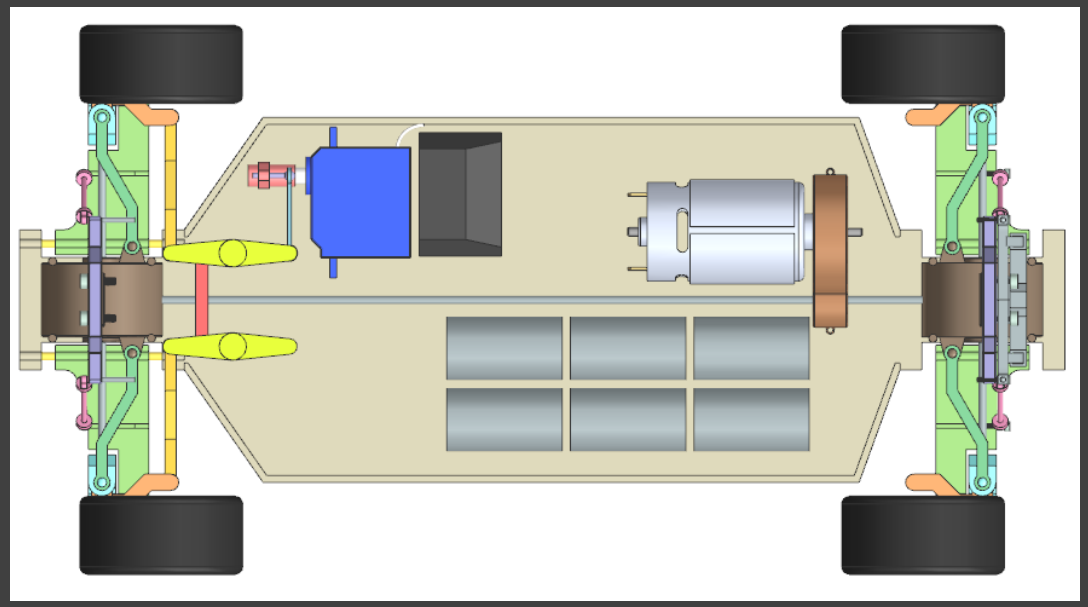
DRIVE TRAIN - MODEL



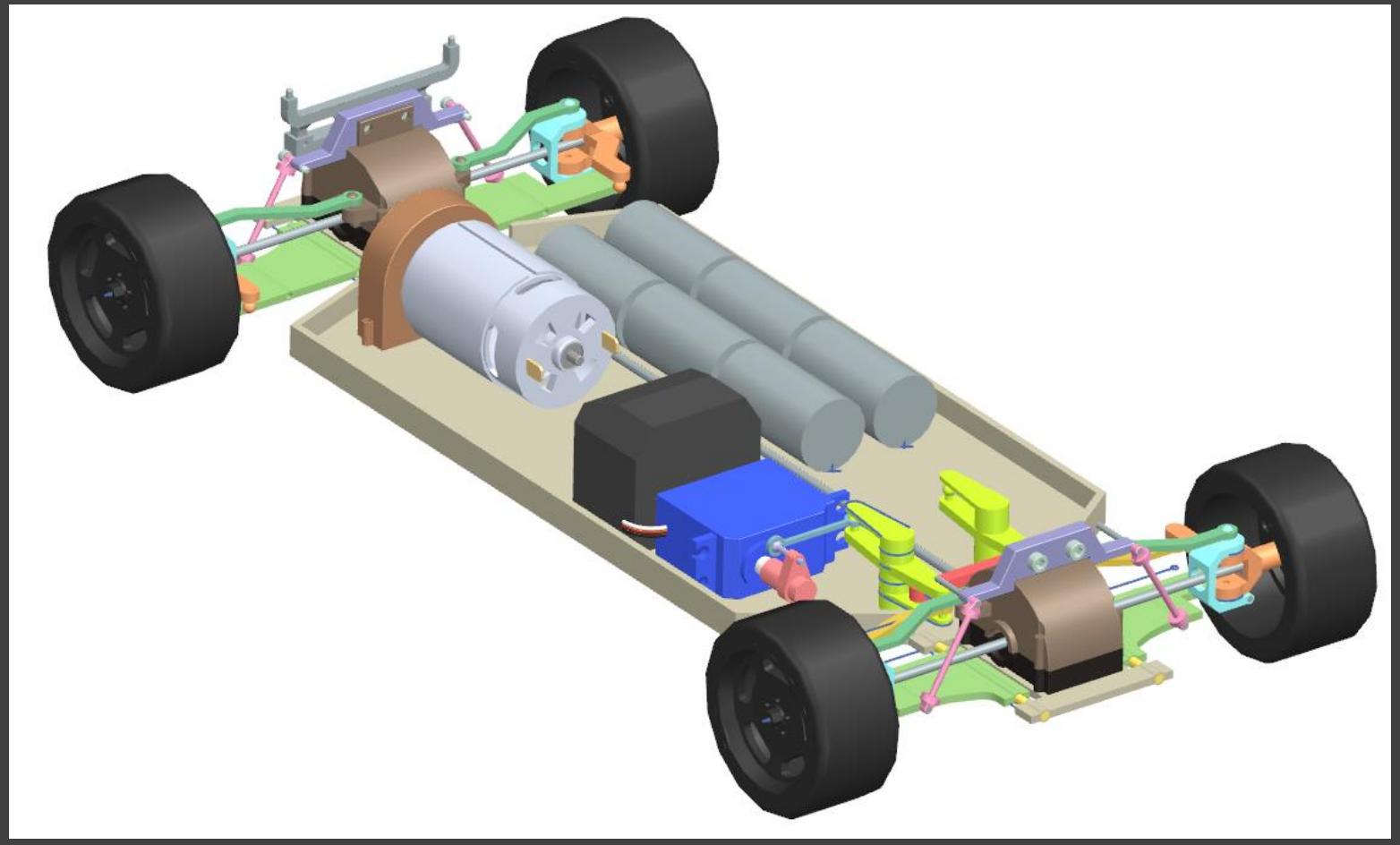


DRIVE TRAIN - PARAMETRICS

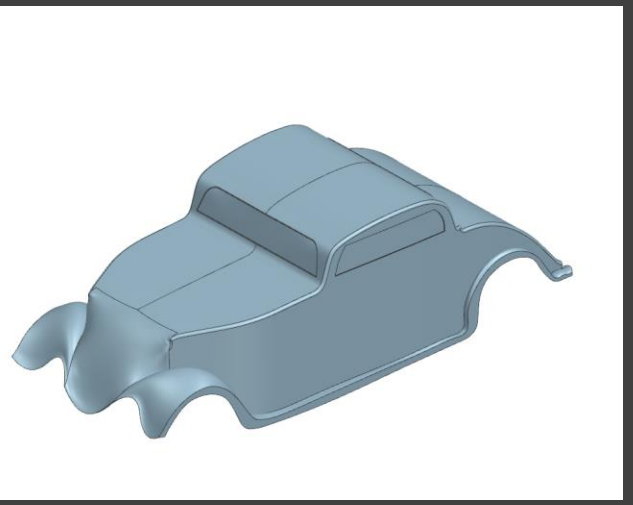


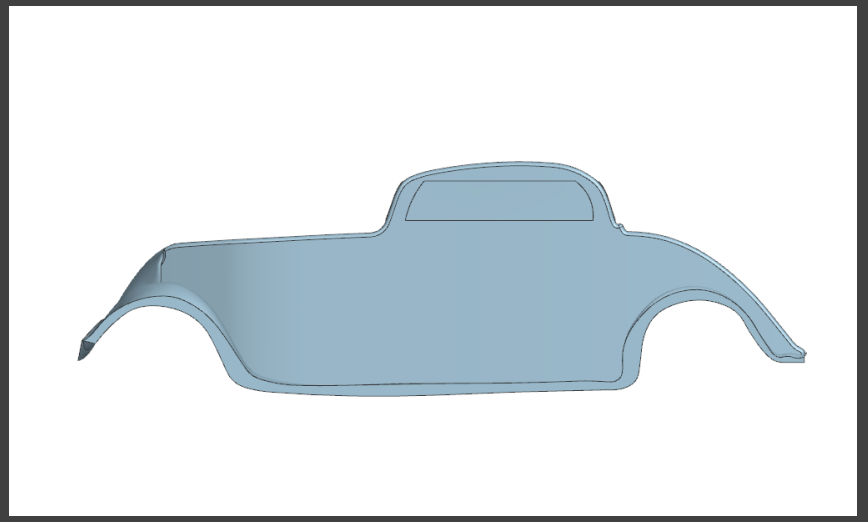


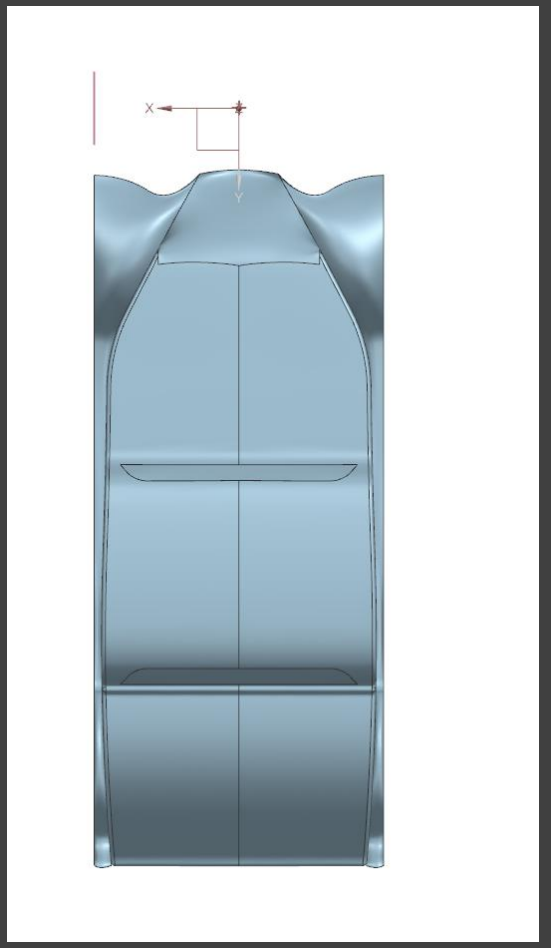
FULL INTERNALS

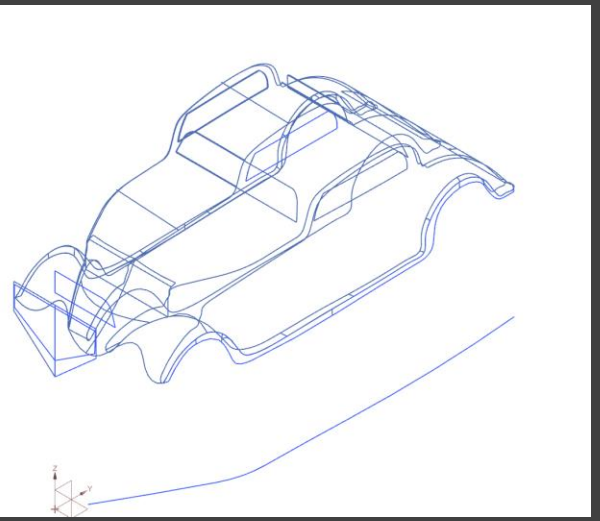


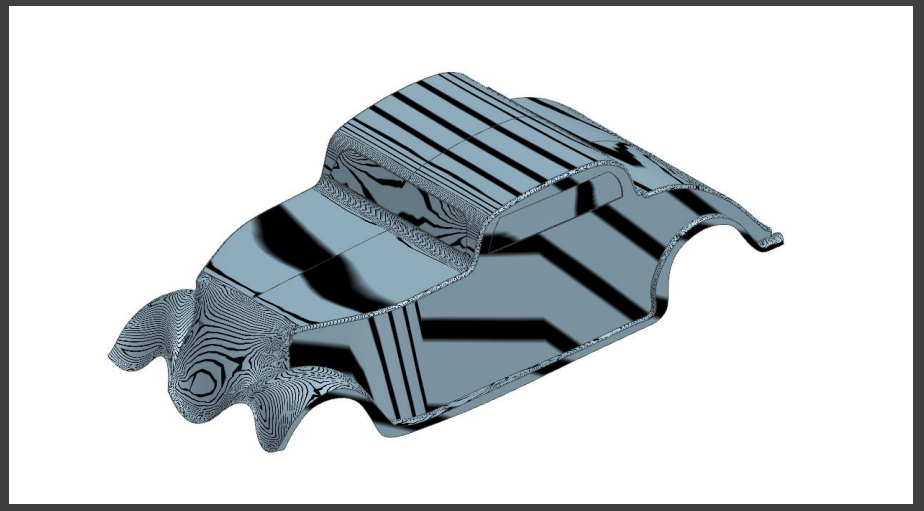
PRIMARY SHELL SURFACES







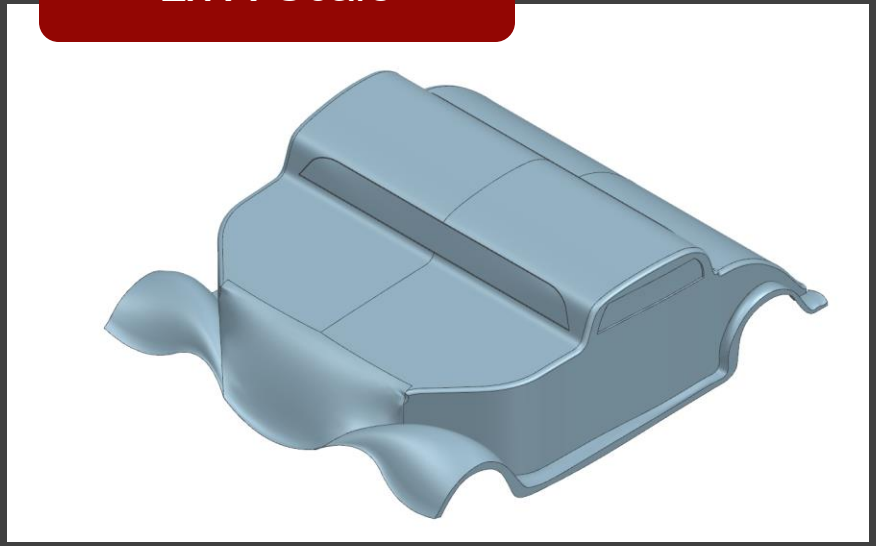




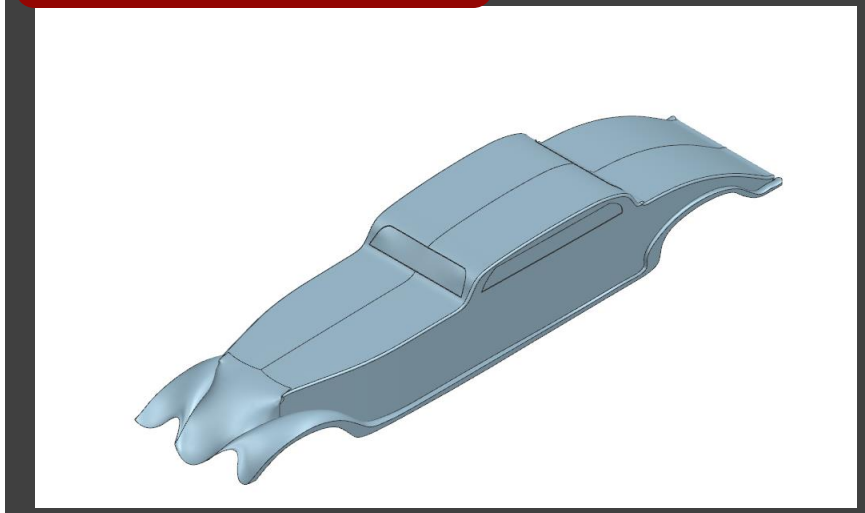
SHELL - PARAMETRICS

Original

2x X-Scale

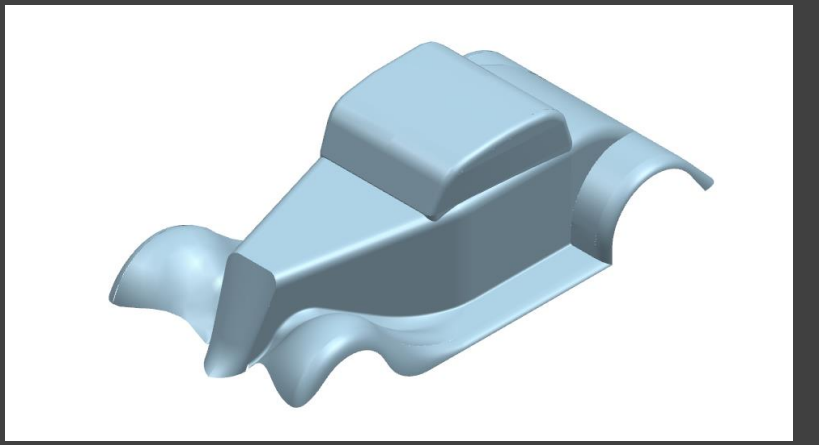


2x Y-Scale

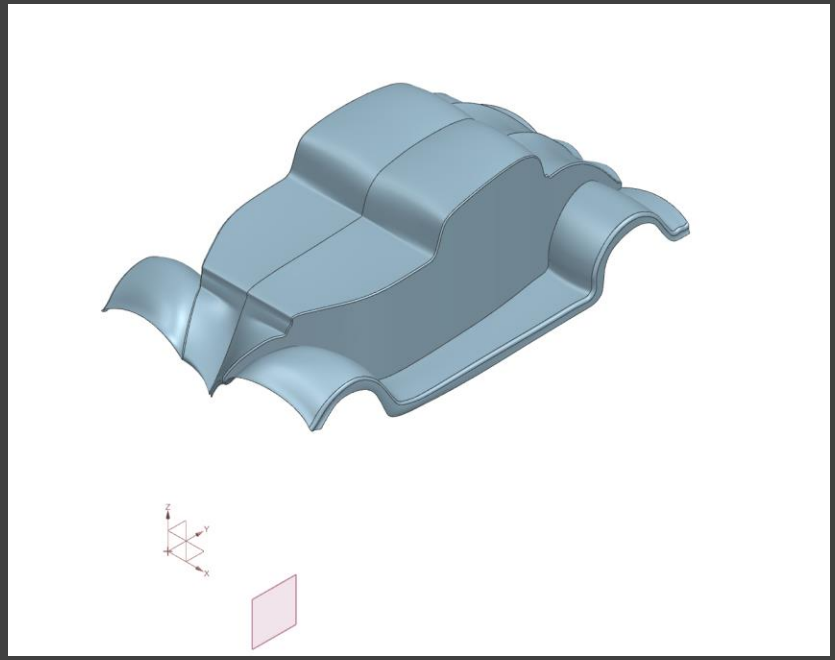


2x Z-Scale

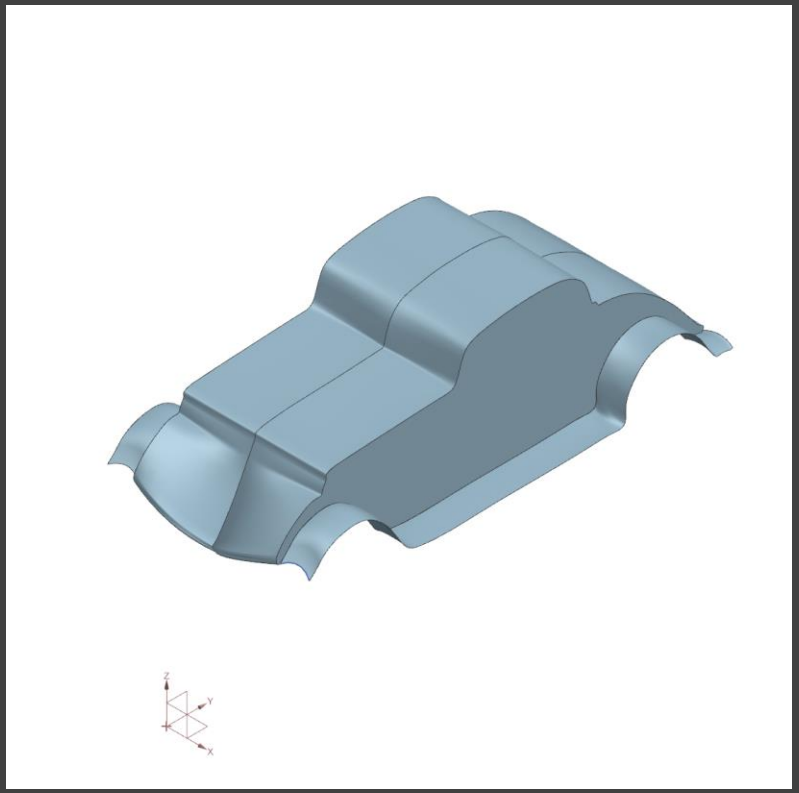
ALTERNATE SHELL SURFACES



(Cael’s Surface)

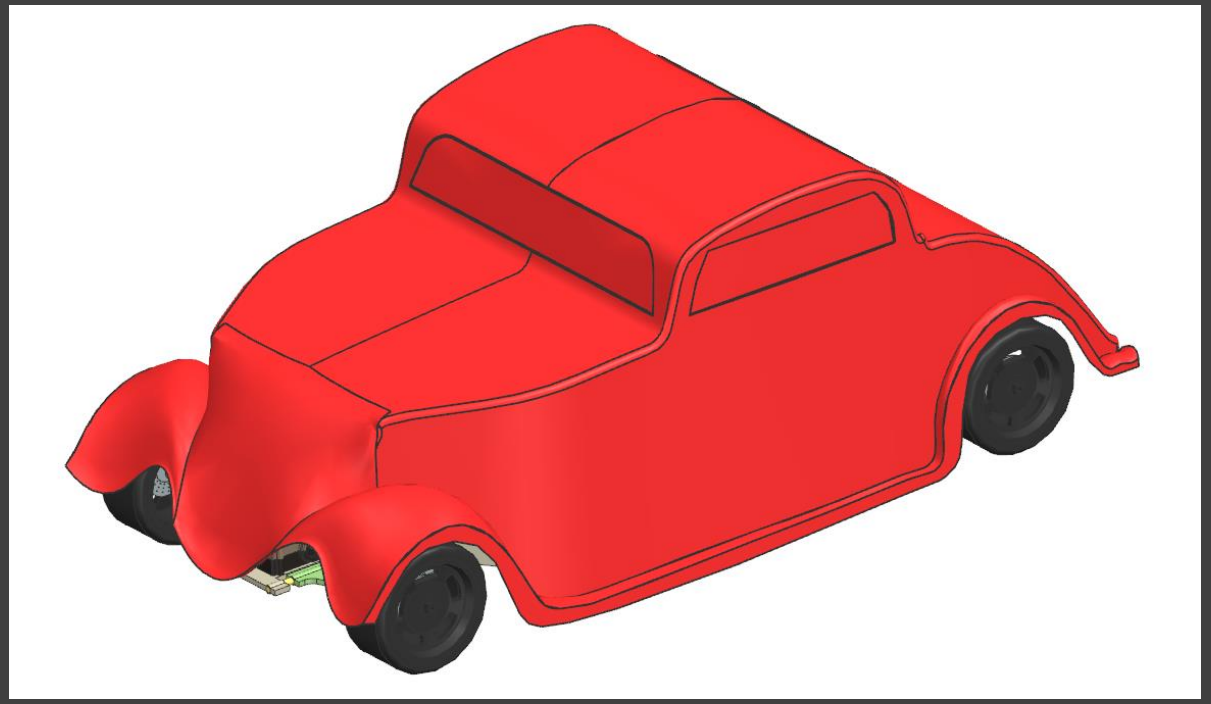


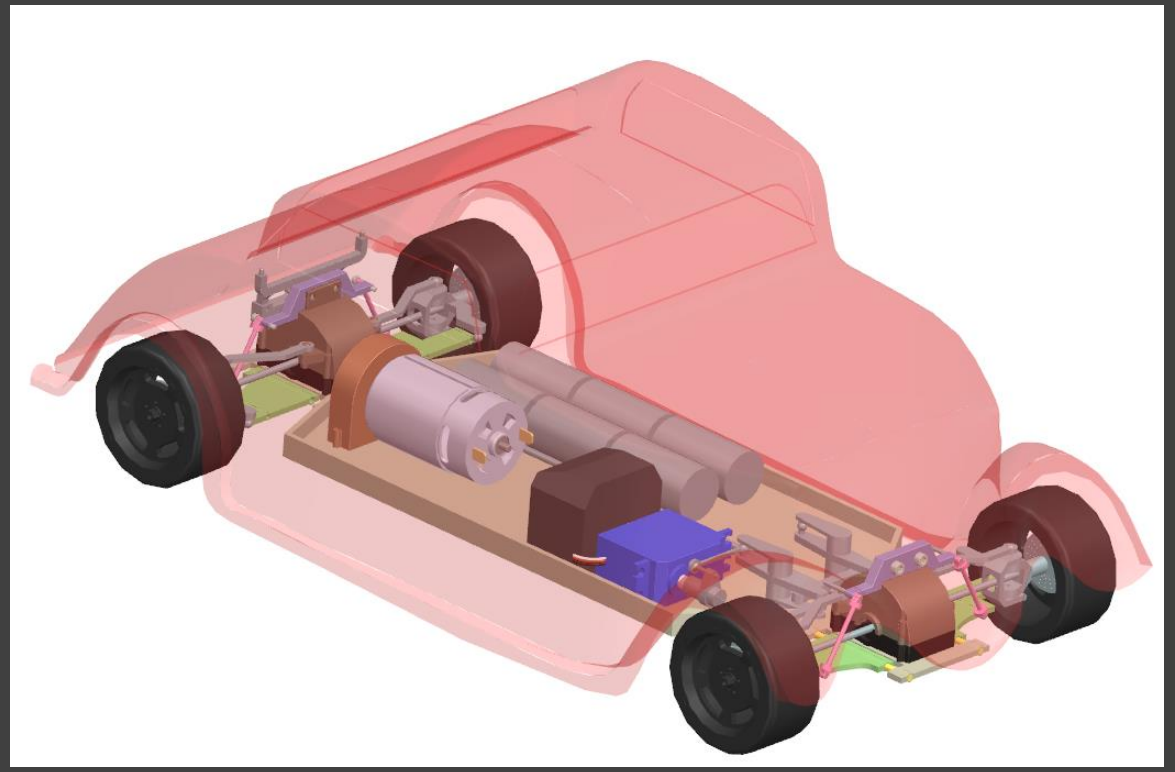
(Hailey’s Surface)



(Thomas’ Surface)

FULL MODEL





MATERIALS + MASS PROPERTIES

Assembly:

- Estimated Mass: 1.266 kg
- Real Mass: 1.919 kg
- Percent Error: 34.03 %

Shell:

- Estimated Mass: .1951 kg
- Real Mass: .166 kg
- Percent Error: 17.53 %

Component	Material
Chassis	Polymer
Shell	Plastic (Polyethylene)
Wheels	Plastic (Polycarbonate)
Tires	Rubber
Suspension	Plastic (Polycarbonate)
Axles	Aluminum

2. Design Improvements

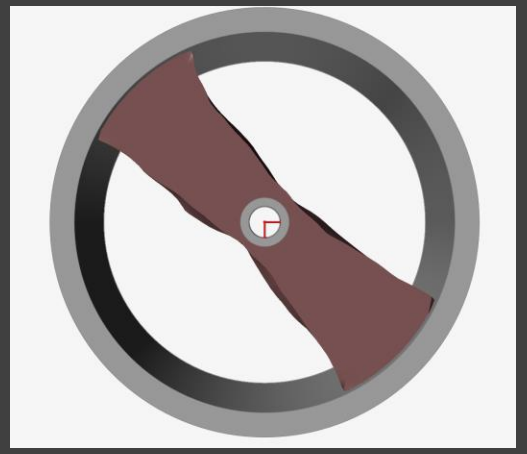
Topology Optimization

Goal: Reduce mass of RC Car while still maintaining structural integrity for optimization

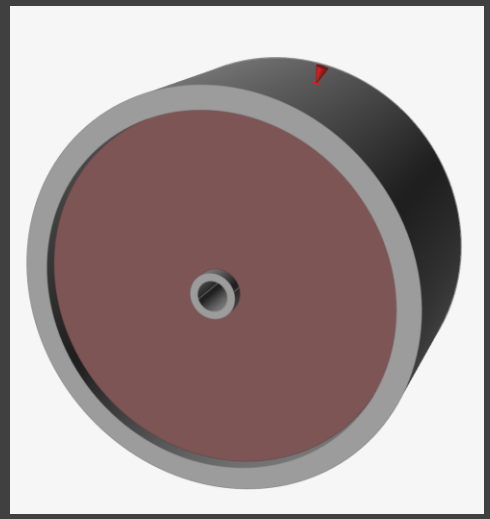
WHEEL – STATIC CASE

- Outer rim and center hub not considered design space
- Inner rim is area of focus
- Fixed constraint on outside rim face
- 20 N force in +Y and -Z on the center axial
- Material: Plastic (ABS)
- Model Mass- 20.429 g
- Optimized Mass- 14.258 kg

Current Design



Optimized Part

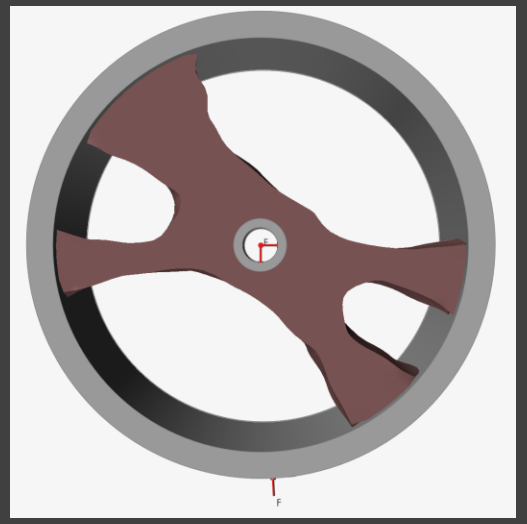


Loading with preserved faces and design space

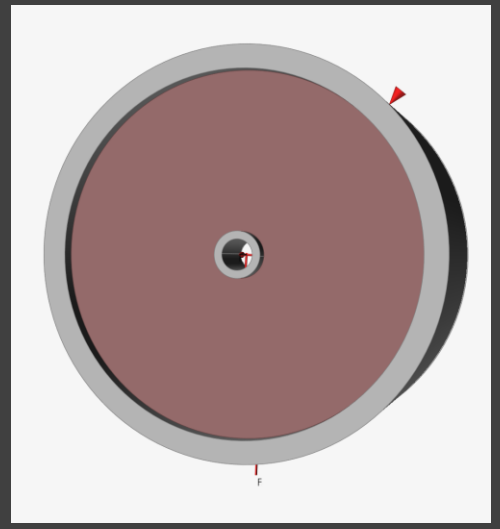
WHEEL – "ROLLING" CASE

- Outer rim and center hub not considered design space
- Inner rim is area of focus
- Fixed constraint on outside rim face
- 20 N force in +Y, -Z and +X on the center axial
- Added a 20 N force on outer rim for basic "motion" force simulation
- Material – Plastic (ABS)
- Model Mass- 20.429 g
- Optimized Mass- 14.64 g

Current Design



Optimized Part



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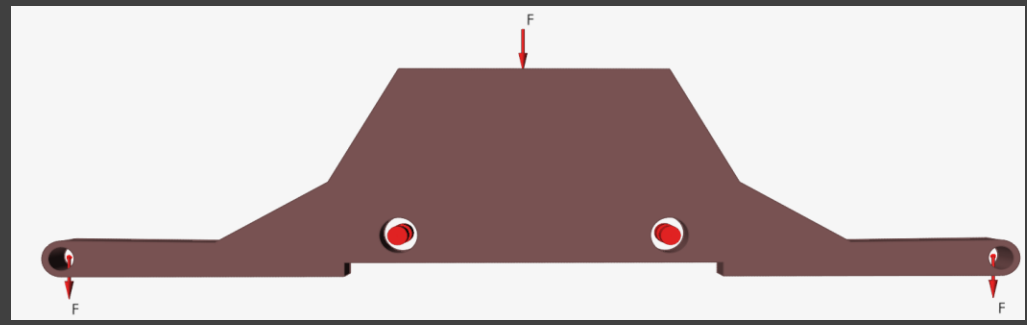
SUSPENSION SPRING ARM – MASS REDUCTION

- 8 N force applied to outer holes in the –Z direction
- 5 N force on top face to simulate shell
- Fixed constraint on two inner holes
- Reduce Mass Safety Factor set to 2
- Material – Polypropylene
- Model Mass- 22.778 g
- Optimized Mass- 10.225 g

Current Design



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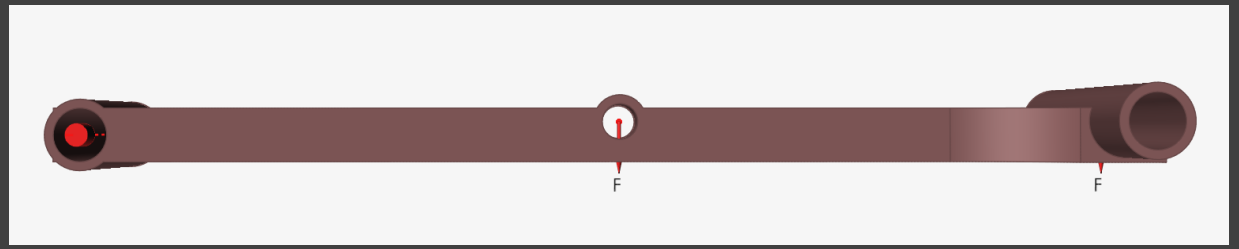
Optimized Part

WHEEL WING – MASS REDUCTION

- 8 N force applied holes in the –Z direction
- Fixed constraint on left side hole
- Reduce Mass Safety Factor set to 2
- Material – Polypropylene
- Model Mass- 20.07 g
- Optimized Mass- 12.95 g

Current Design



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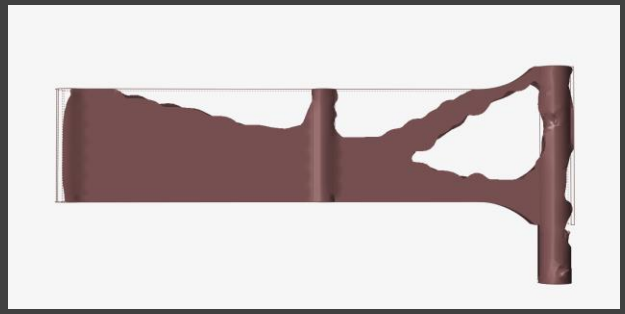


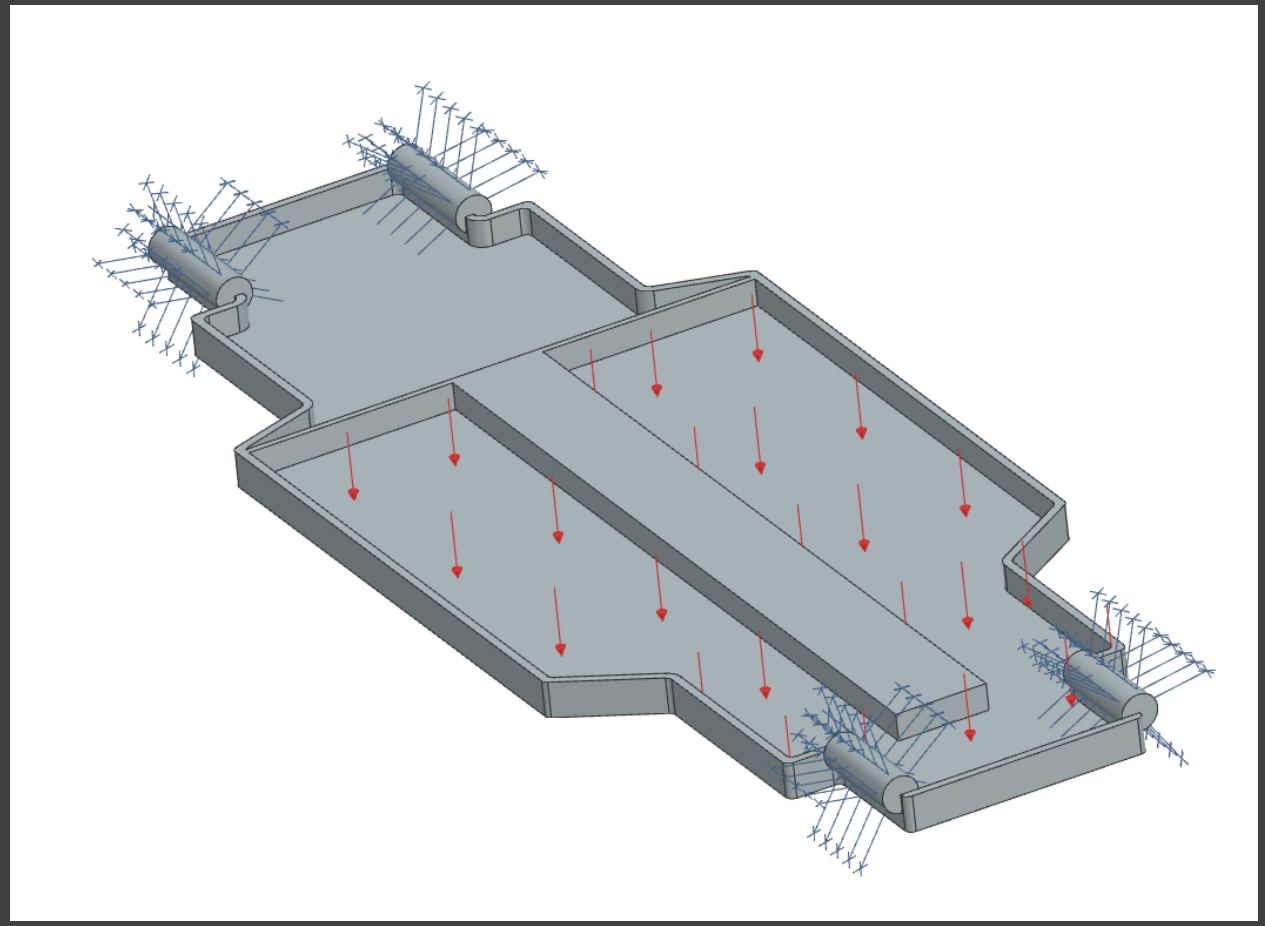
Optimized Part

Finite Element Analysis

Goal: Analyze the different forces and load conditions to **confirm the design** of the selected component

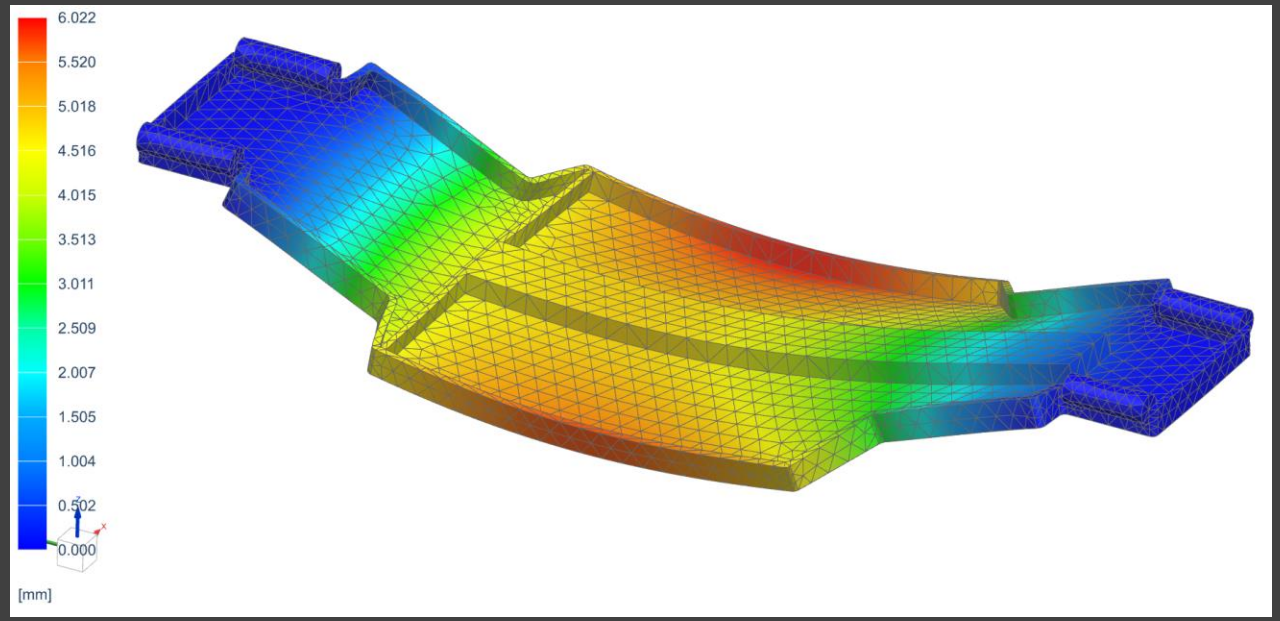
CHASSIS (PART) - SETUP

- To study the overall form and the impact of ribbing
- 20N distributed across floor to simulate electronics weight



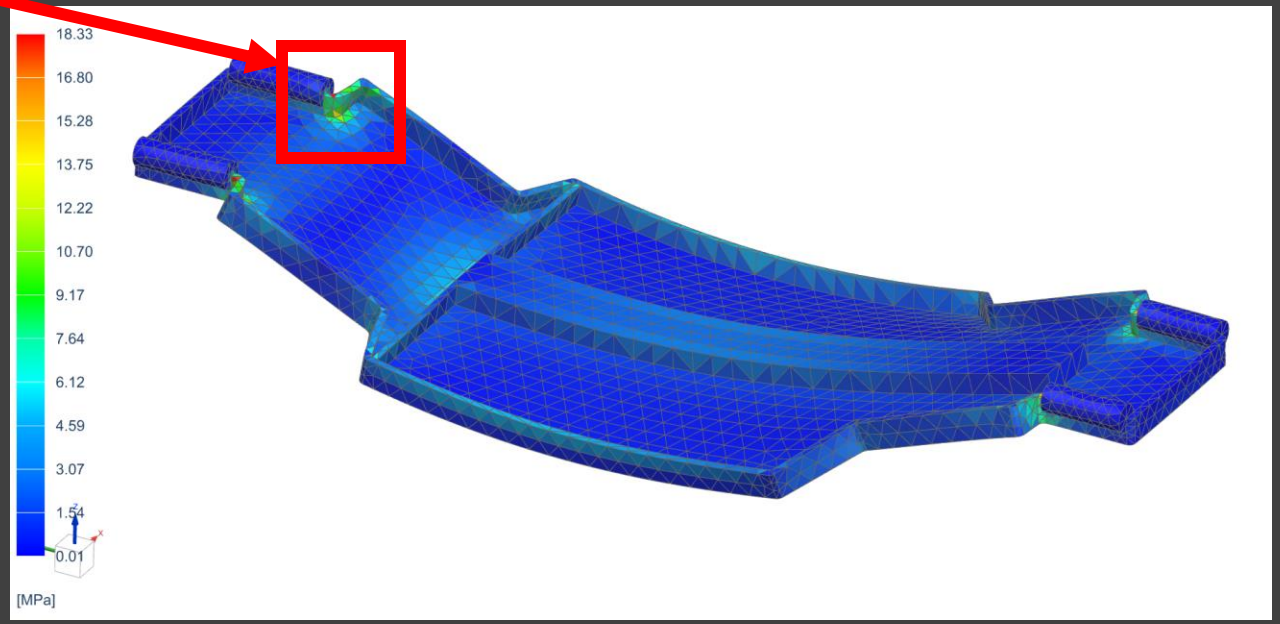
CHASSIS - RESULTS

Displacement



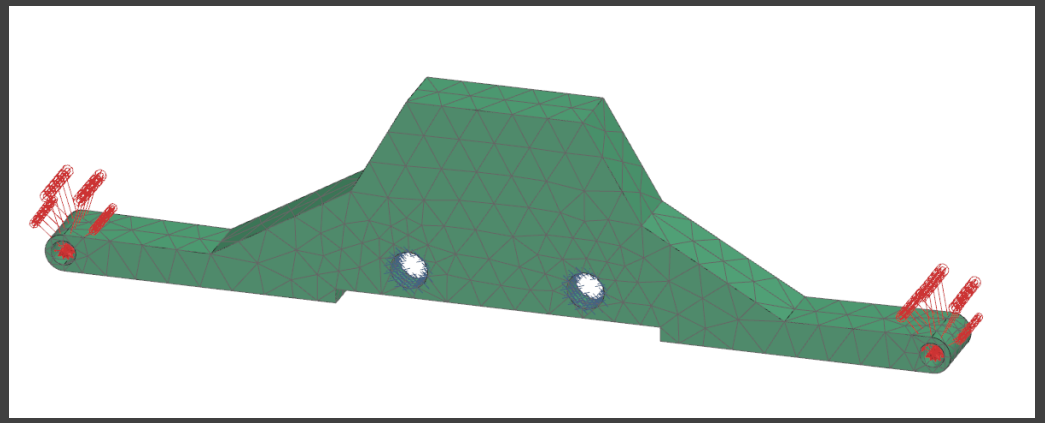
Von Mises

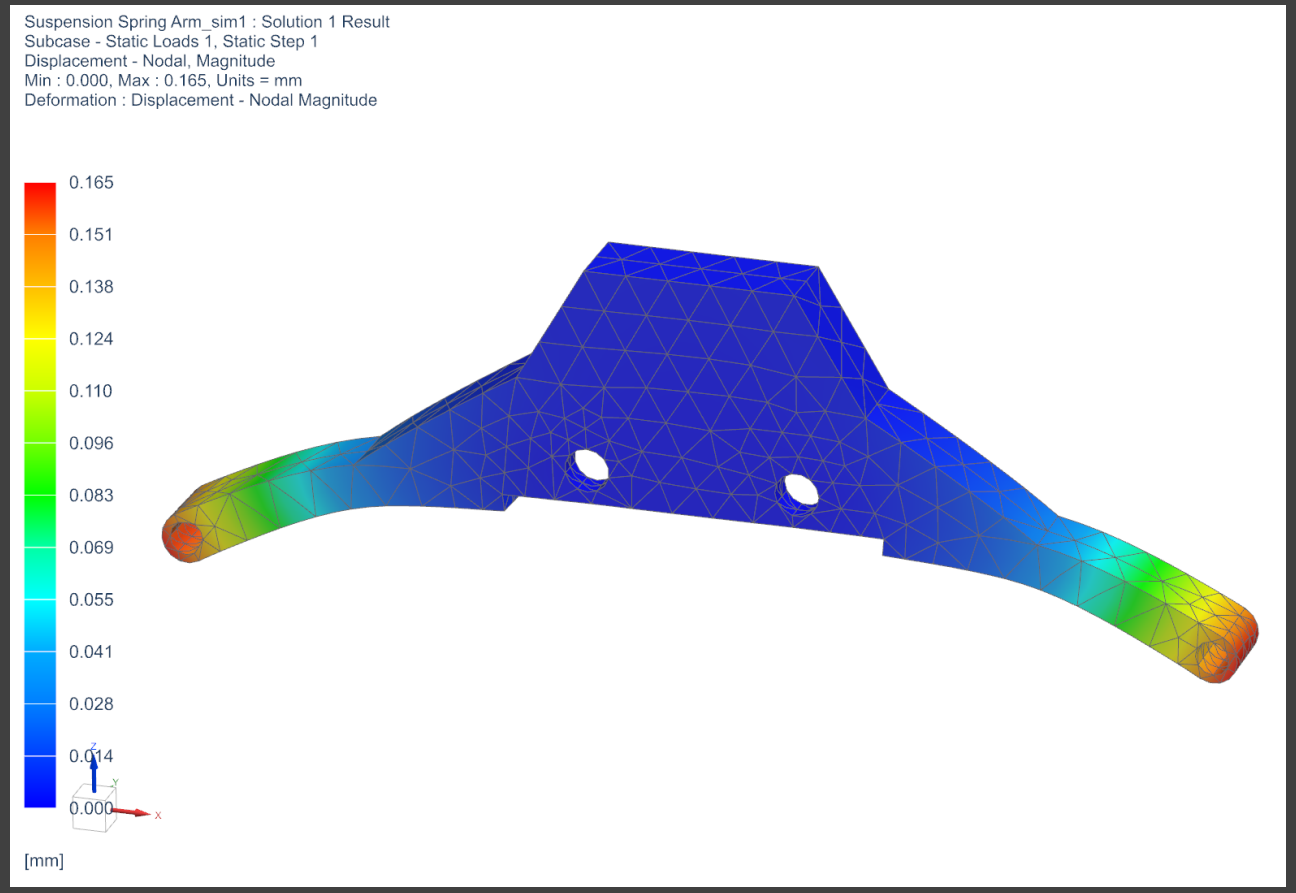
Stress Concentration



SUSPENSION SPRING ARM (PART)

- Key component of suspension supporting forces from wheels
- 5N on each arm, fixed bolt holes
- Max Deflection of **0.165 mm** (acceptable)

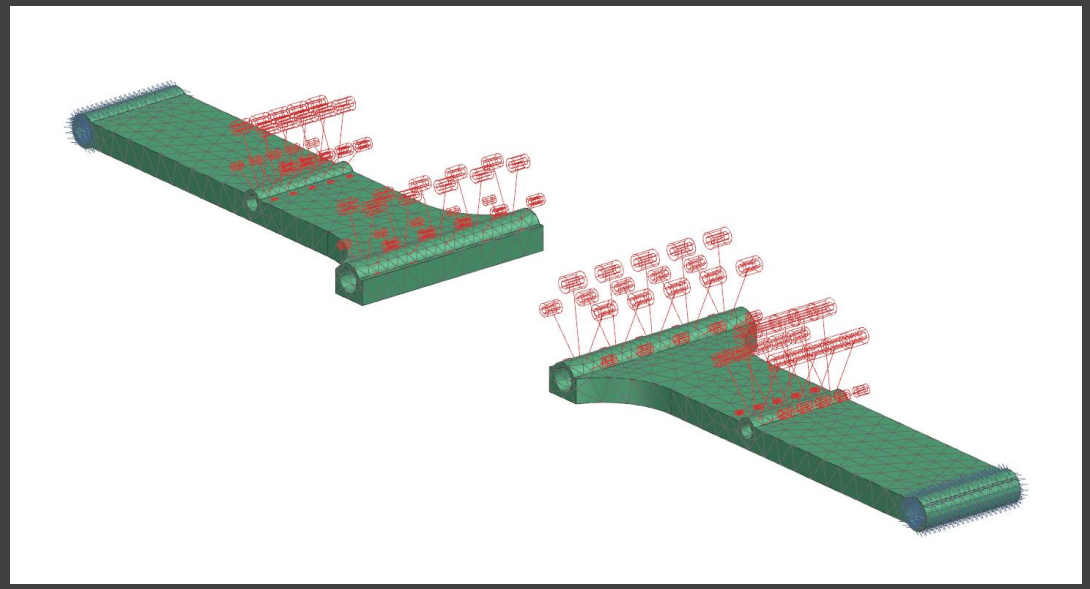


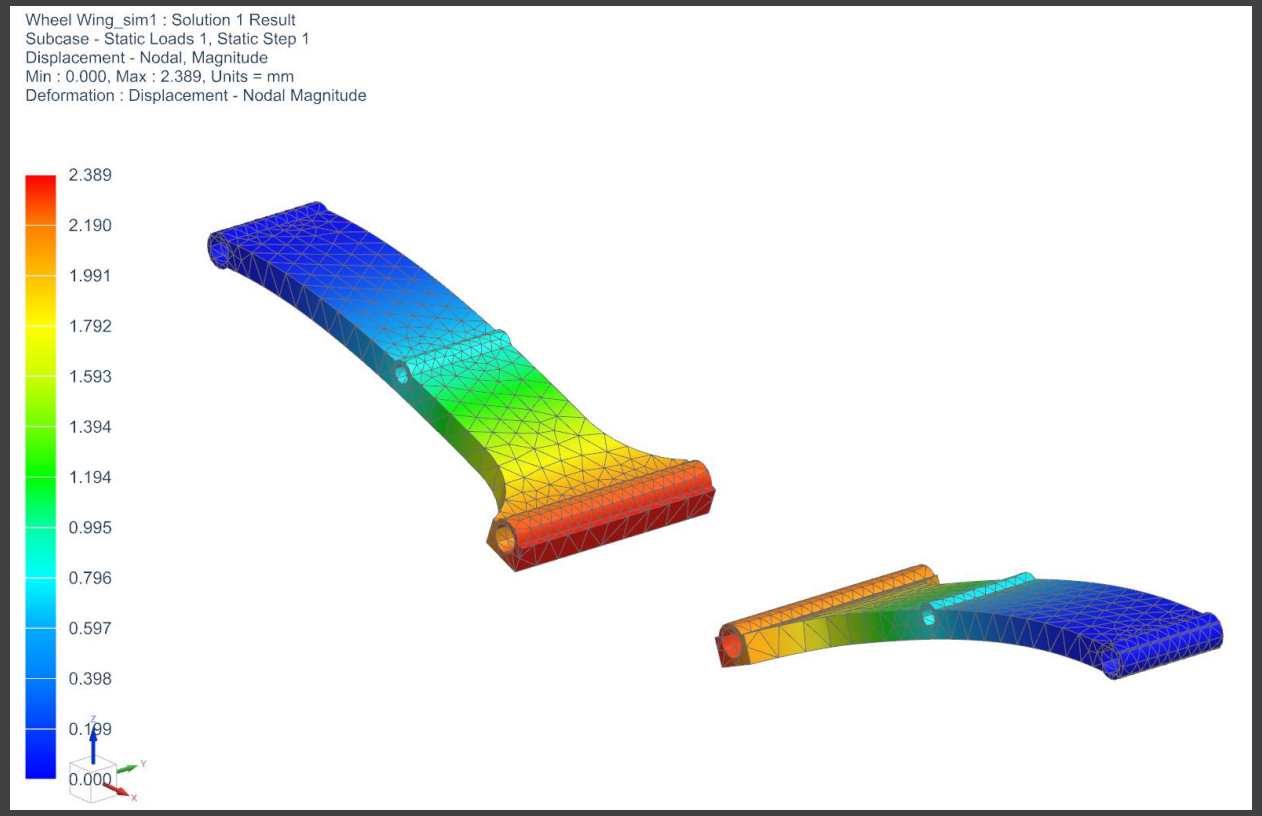


(Displacement)

WHEEL WING (PART)

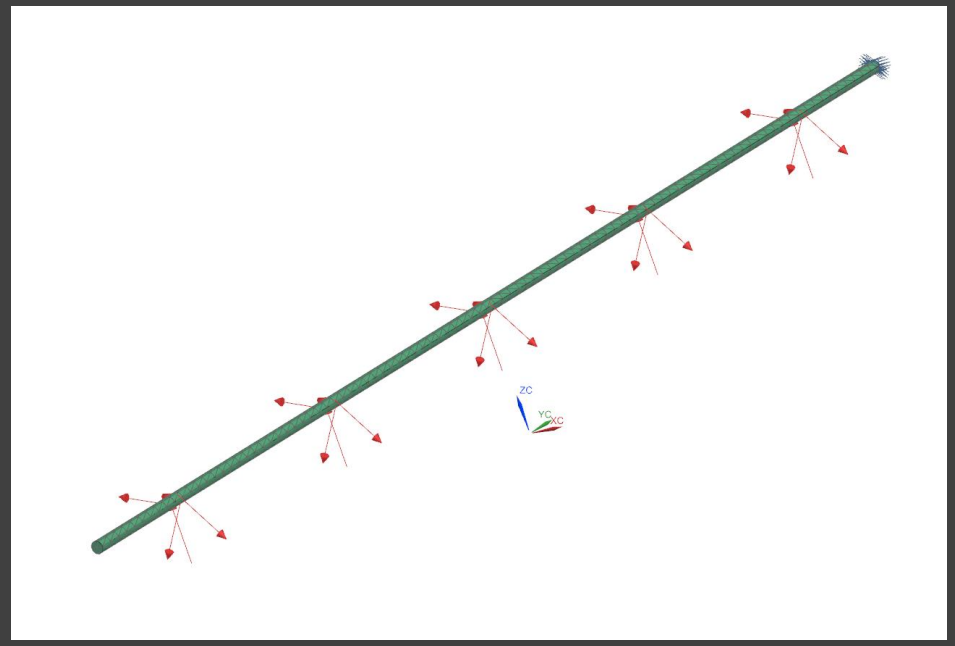
- Flexible element of suspension
- 5N on inner and middle holes
- Fixed outer hole
- Max Deflection of **2.4** mm (acceptable)

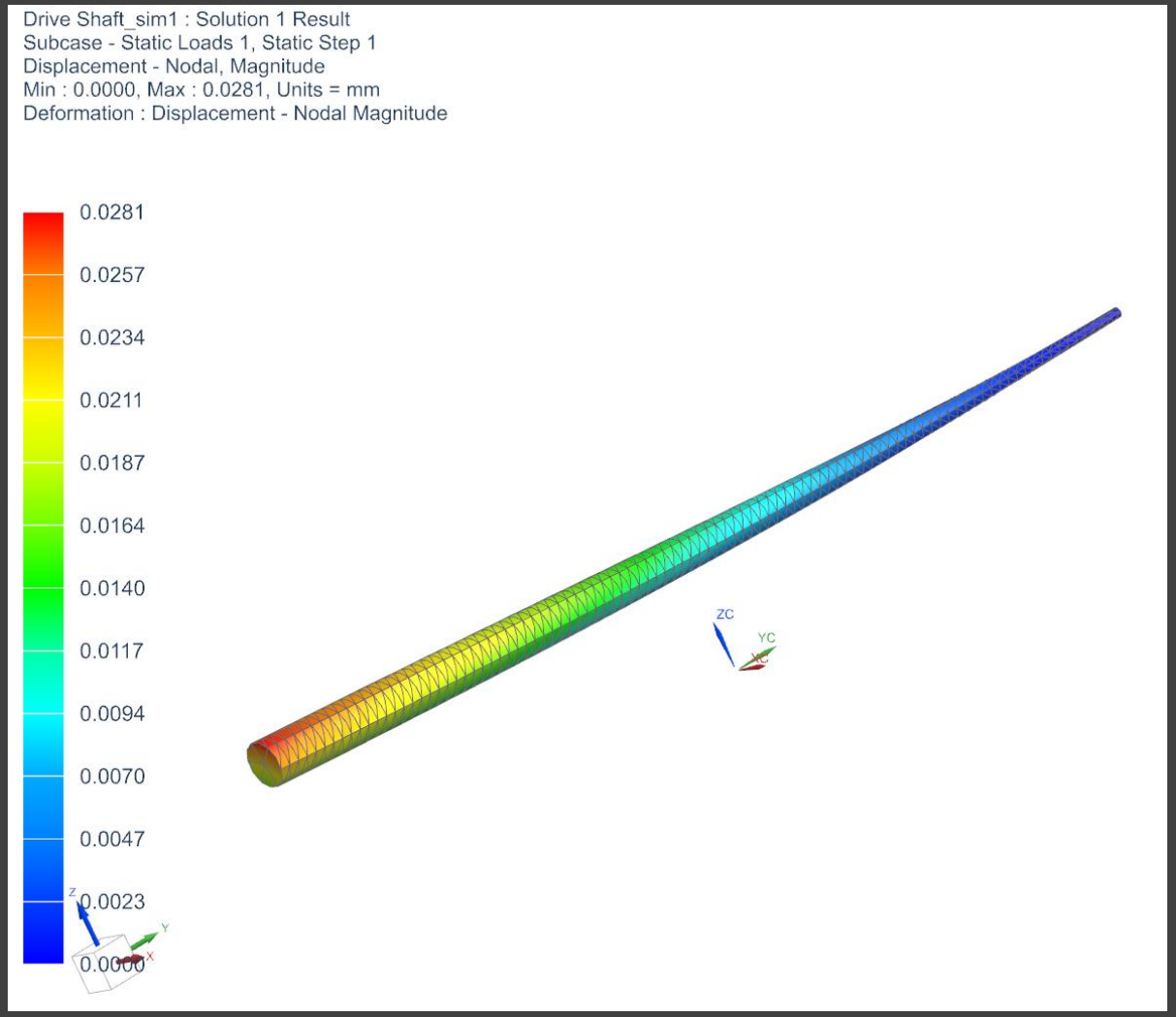




DRIVE SHAFT (PART)

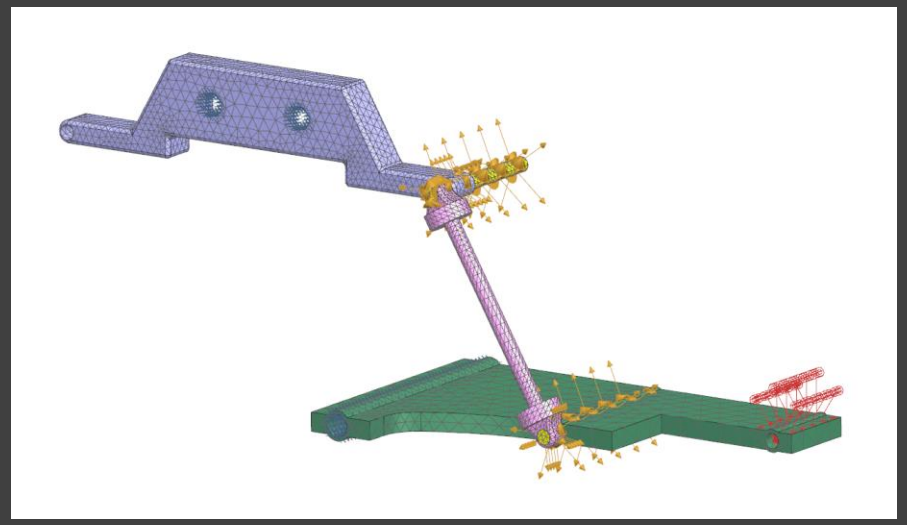
- Important torque bearing component for steering
- Max Deflection of **0.03** mm (acceptable)

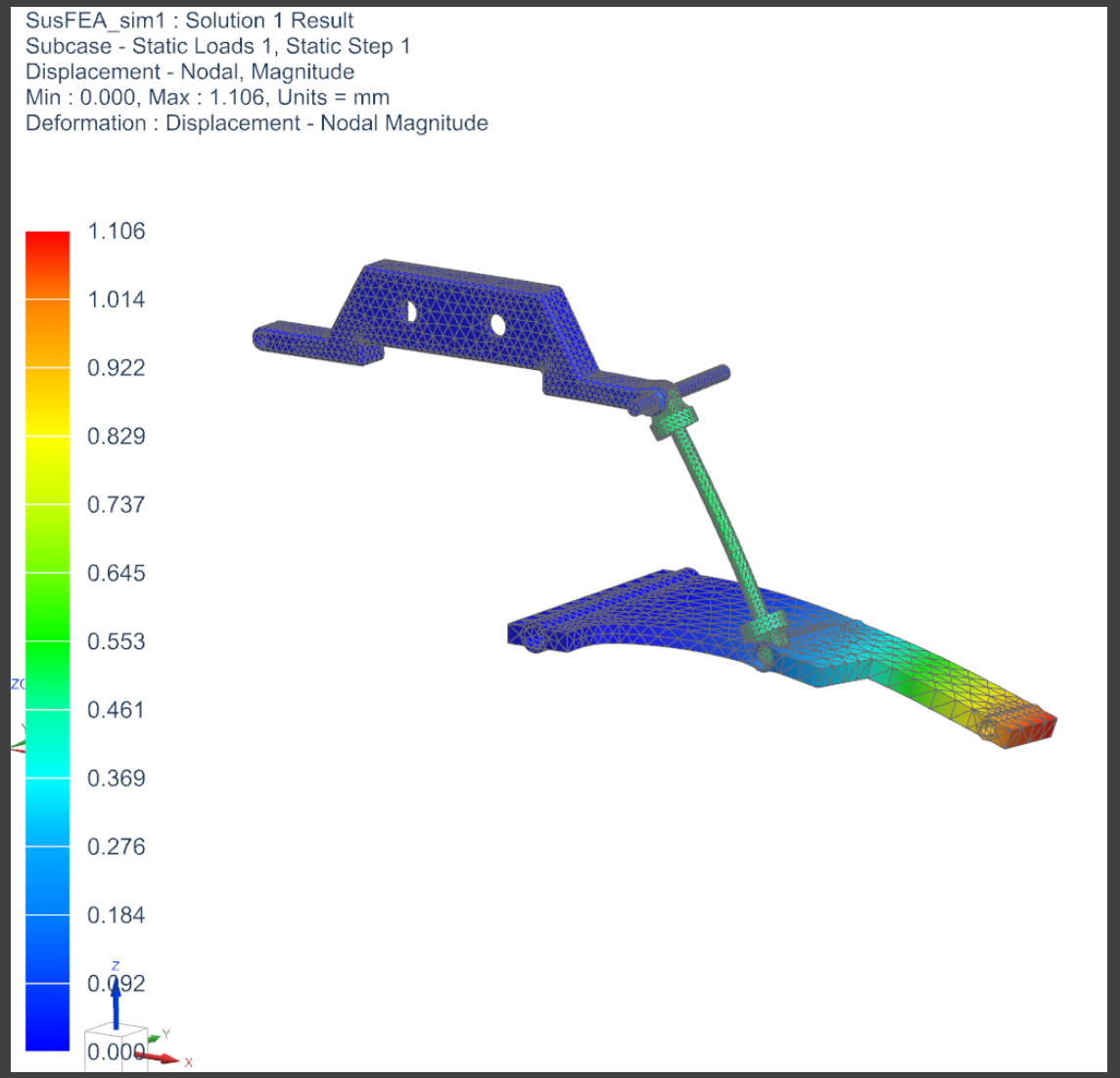




SUSPENSION ASSEMBLY

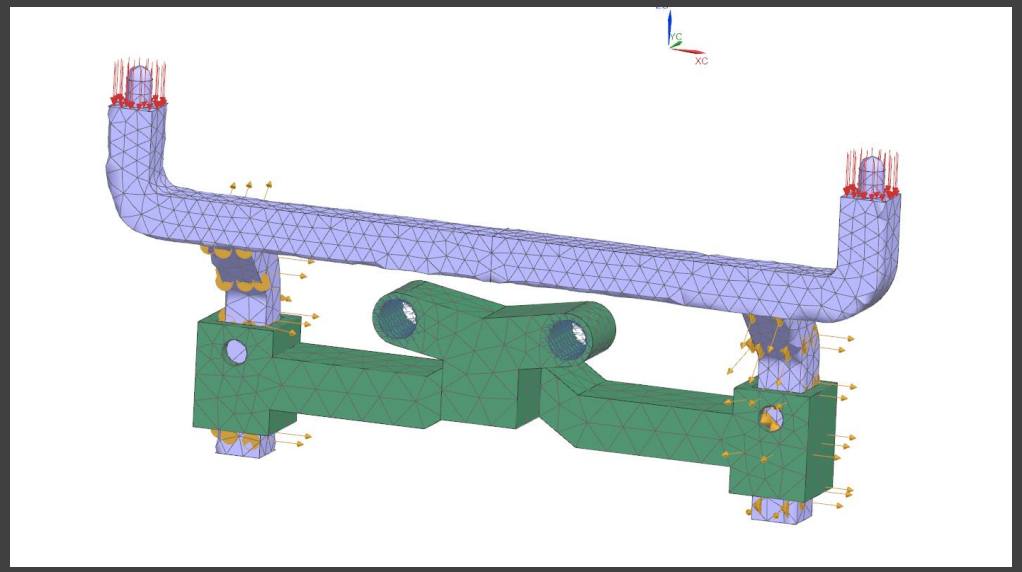
- To check if loads can be properly supported with selected materials
- 5N force to simulate quarter of car's weight
- Utilizing symmetry for simplification
- Max deflection of 1.1 mm in wheel wing (acceptable)

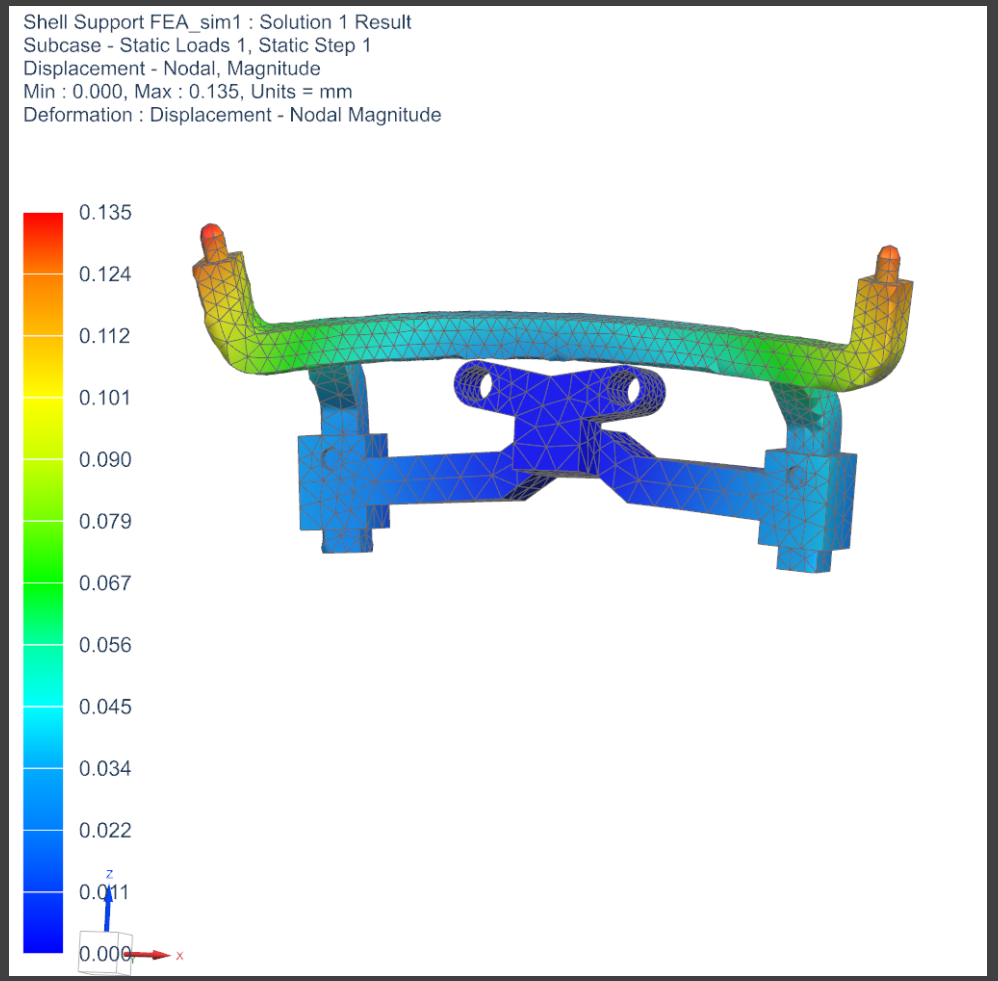




SHELL SUPPORT ASSEMBLY

- To check if shell can be supported
- 2N applied
- Max deflection of 0.135 mm (acceptable)





CFD

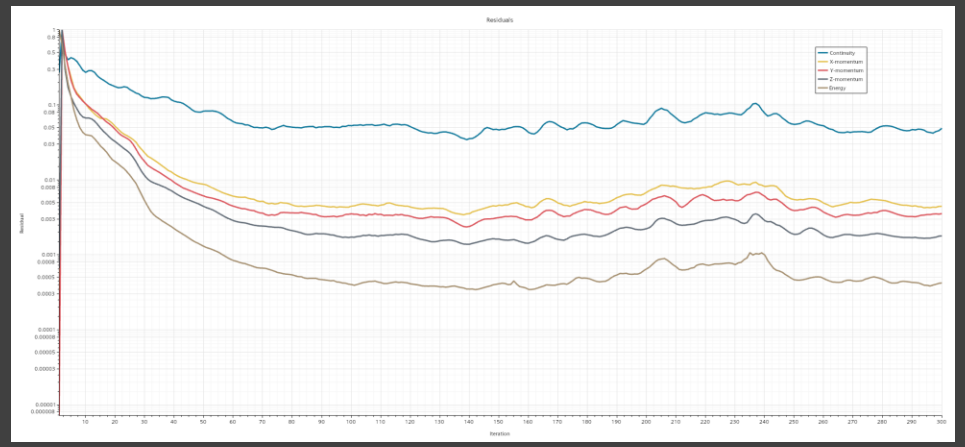
Goal: Reduce the drag force while still maintaining the visual design of the Hot Rod

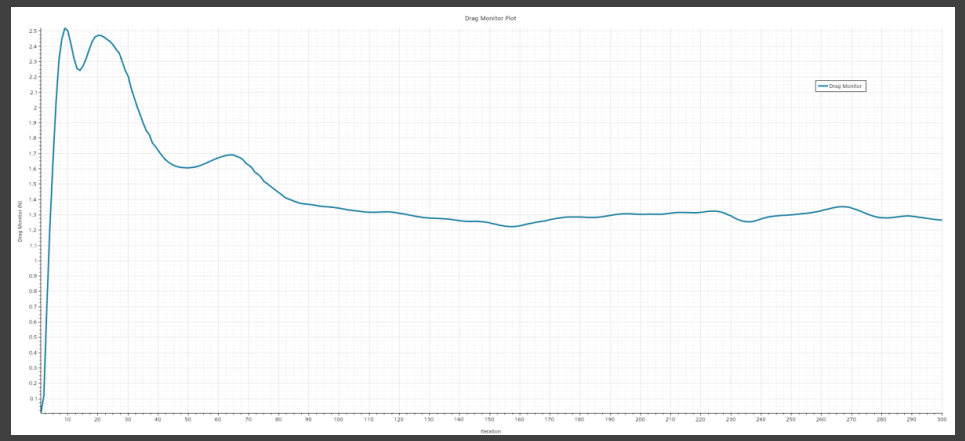
CFD (MAIN SHELL)

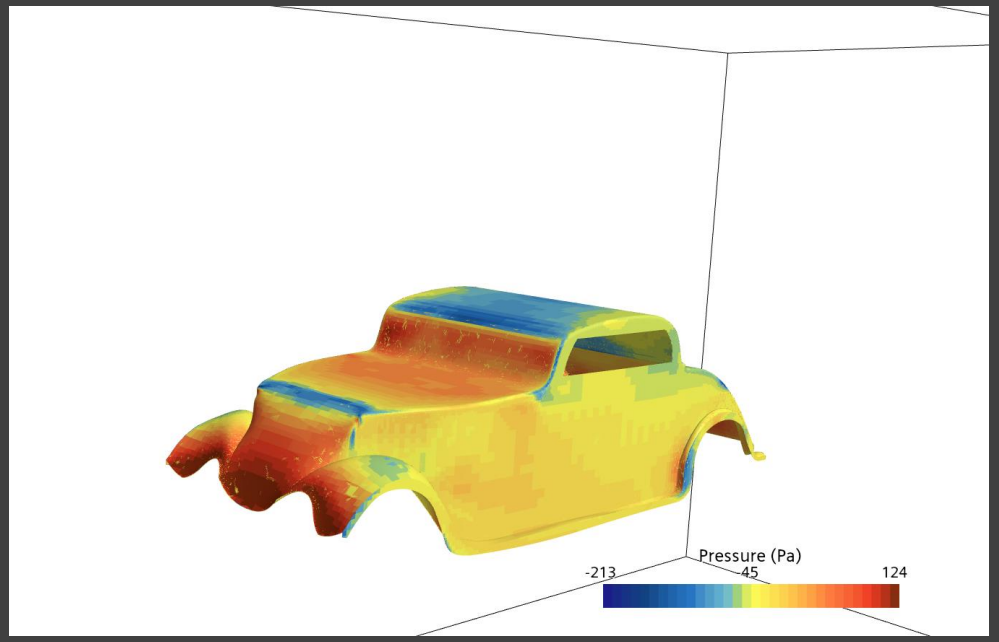
Measured: Drag force

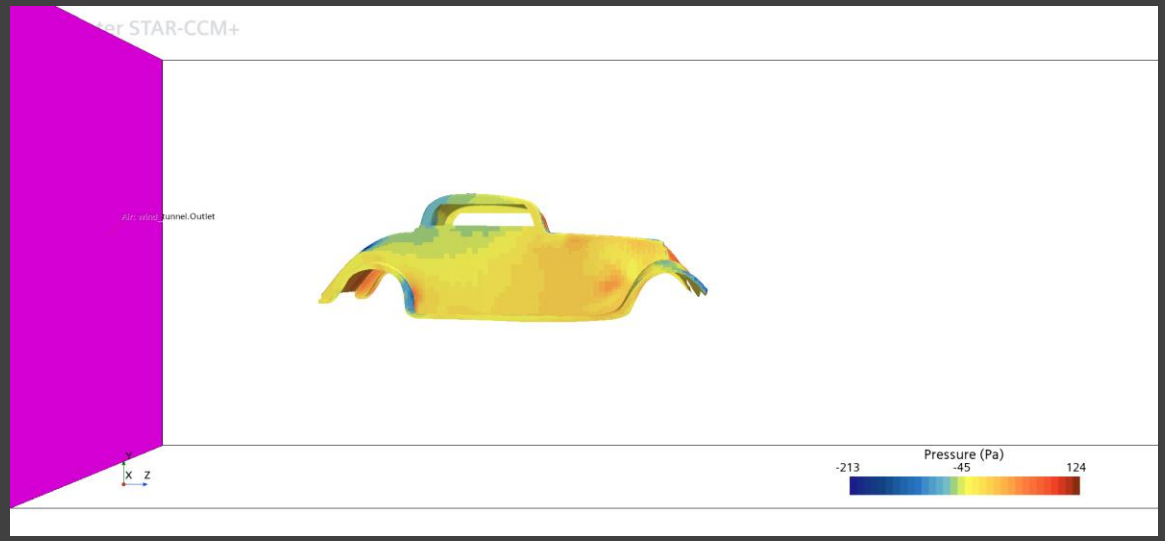
Speed: 30 MPH

Drag Force: 1.3 N







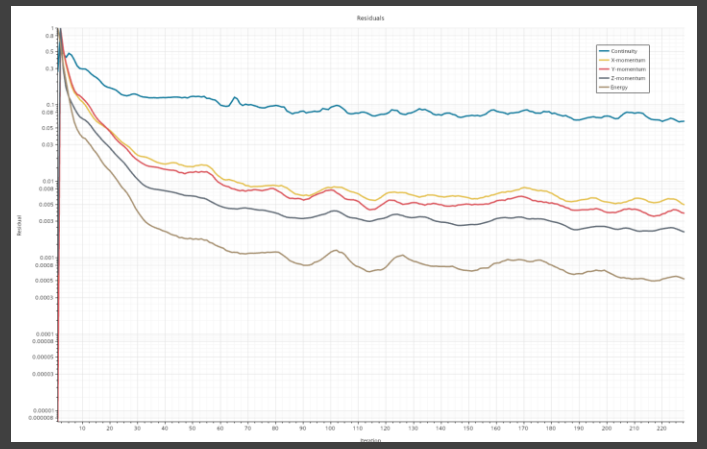


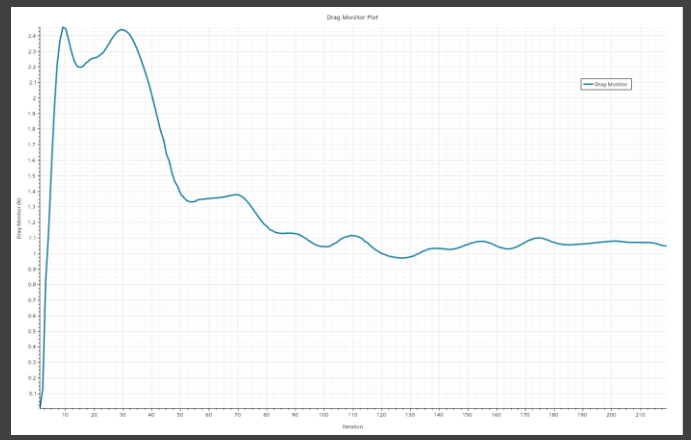
CFD (SECOND SHELL)

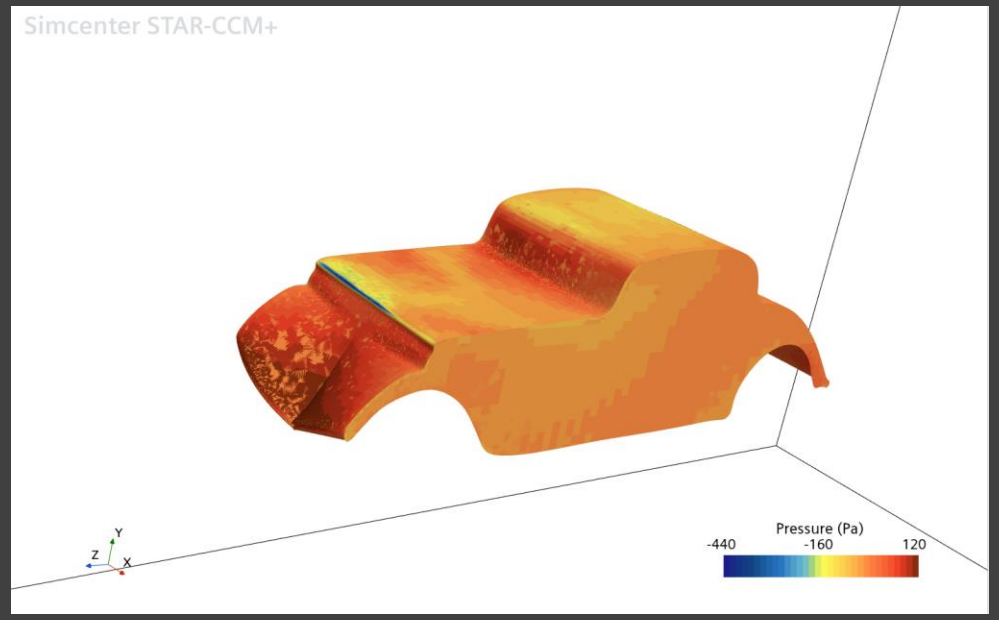
Measured: Drag force

Speed: 30 MPH

Drag force: 1.4 N





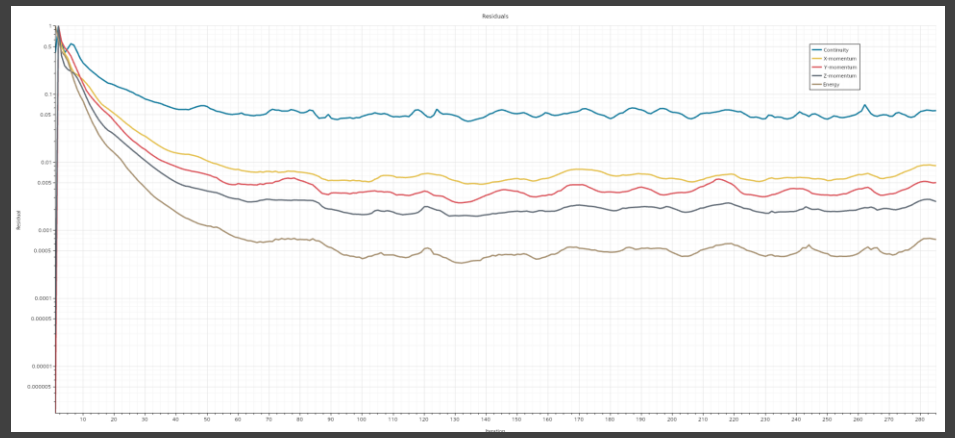


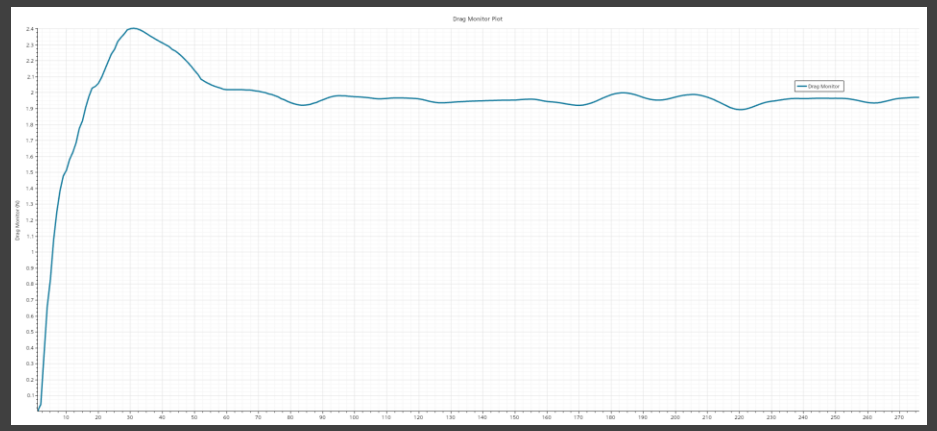
CFD (MODIFIED SHELL)

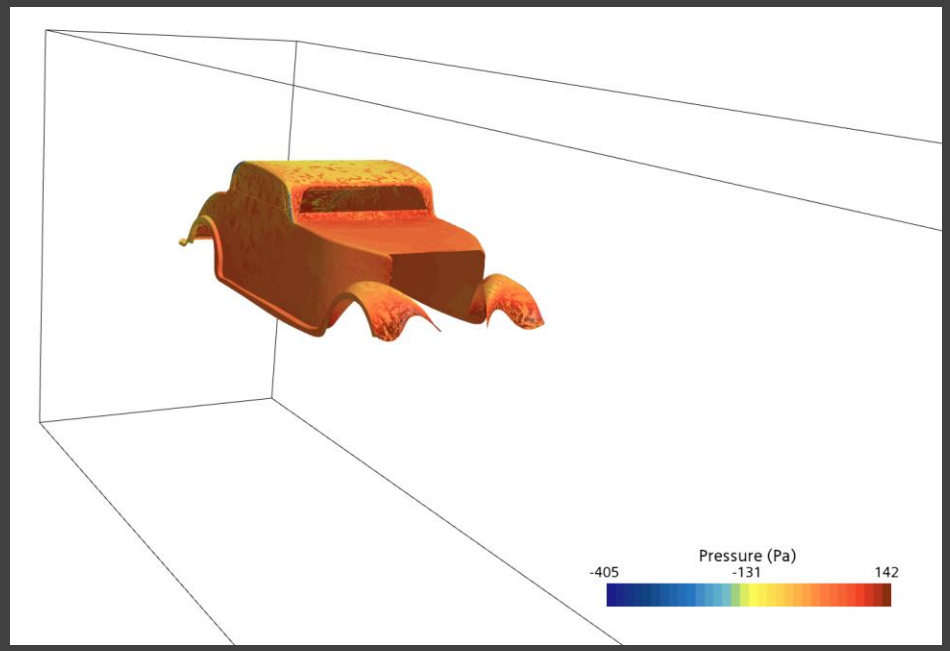
Altered Shell w/o Grill and Windshield

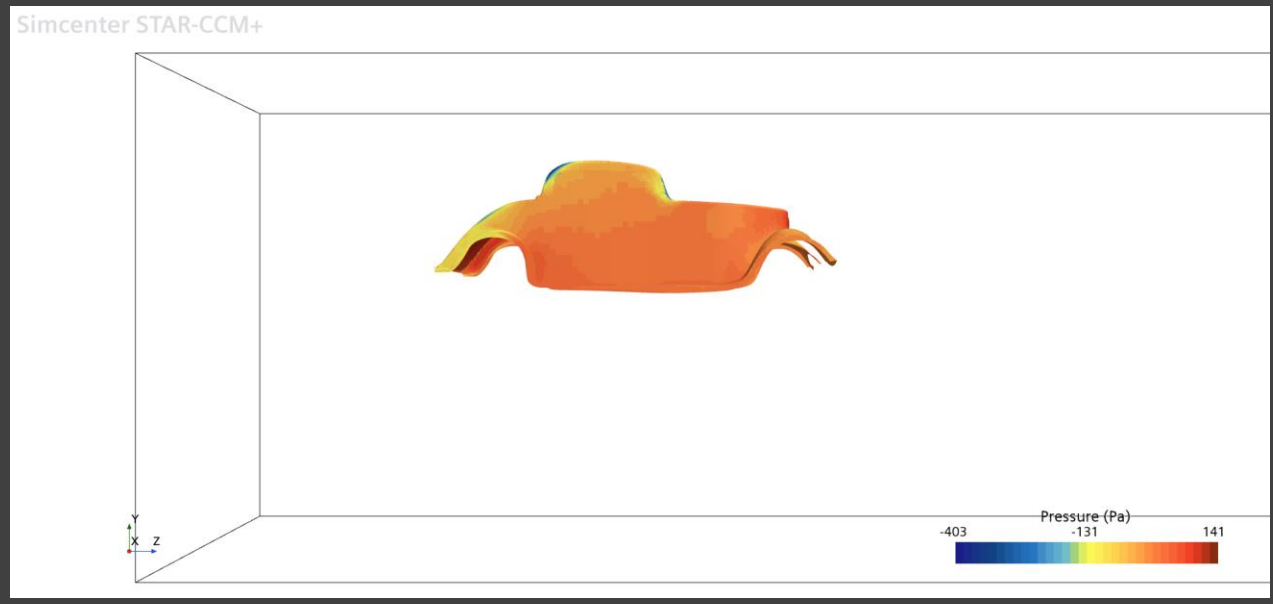
Measured: Drag force [2.0 N]

Speed: 30 MPH







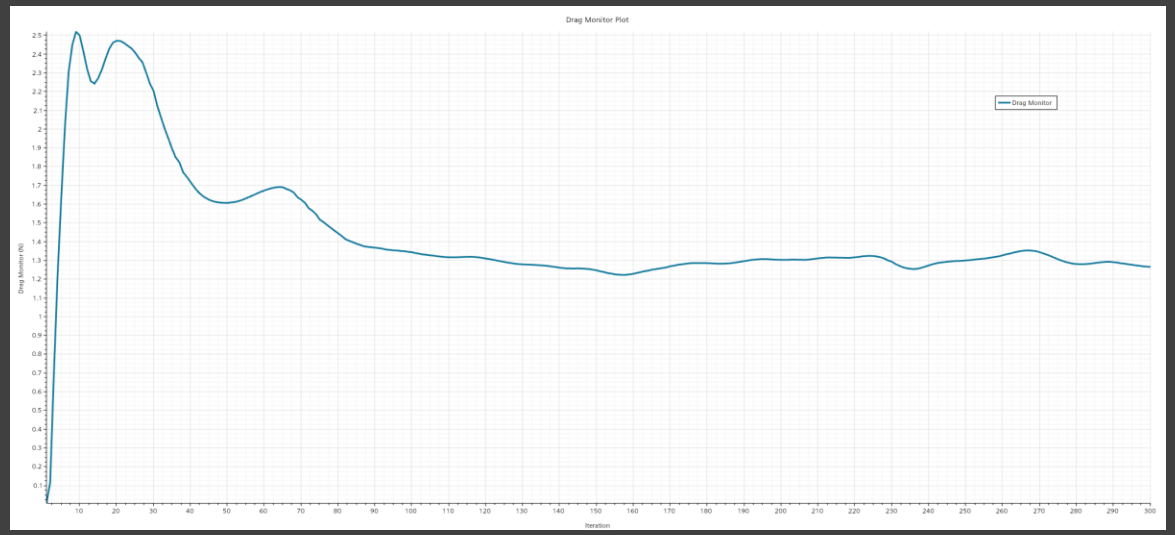


CFD - IMPACT

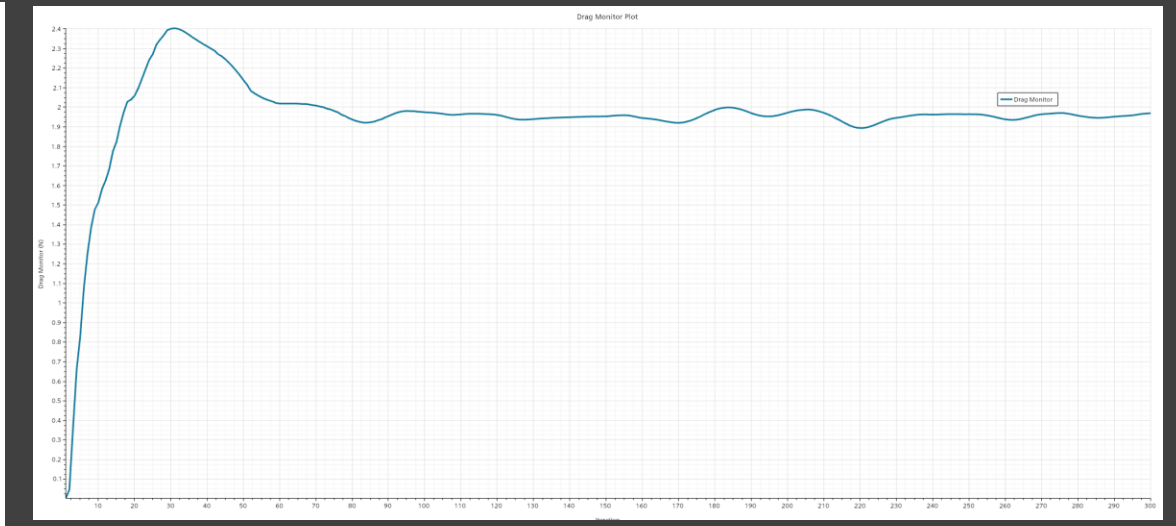
Designed Grill is better for drag force

Drag force: 1.3 Newtons

Removing the grill and windshield results in weight savings but drastically increase the drag force from 1.3 Newtons to 2.0 Newtons



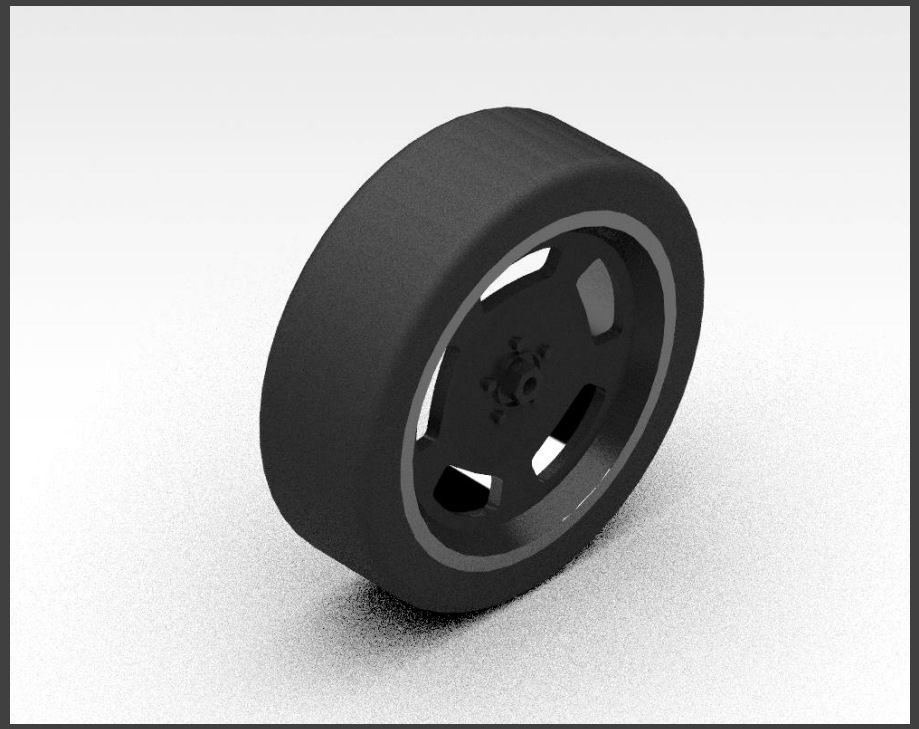
Designed Shell

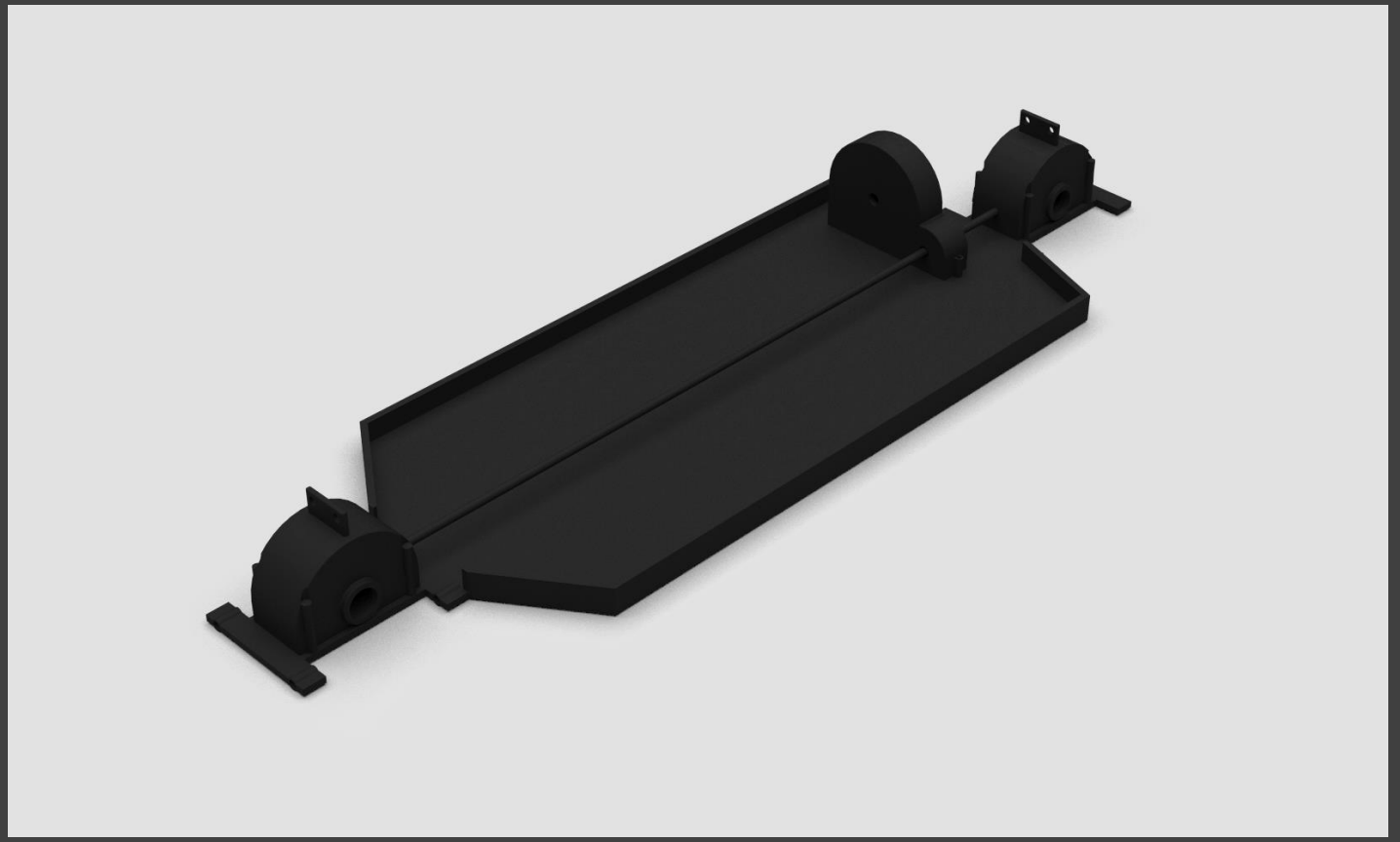


Modified (No grill) Shell

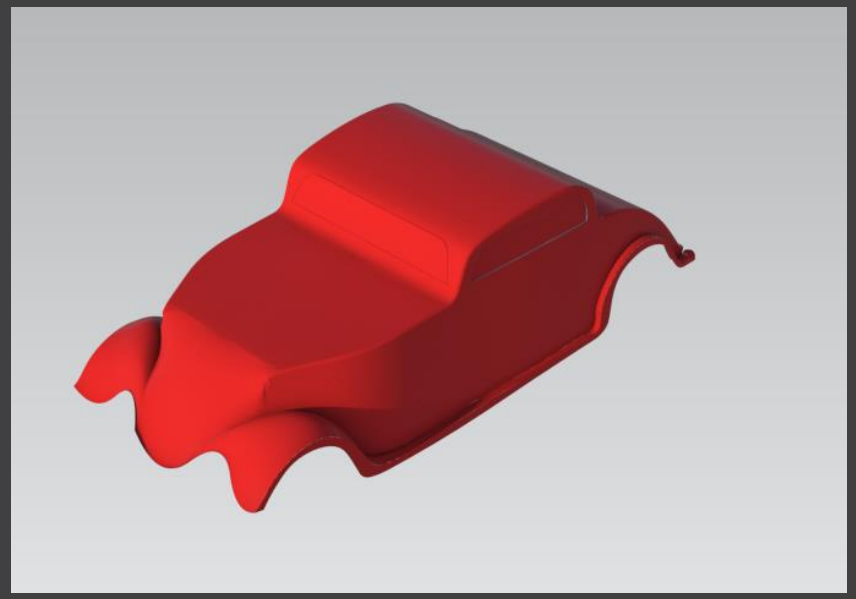
3. Visualization

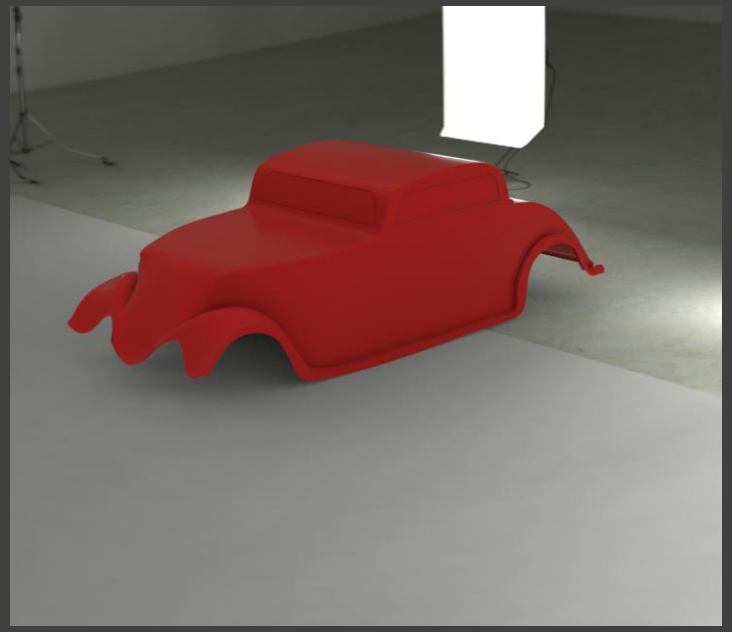
PART VISUALIZATIONS

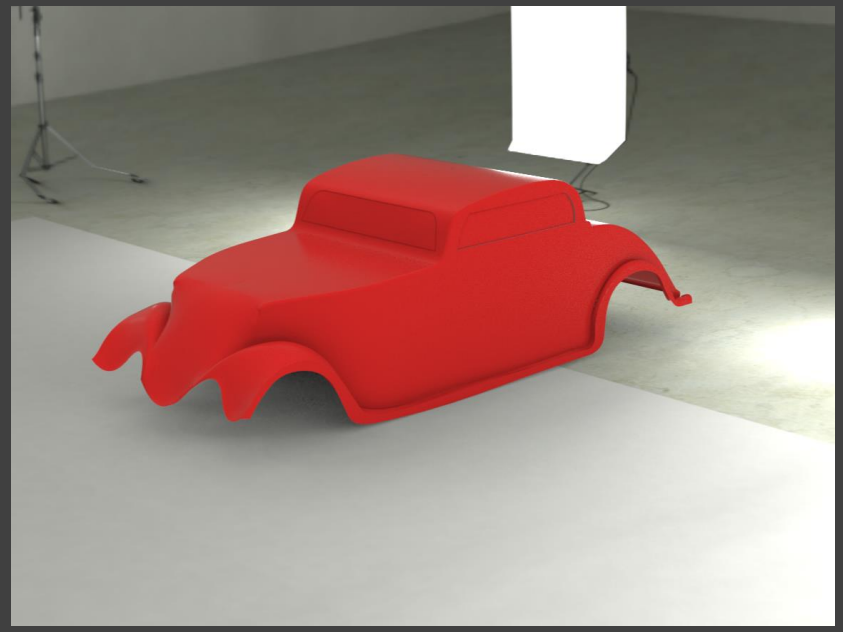




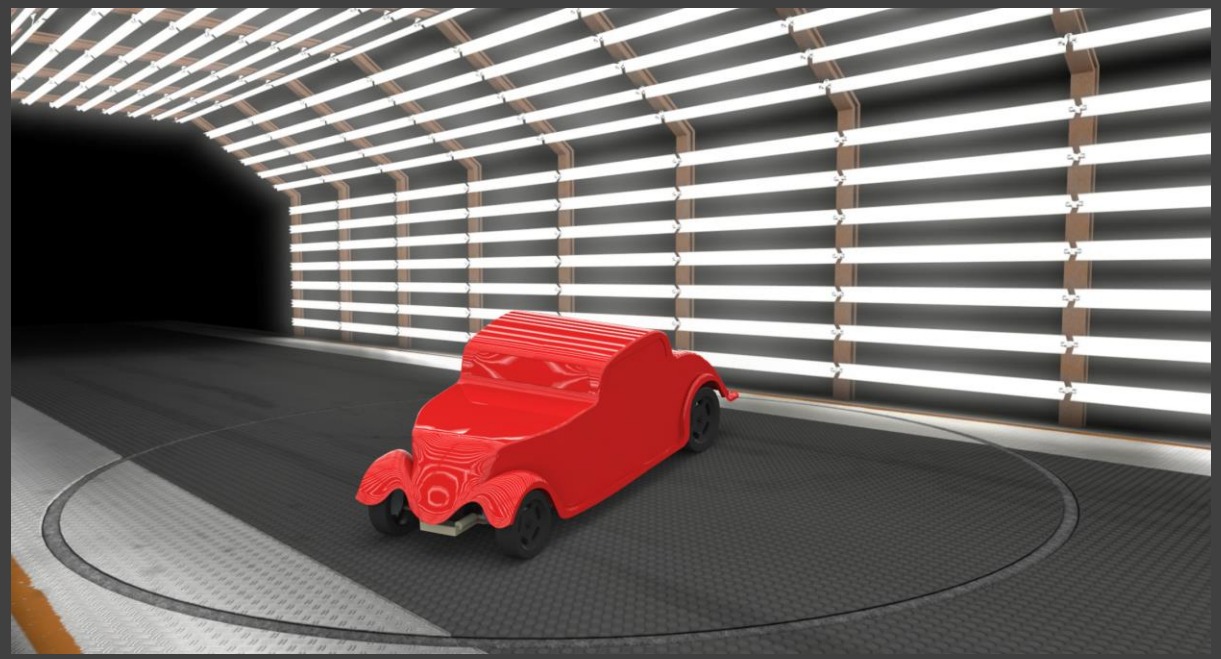
SHELL VISUALIZATION

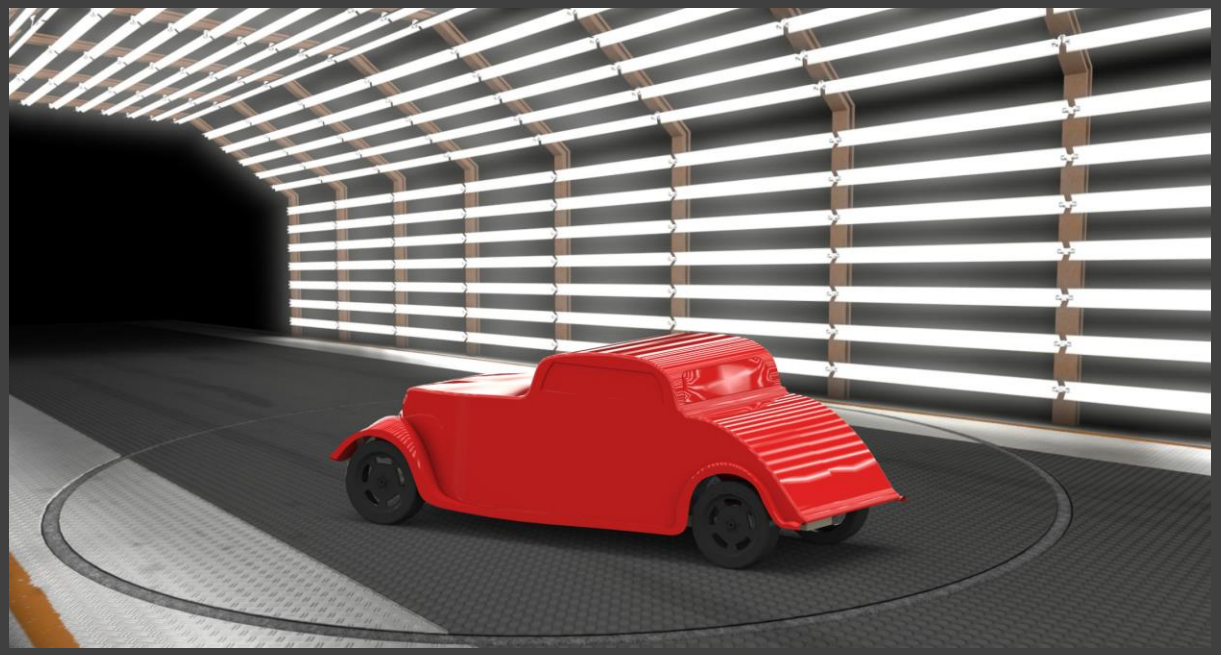






FULL CAR VISUALIZATION





FULL CAR VISUALIZATION

FULL CAR VISUALIZATION

ACCOMPLISHMENTS AND DIFFICULTIES

Accomplishments:

- Experience with complex CAD modeling
- Successful simulations (Optimization, CFD, FEA)
- Reducing mass on certain parts
- Reverse engineering

Difficulties:

- Time constraint
- Suspension and drivetrain modeling and parametrization
- Unknown fatal CAD errors


THANK YOU!