

Texas Tech University

Computational Techniques

ME 3264-301

Group 2

Project 2:Aerodynamic Design of an SUV Vehicle

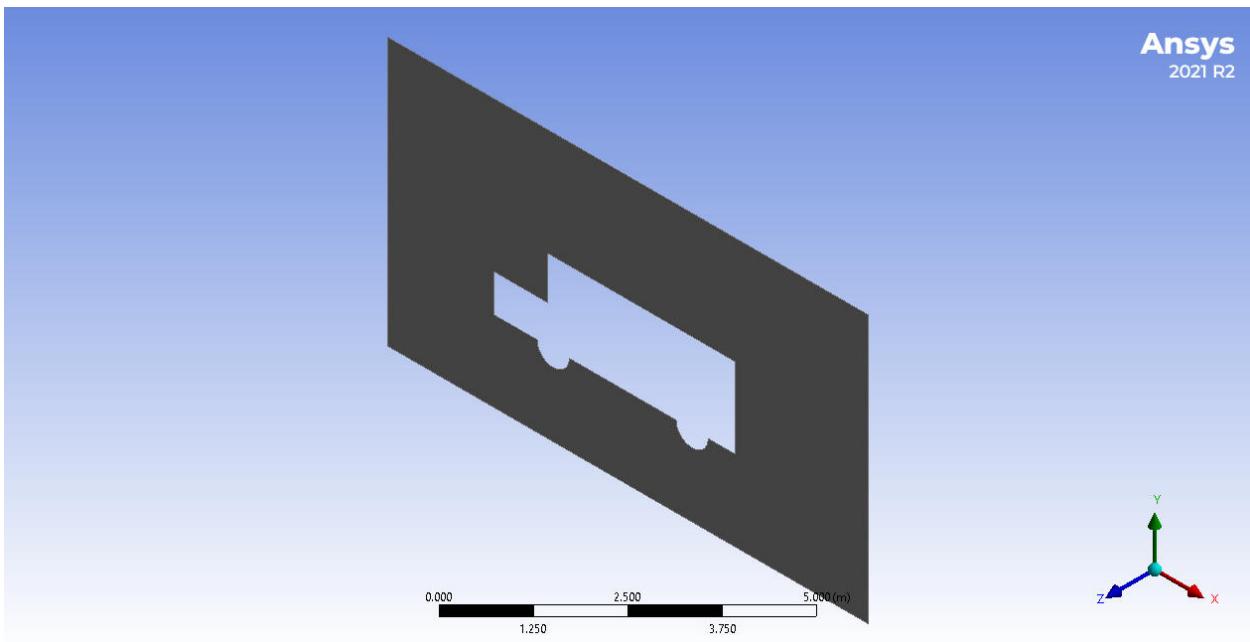
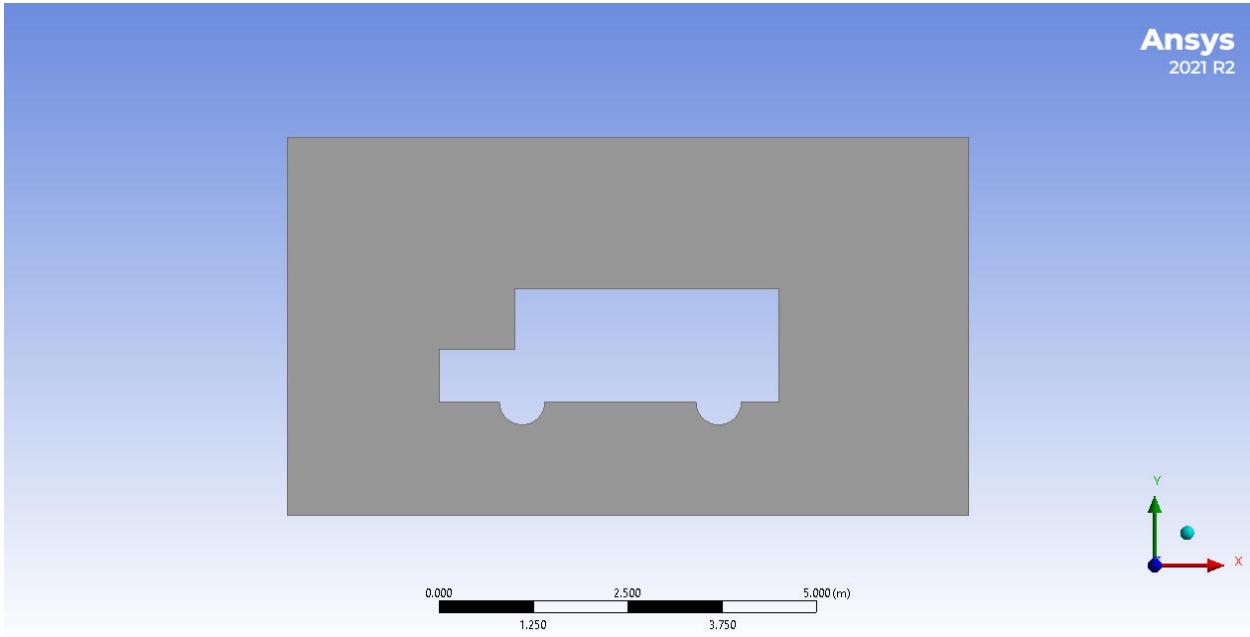
Trey Vela - Pinak Bhuban - Dane McMahon-Dawson Abernethy

Professor: Rabin Dhakal

Initial Design:

Creating a 2D analysis of the design with given dimensions of base car design and the wind tunnel (2x the length and height of car).

Geometric Design:

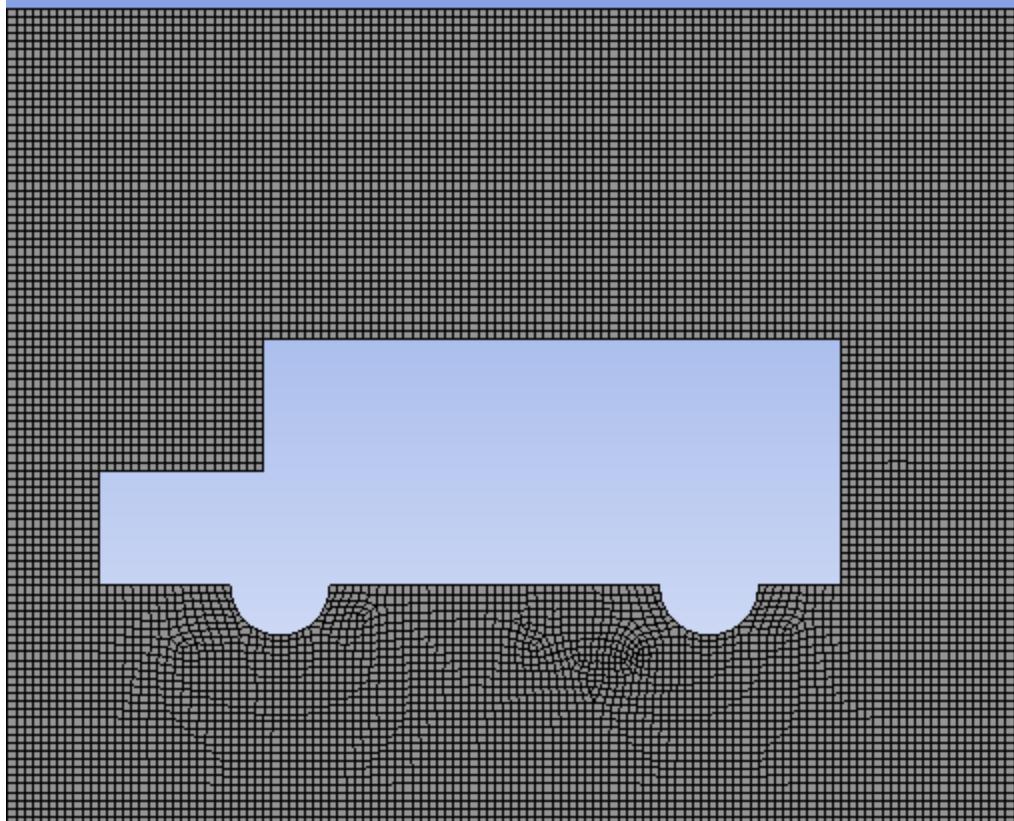


Meshing:

Ansys

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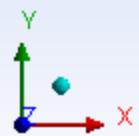


0.000



2.000 (m)

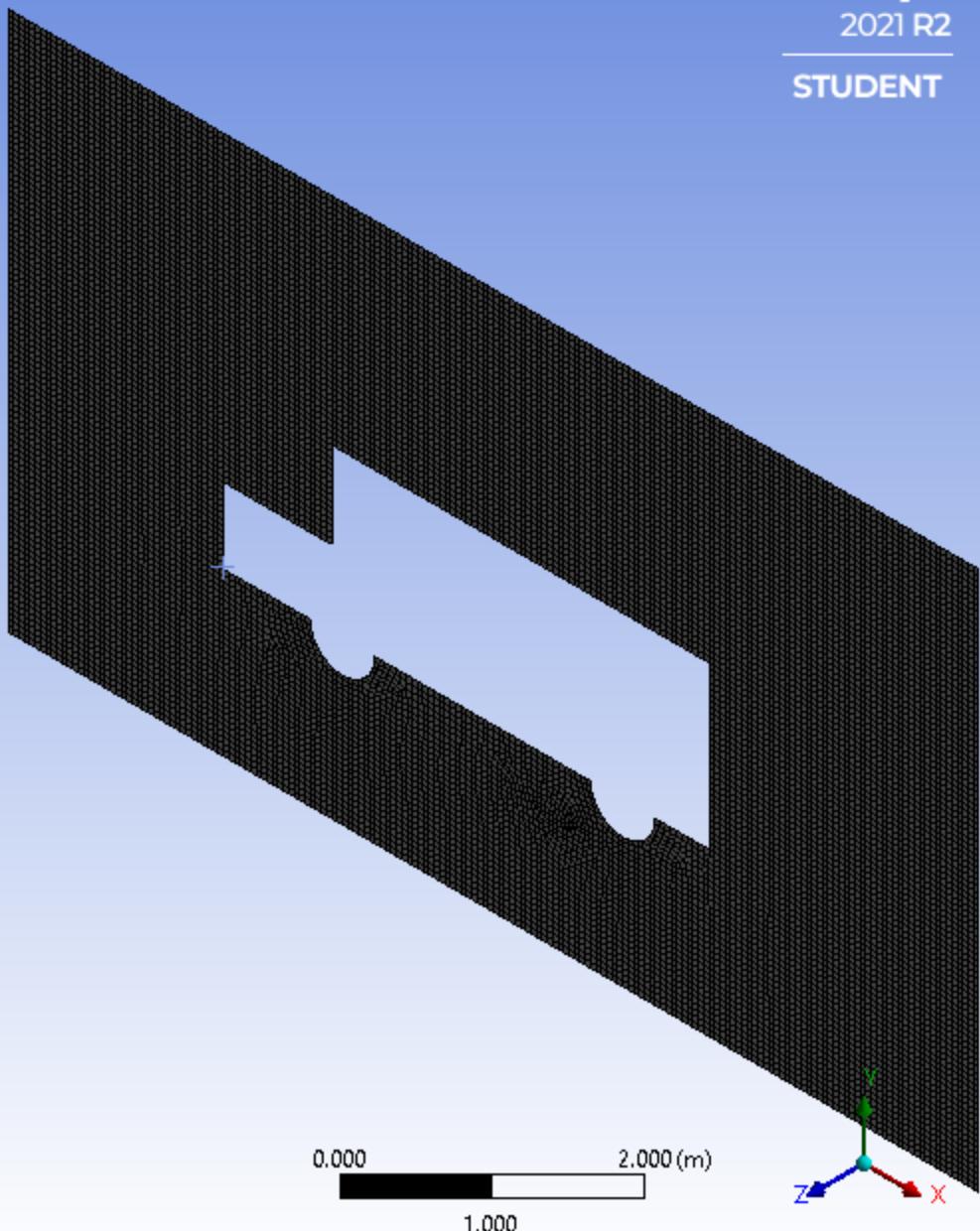
1.000



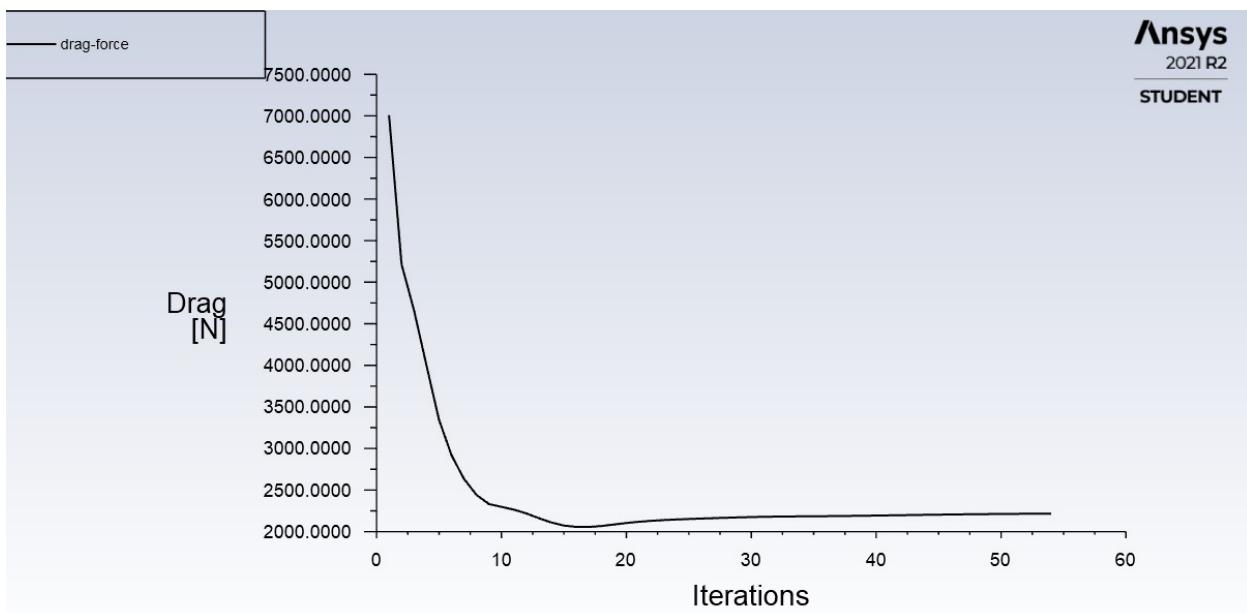
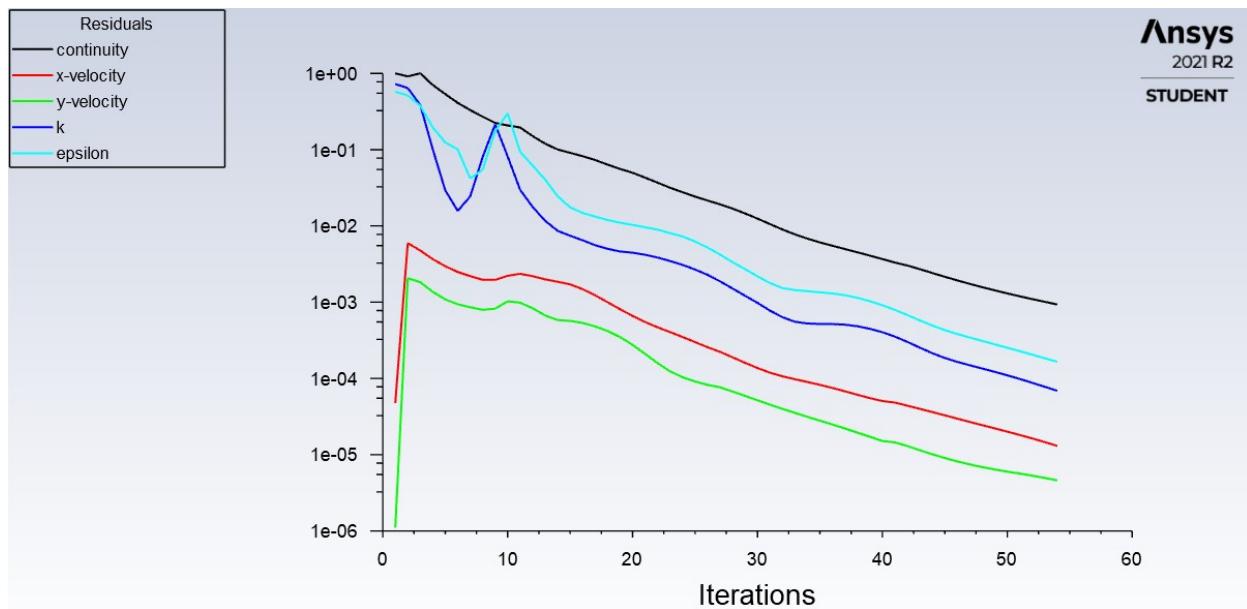
Ansys

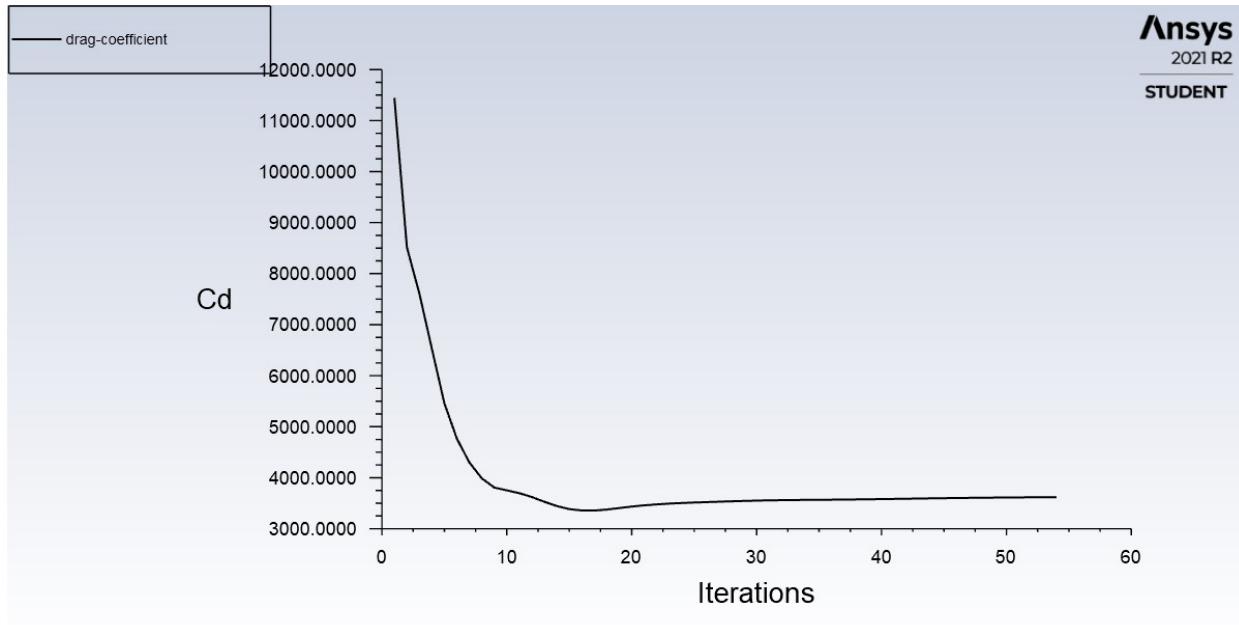
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Plots:



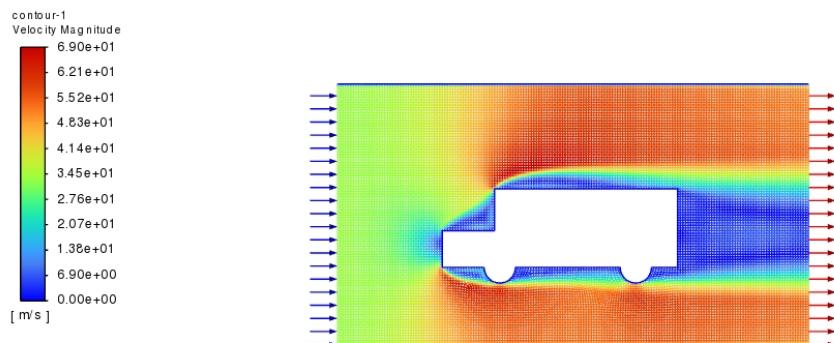


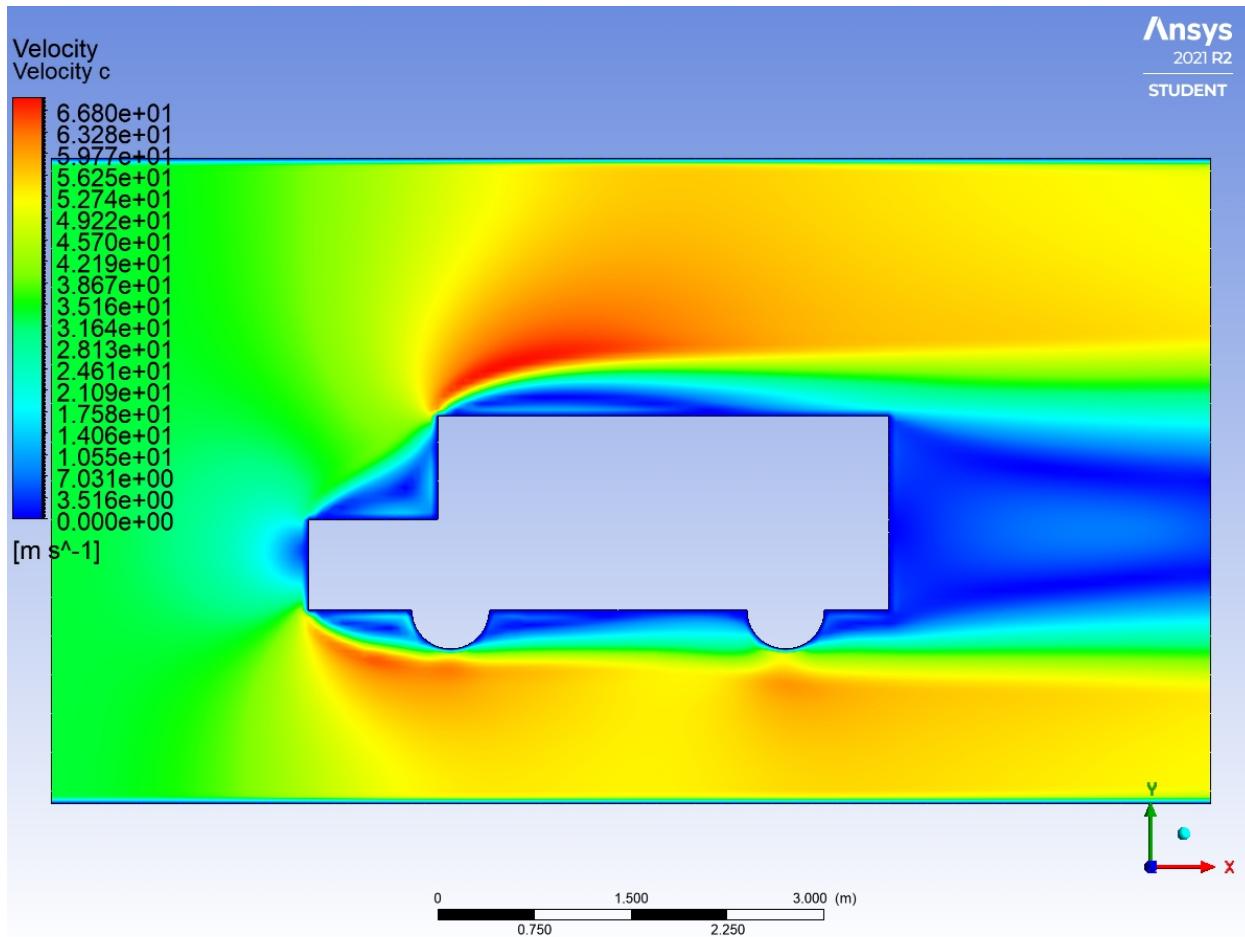
Ansys Fluent Analysis on the car at **120km/hr (33.33m/s ,through Air)** :

- **Drag Force:** 2216.3413 N
- **Drag coefficient :** 3.618.5164

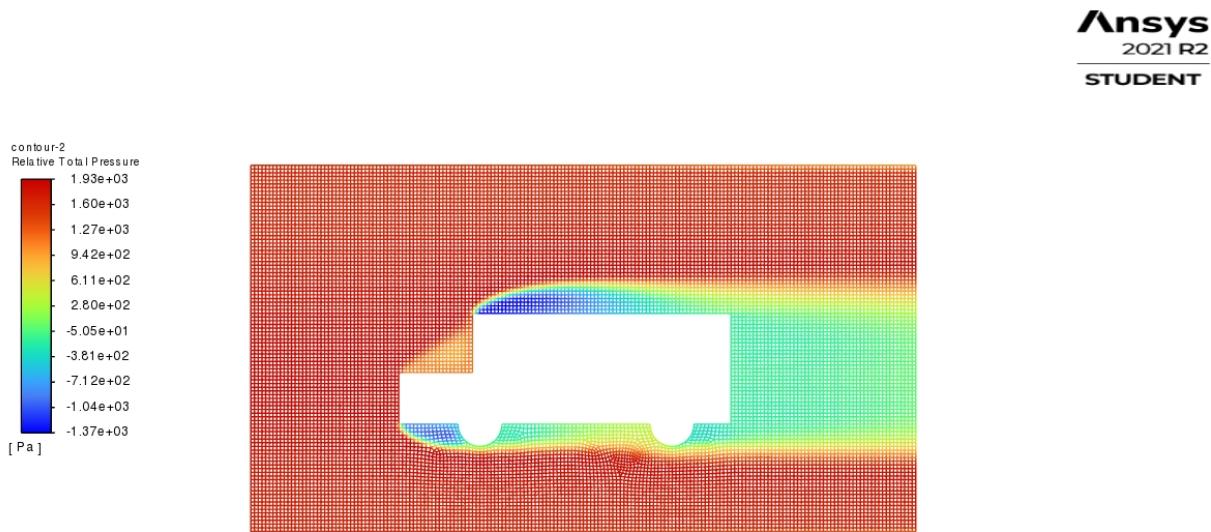
Velocity contour:

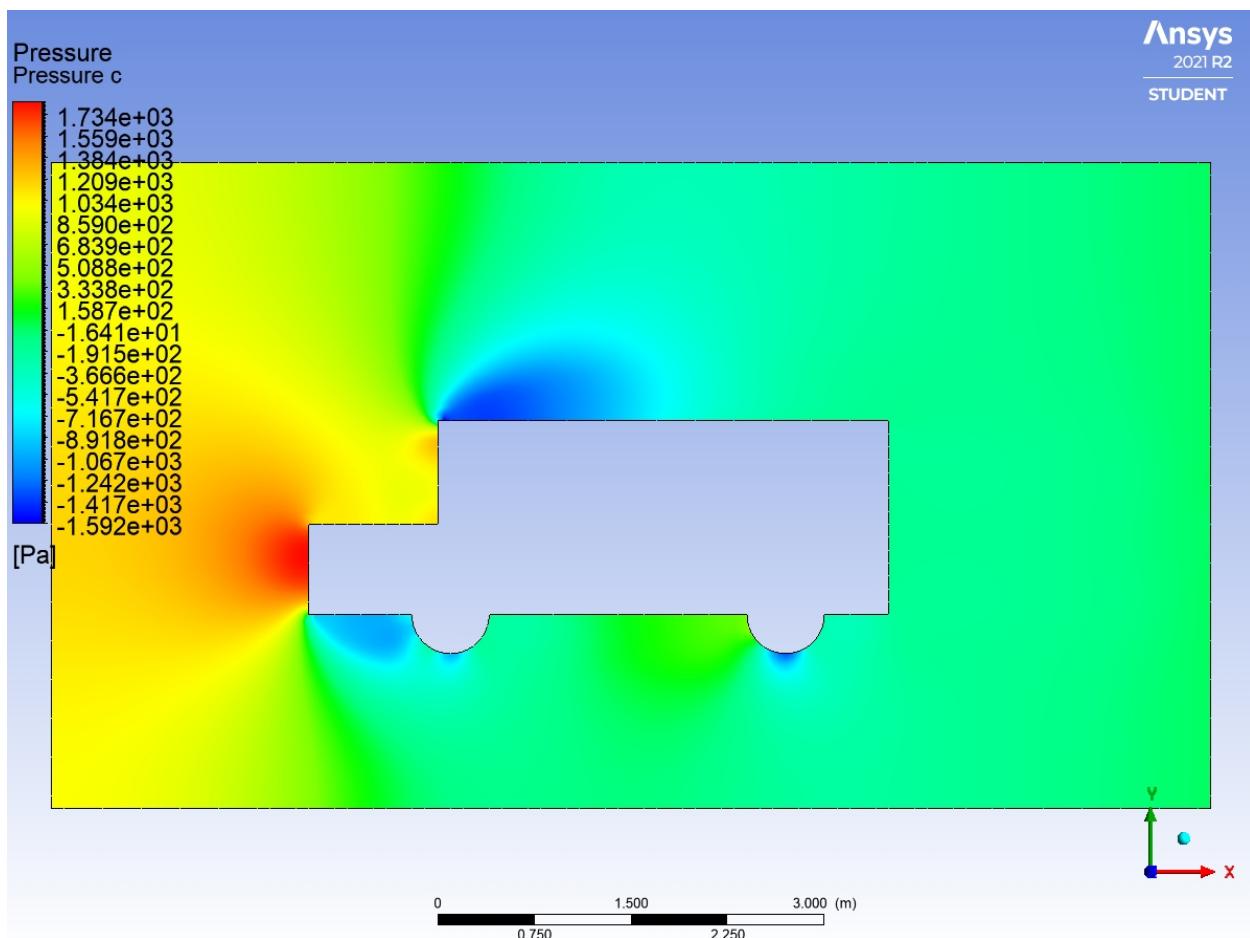
Ansys
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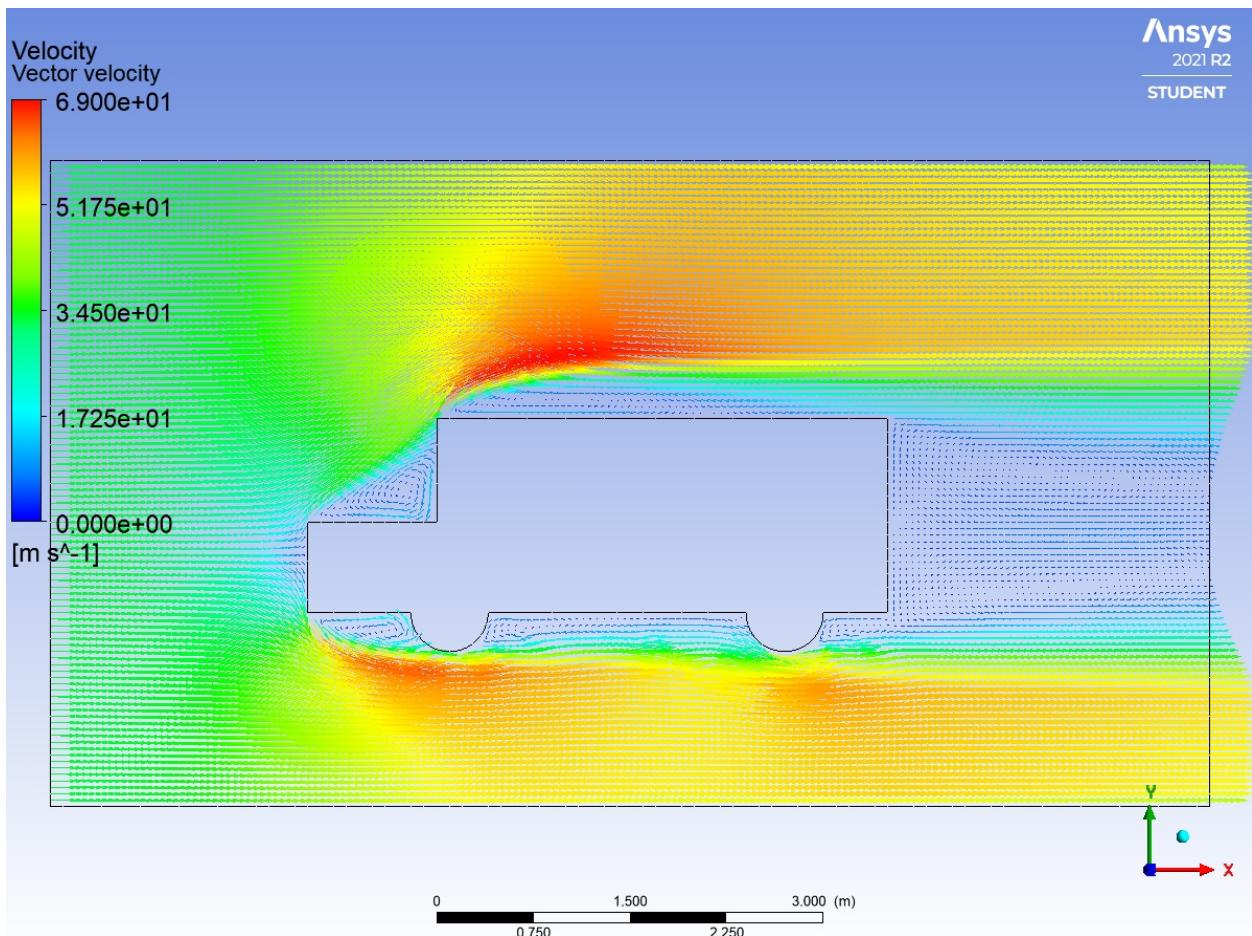


Pressure contour:

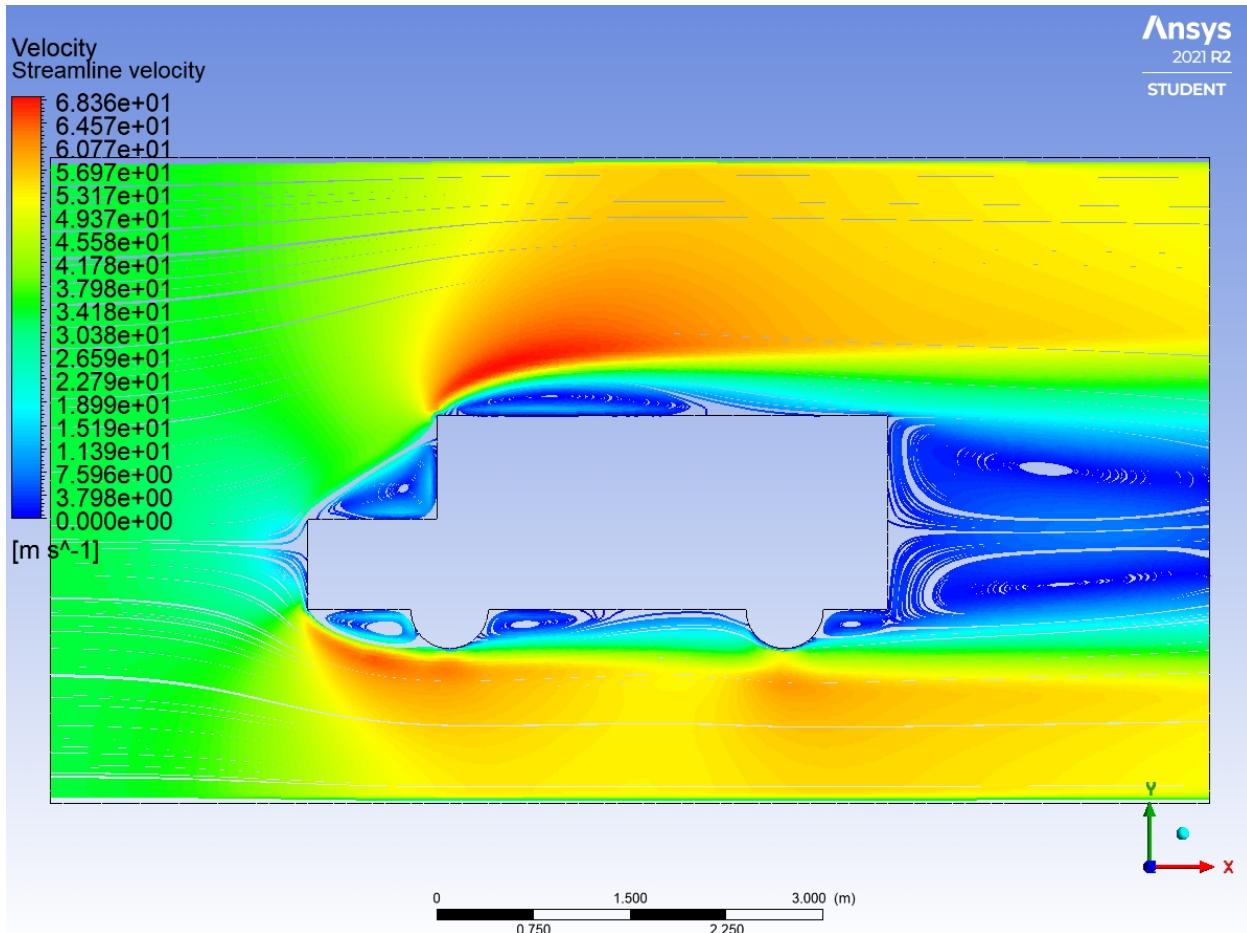




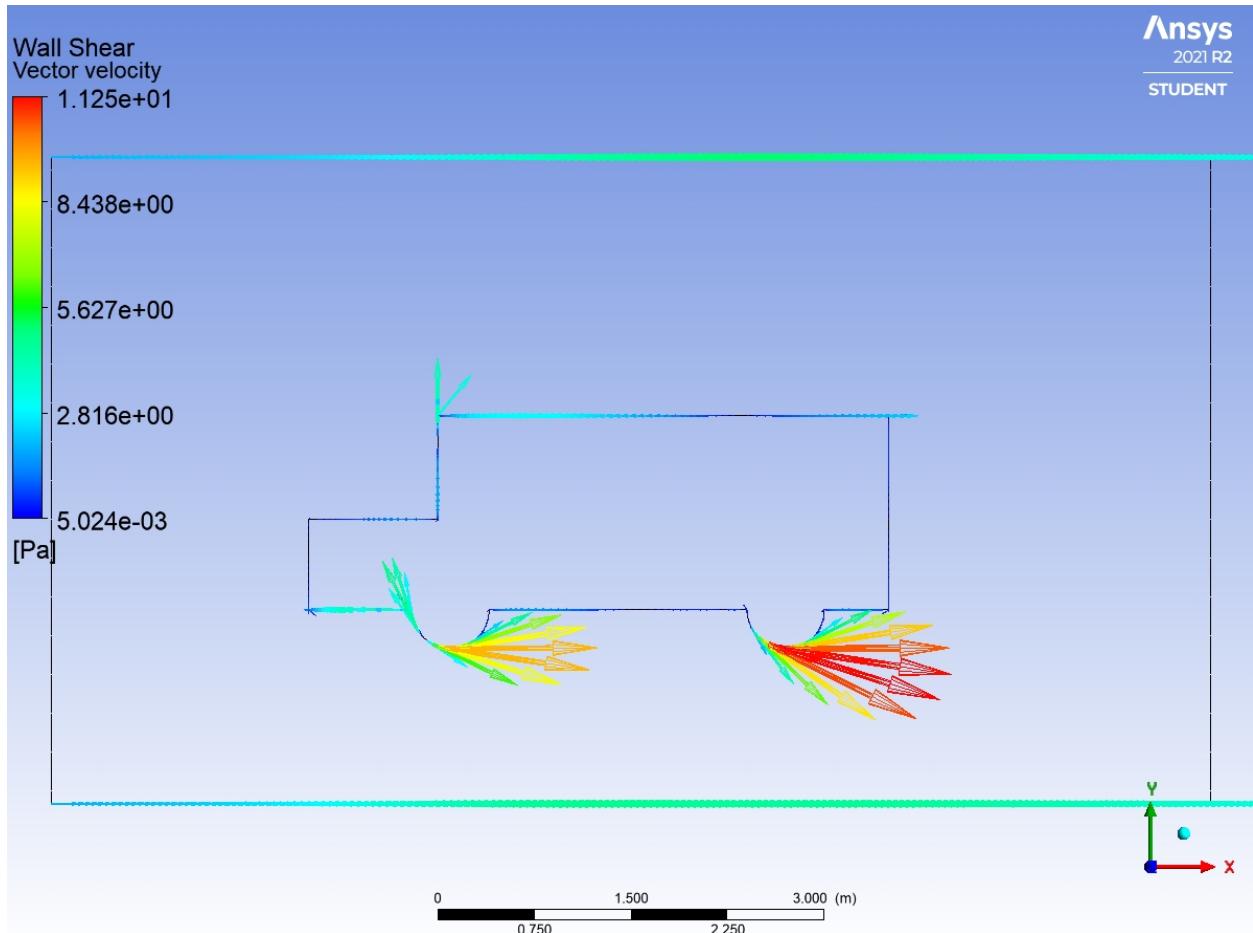
Velocity Vector:



Velocity pathline:



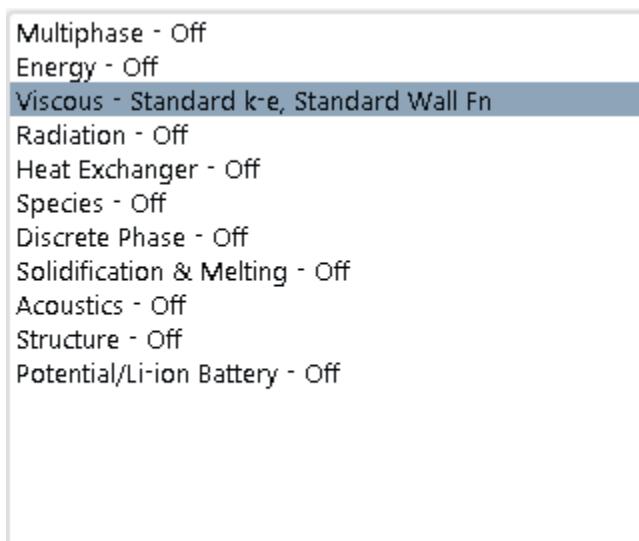
Shear force:



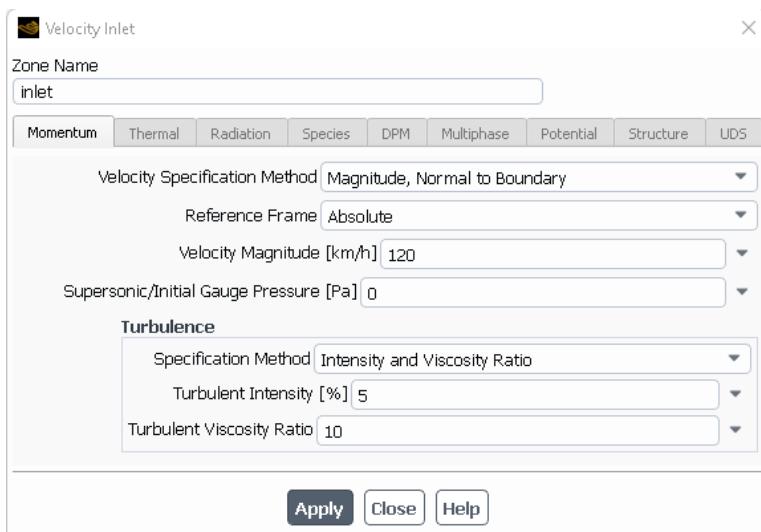
Intermediate Design 1: Trey's Design

Setup:

Models:



Boundary Conditions:



Pressure Outlet

Zone Name: outlet

Momentum

- Backflow Reference Frame: Absolute
- Gauge Pressure [Pa]: 0
- Pressure Profile Multiplier: 1

Backflow Direction Specification Method: Normal to Boundary

Backflow Pressure Specification: Total Pressure

Prevent Reverse Flow

Average Pressure Specification

Target Mass Flow Rate

Turbulence

- Specification Method: Intensity and Viscosity Ratio
- Backflow Turbulent Intensity [%]: 5
- Backflow Turbulent Viscosity Ratio: 10

Apply **Close** **Help**

wall

Zone Name: carwalls

Adjacent Cell Zone: surface_body

Momentum

Stationary Wall Relative to Adjacent Cell Zone

Moving Wall

Motion

No Slip

Specified Shear

Specularity Coefficient

Marangoni Stress

Shear Condition

Wall Roughness

Roughness Models

Standard High Roughness (Icing)

Sand-Grain Roughness

Roughness Height [m]: 0

Roughness Constant: 0.5

Apply **Close** **Help**

wall

Zone Name: ground

Adjacent Cell Zone: surface_body

Momentum

Stationary Wall Relative to Adjacent Cell Zone

Moving Wall

Motion

No Slip

Specified Shear

Specularity Coefficient

Marangoni Stress

Shear Condition

Wall Roughness

Roughness Models

Standard High Roughness (Icing)

Sand-Grain Roughness

Roughness Height [m]: 0

Roughness Constant: 0.5

Apply **Close** **Help**

Reference Values

Compute from

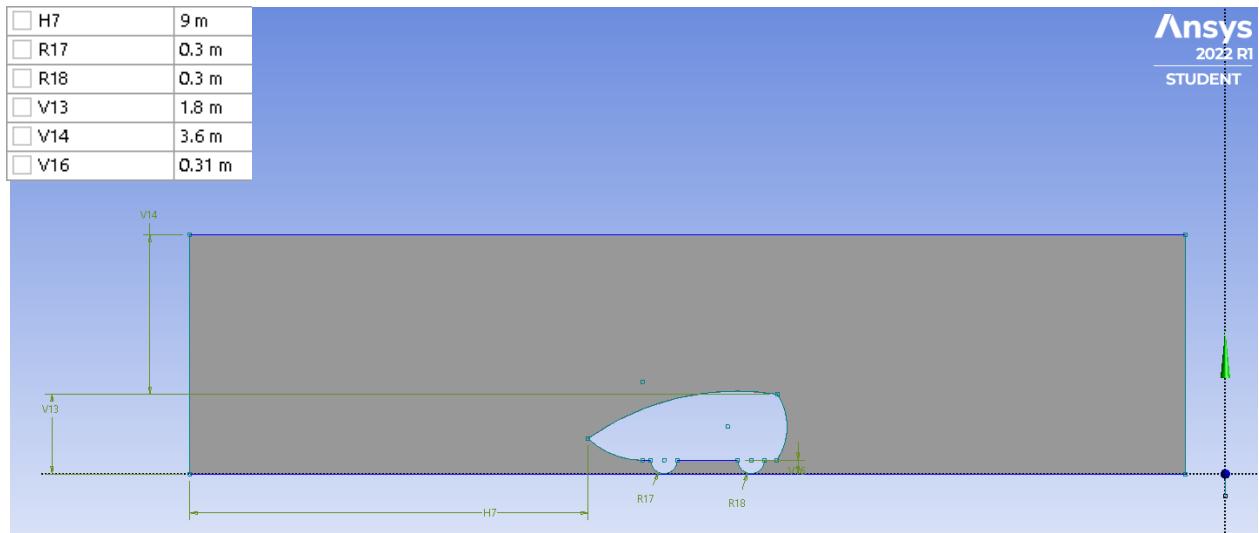
Reference Values

Area [m ²]	5.82
Density [kg/m ³]	1.225
Depth [m]	1
Enthalpy [J/kg]	0
Length [m]	1
Pressure [Pa]	0
Temperature [K]	288.16
Velocity [km/h]	3.599997
Viscosity [kg/(m s)]	1.7894e-05
Ratio of Specific Heats	1.4
Yplus for Heat Tran. Coef.	300

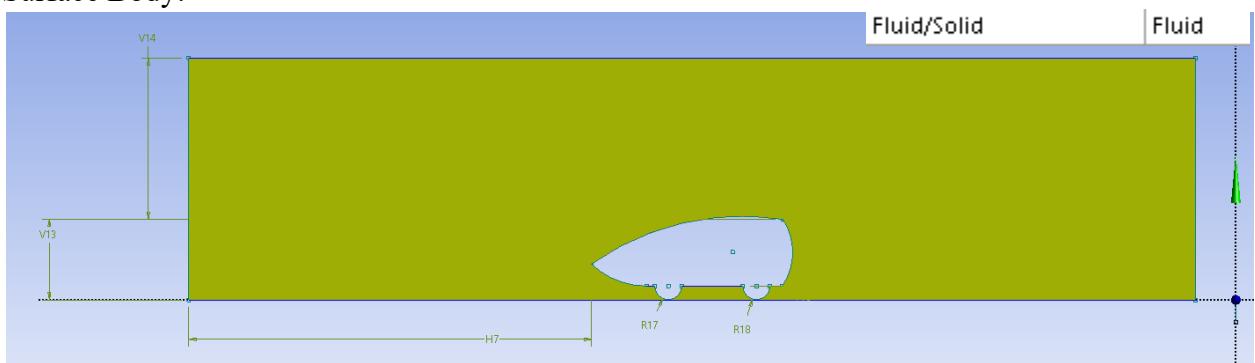
Reference Zone

Geometry:

My design is similar to the shape of a bullet because I know these are very aerodynamic shapes that would lower the drag coefficient and force from the original design. The dimensions for my design are almost identical to the original design given to us that way it would still be able to fit 4 passengers in the upright position. I also left 2 car lengths in front of and behind the vehicle in order to see how this design is affected as it travels at a speed of 120 km/hr. I also incorporated 2x the height of the vehicle above in order to see how the air is affected above and behind the vehicle.



Surface Body:

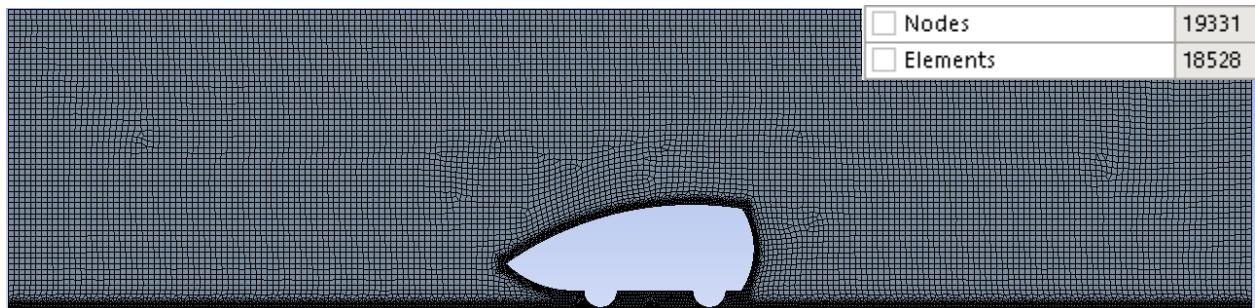


Mesh:

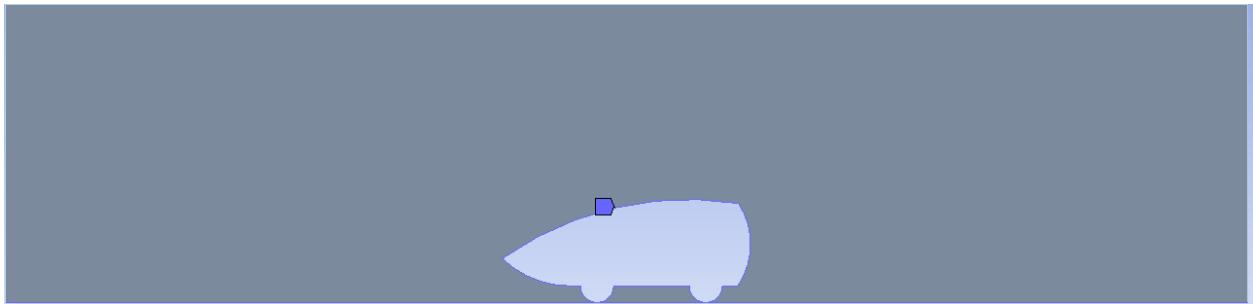
Element size: 0.1m

Nodes: 19331

Elements: 18528



Mesh Refinement: Around all the walls of the car and the ground beneath the vehicle.

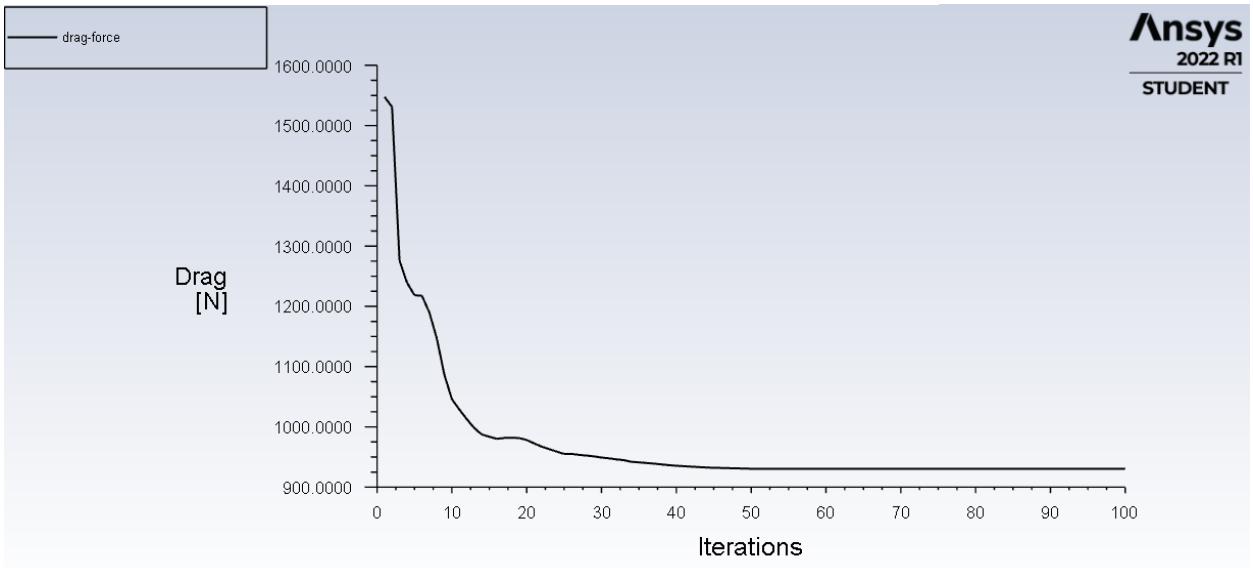


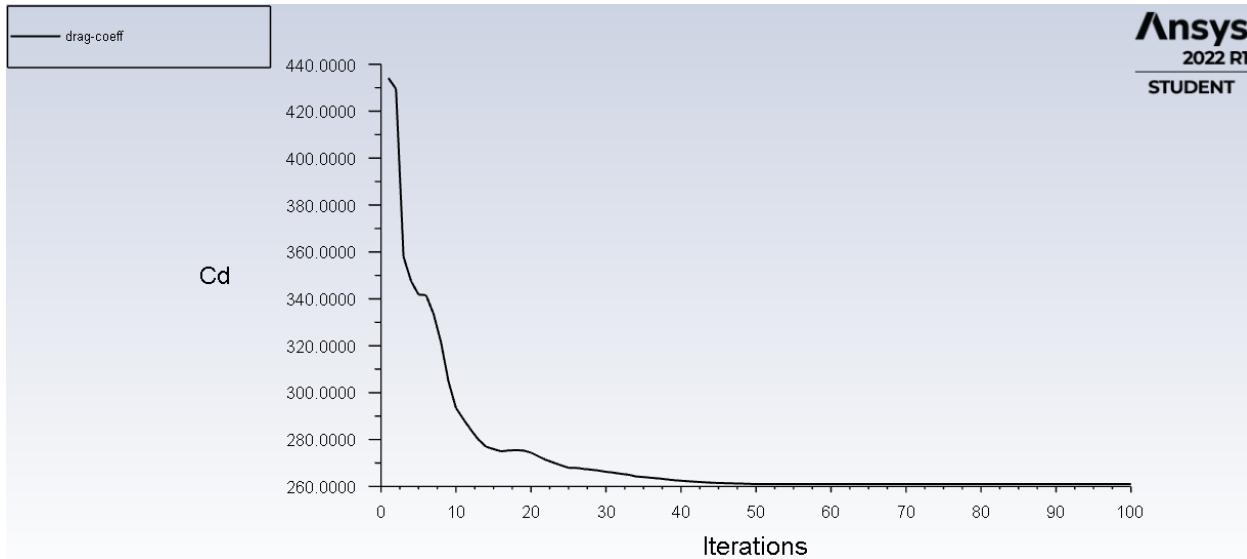
For Trey's Design moving at 120km/hr

Drag Force: 939.65363 N

Drag Coefficient: 0.26359592

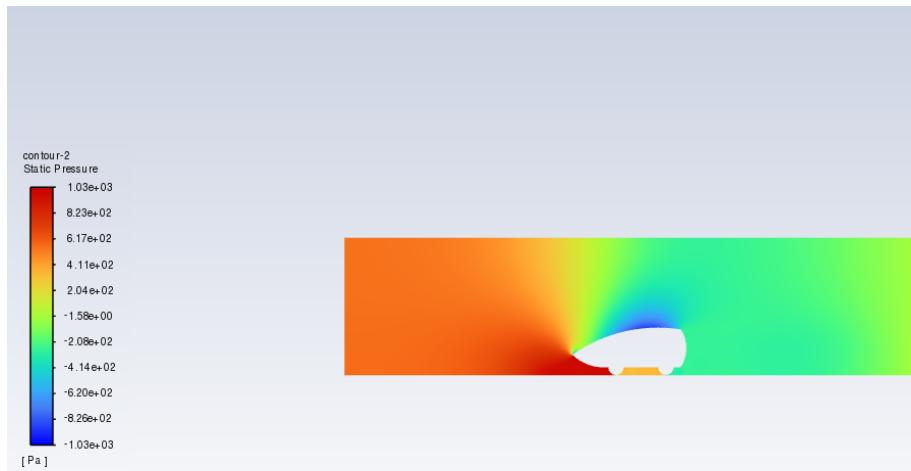
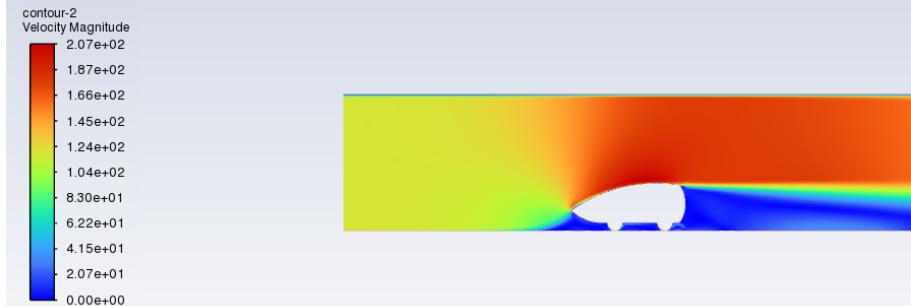
Cd	
drag-coeff	263.59592
Drag	
drag-force	[N] 939.65363

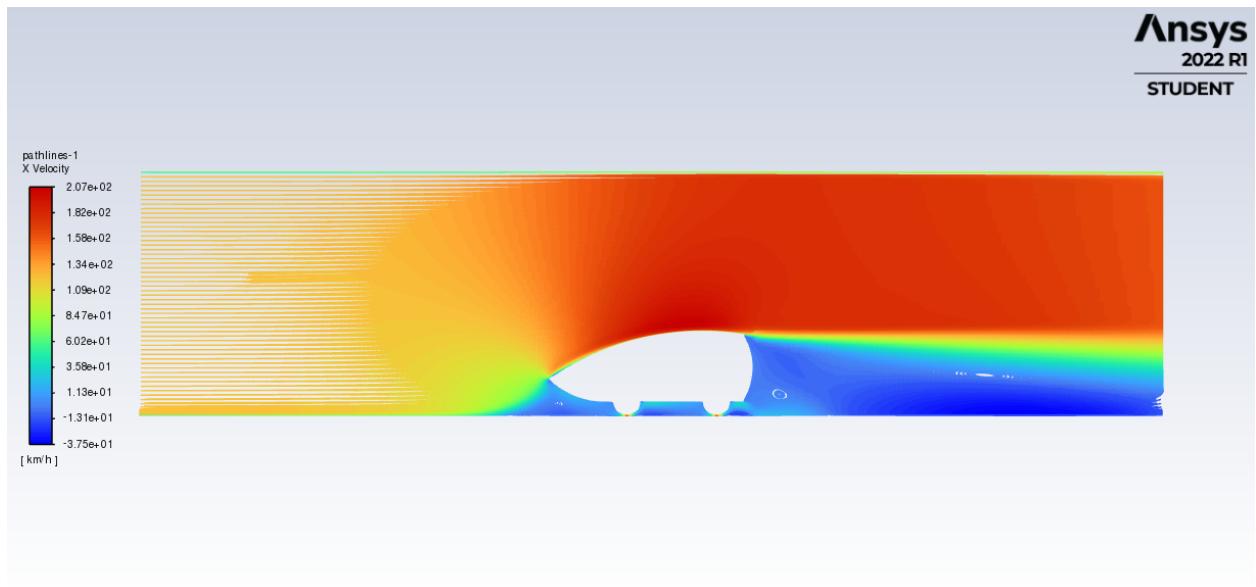
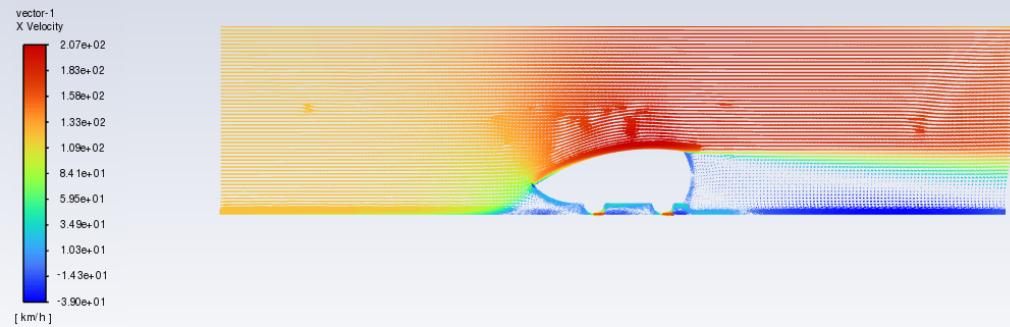




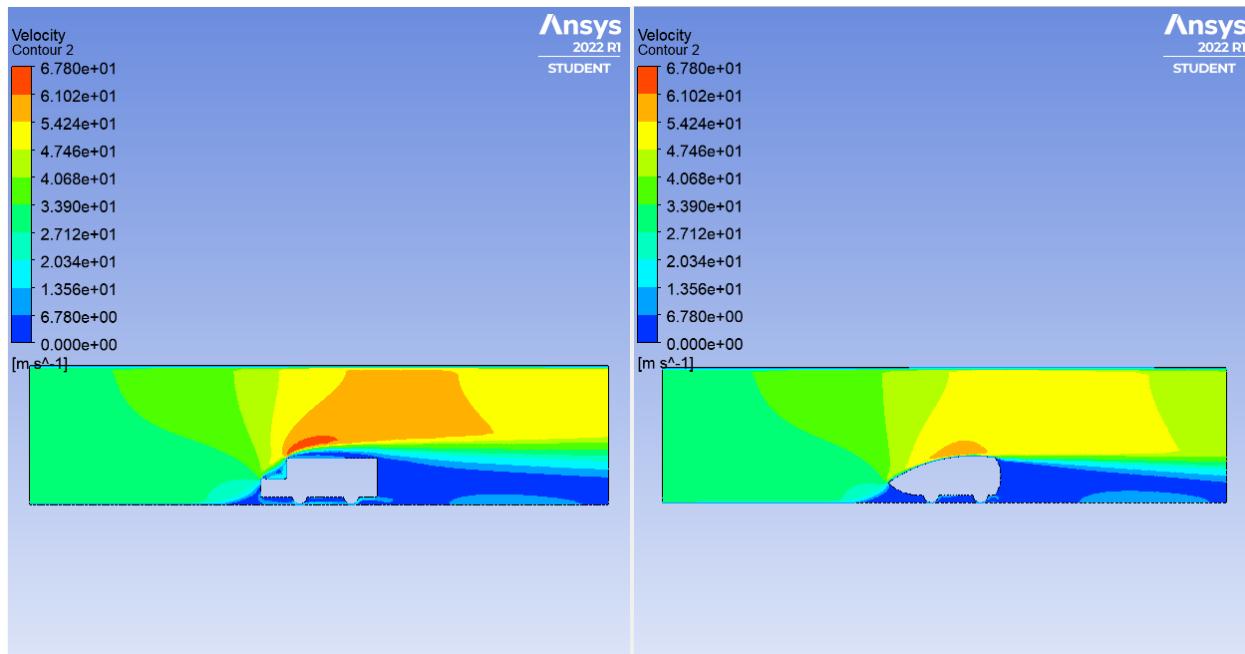
Motivation: The motivation behind my design was a culmination of various ideas that I used to add specific features to my design in order to minimize the drag coefficient and force. At first, I researched different types of vehicles that were known to be aerodynamically efficient. This allowed me to get an idea of the type of body I wanted to use that would be similar to the original design given to us so that way it could meet the specifications needed for this project. I then research various objects that are aerodynamically efficient and I found that the shape of a bullet could be a good shape to base my design around. I then decided to incorporate these ideas while designing and testing my design to find what specific components would reduce the specific factors I was focused on. I found that a shape with the top half of a bullet and the bottom half of a tesla would be the best design to minimize the drag coefficient and force.

Flow Field Analysis:

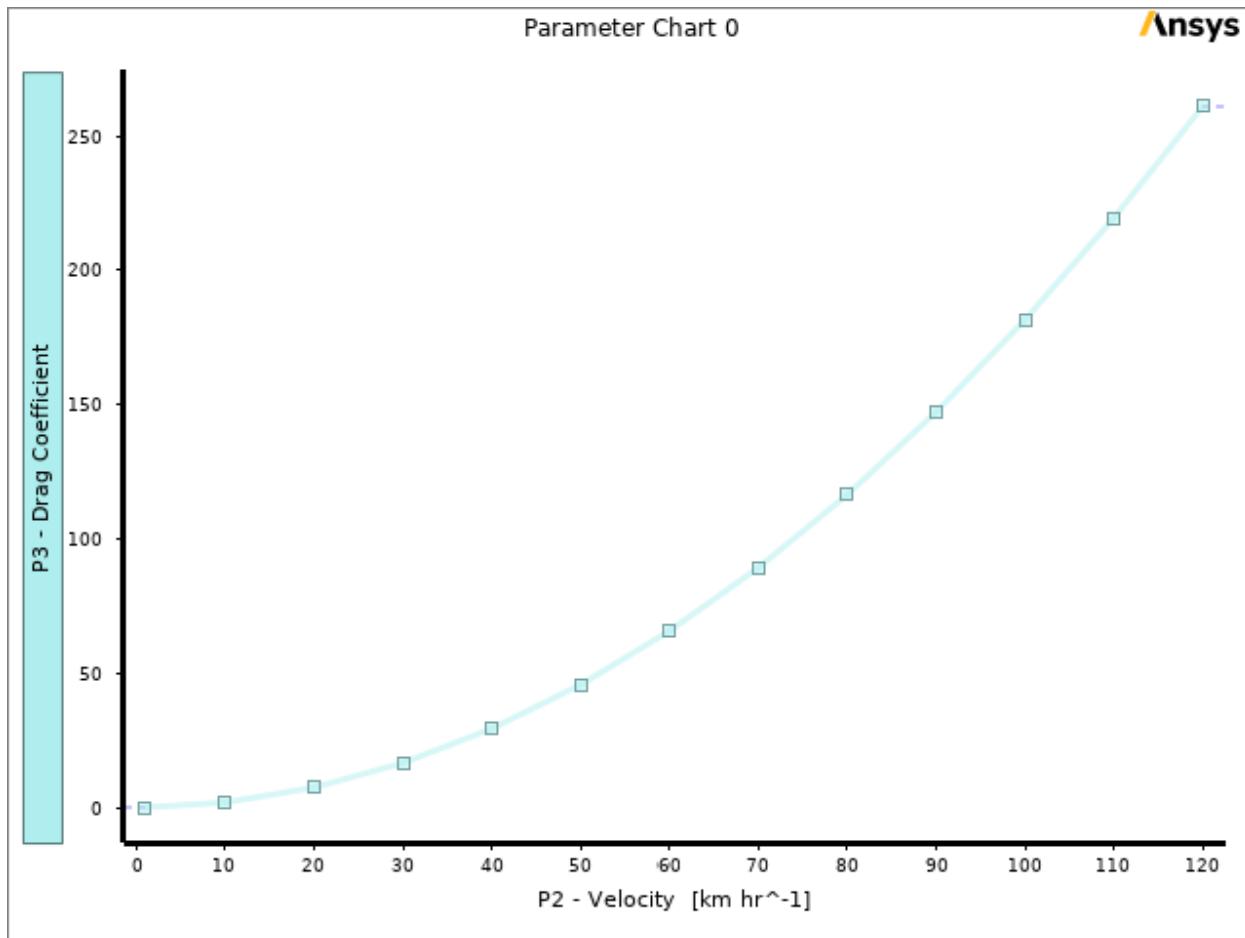




Drag Coefficient Comparison: For the initial design given to us in this assignment, I found that it would have a drag coefficient of 0.533 and when optimizing my design I found that it would have a drag coefficient of 0.26359592. This means that my design was able to reduce the drag coefficient by a factor of 2.023. This would significantly improve the aerodynamic capability making my design more efficient than the SUV sold in the market.

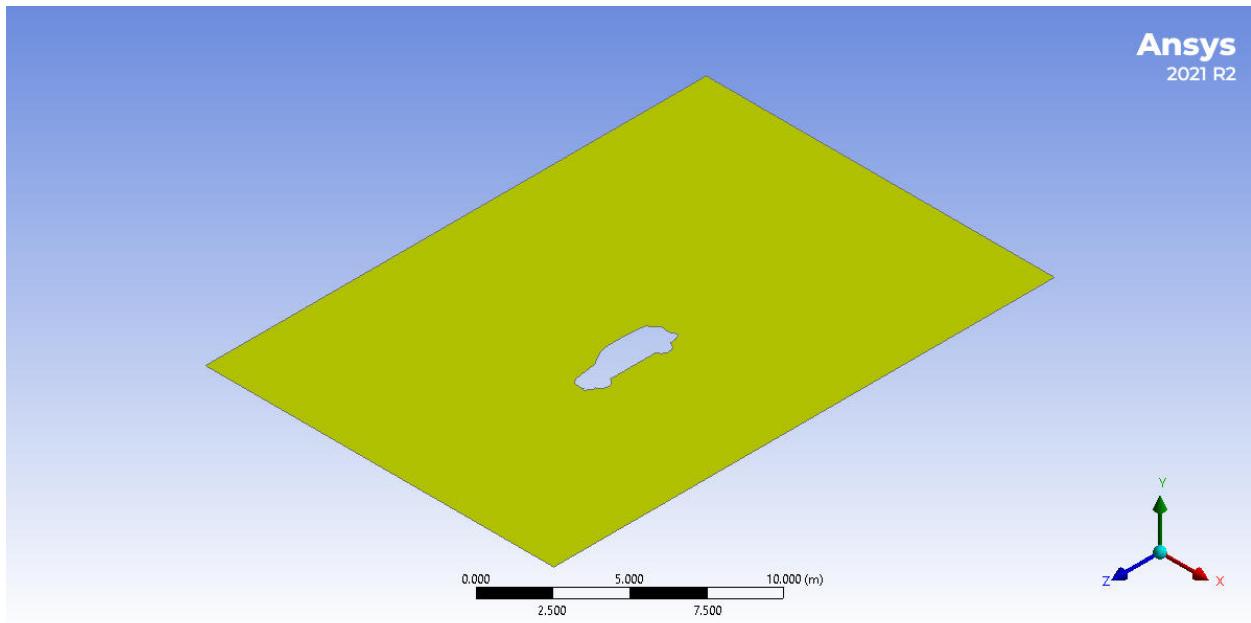


Plot of Vehicle velocity vs. Drag Coefficient

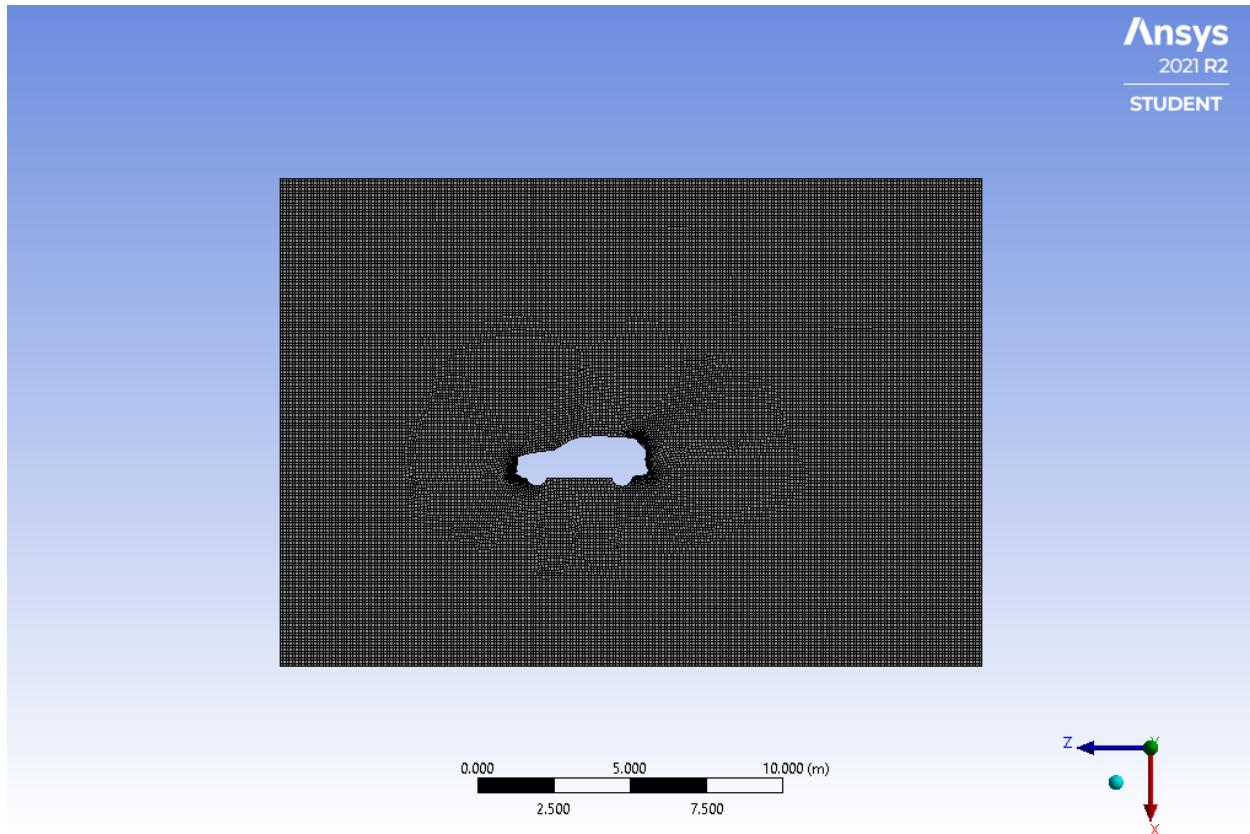


Intermediate design 2 : Pinak Bhuban

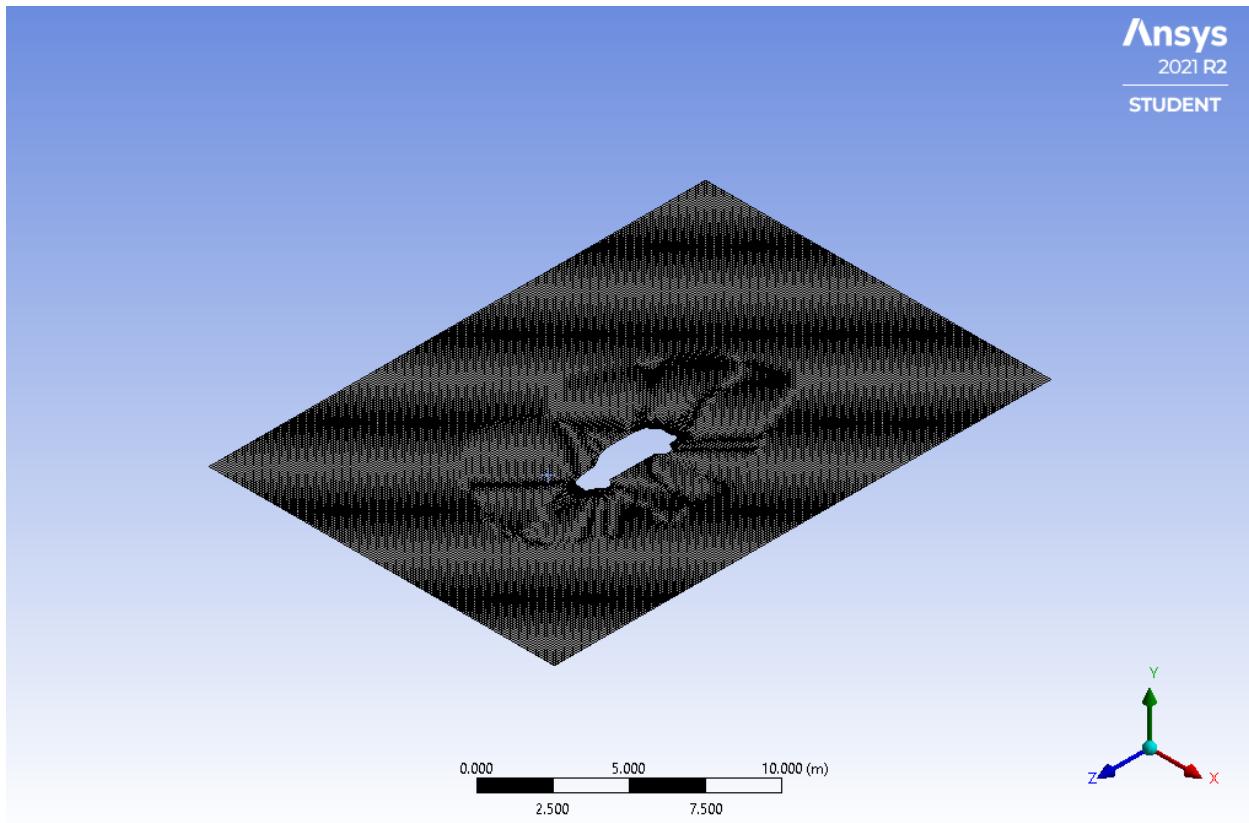
Geometry: BMWX5



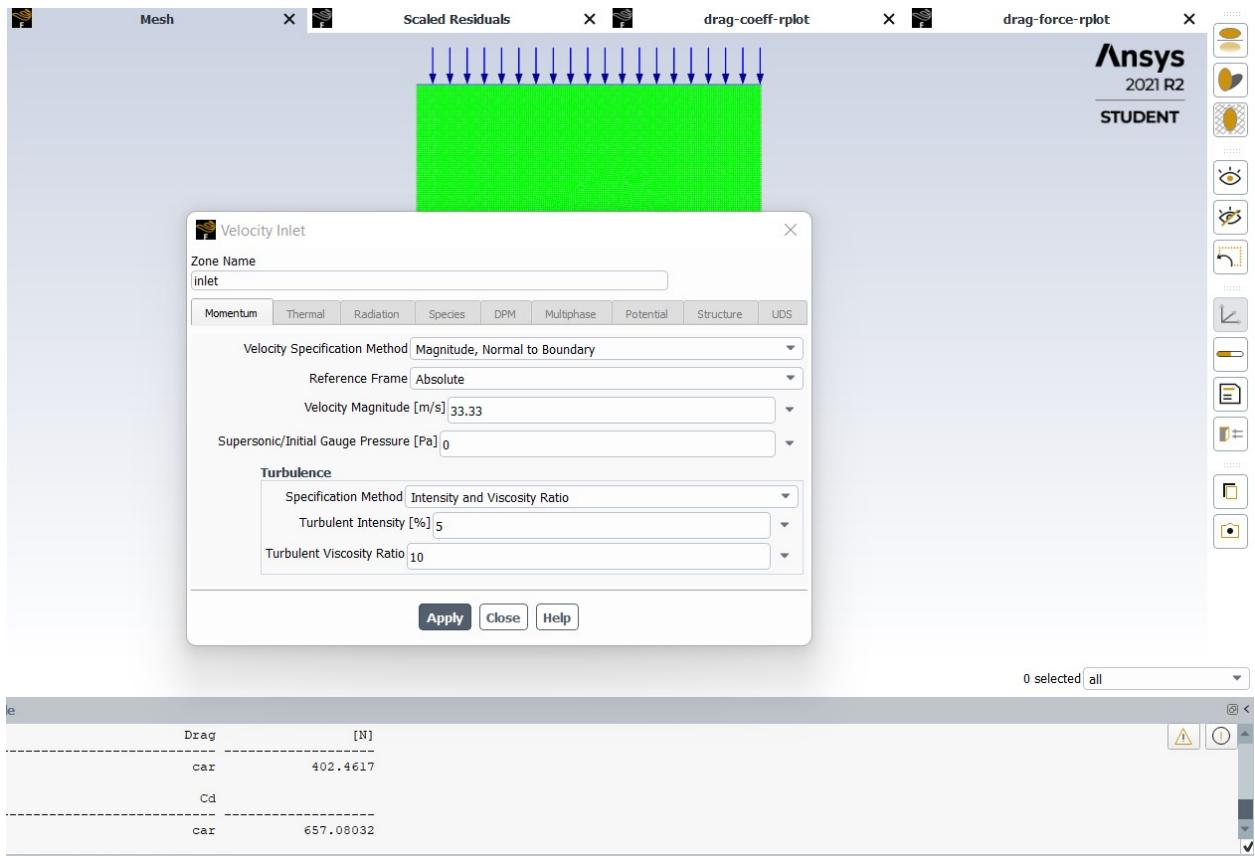
Meshing:



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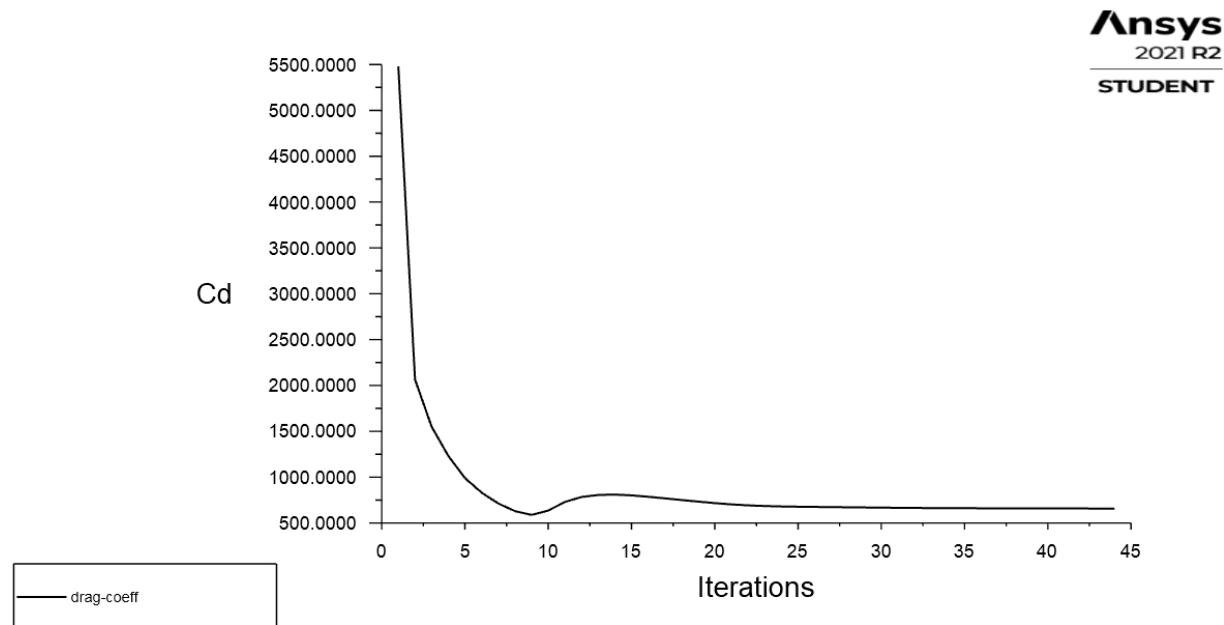
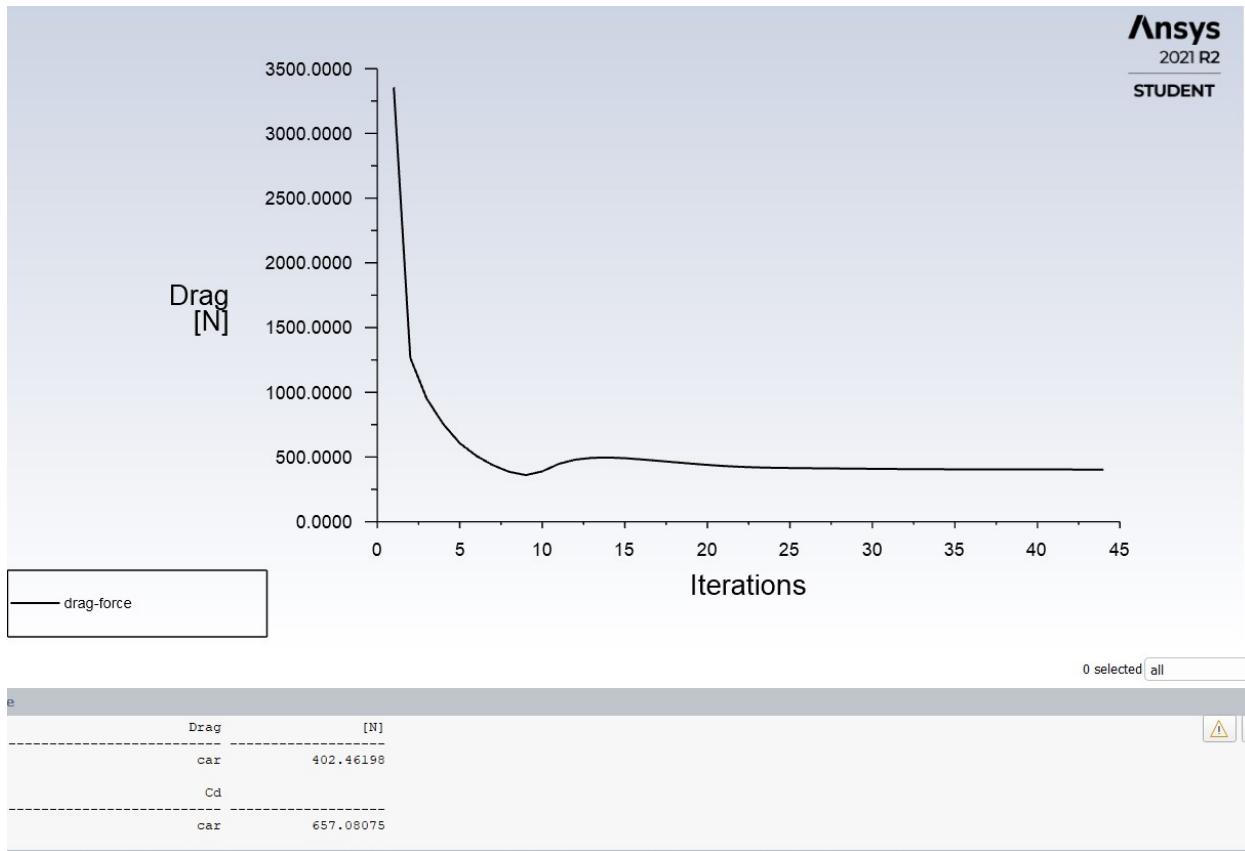


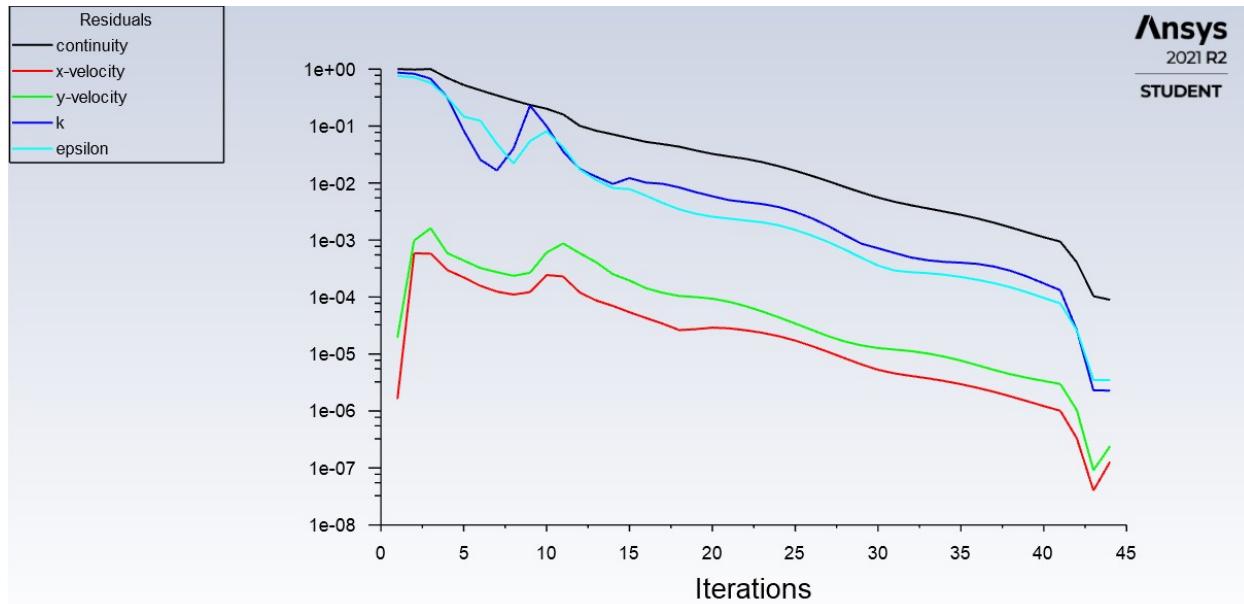
For BMW X5 moving at 120km/hr(33.33 m/s):



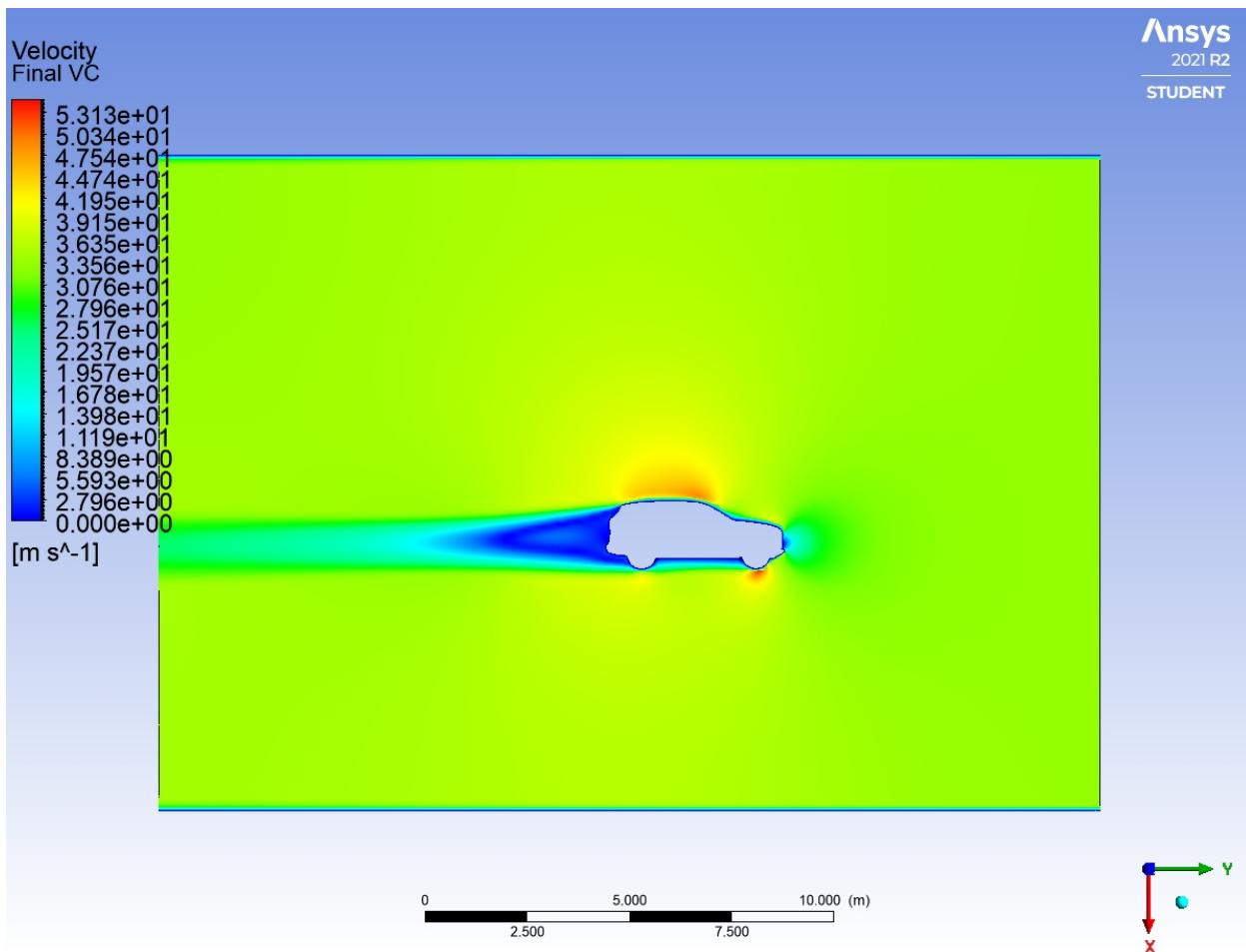
Drag Force: **402.4617 N**

Drag Coefficient: **0.65708**

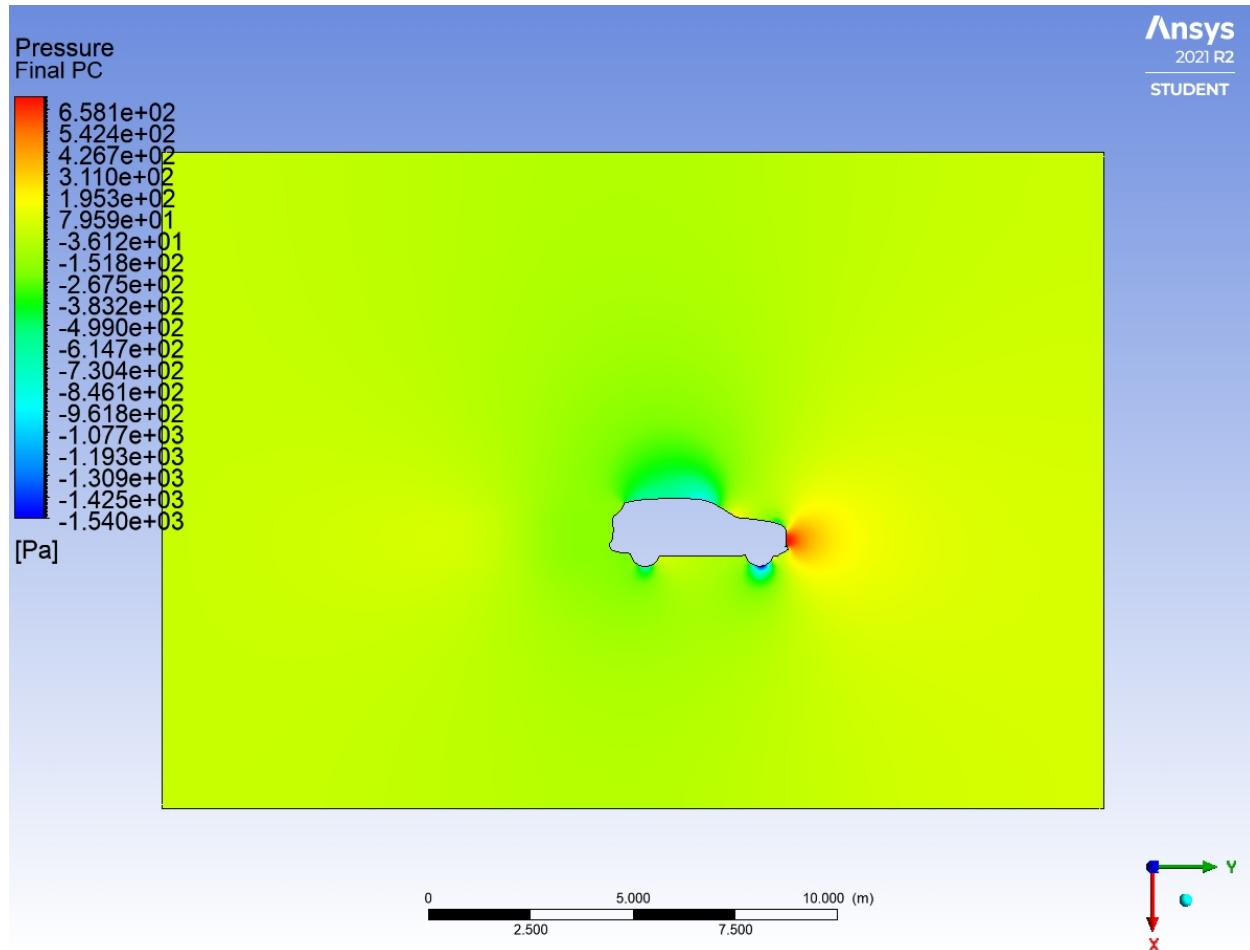




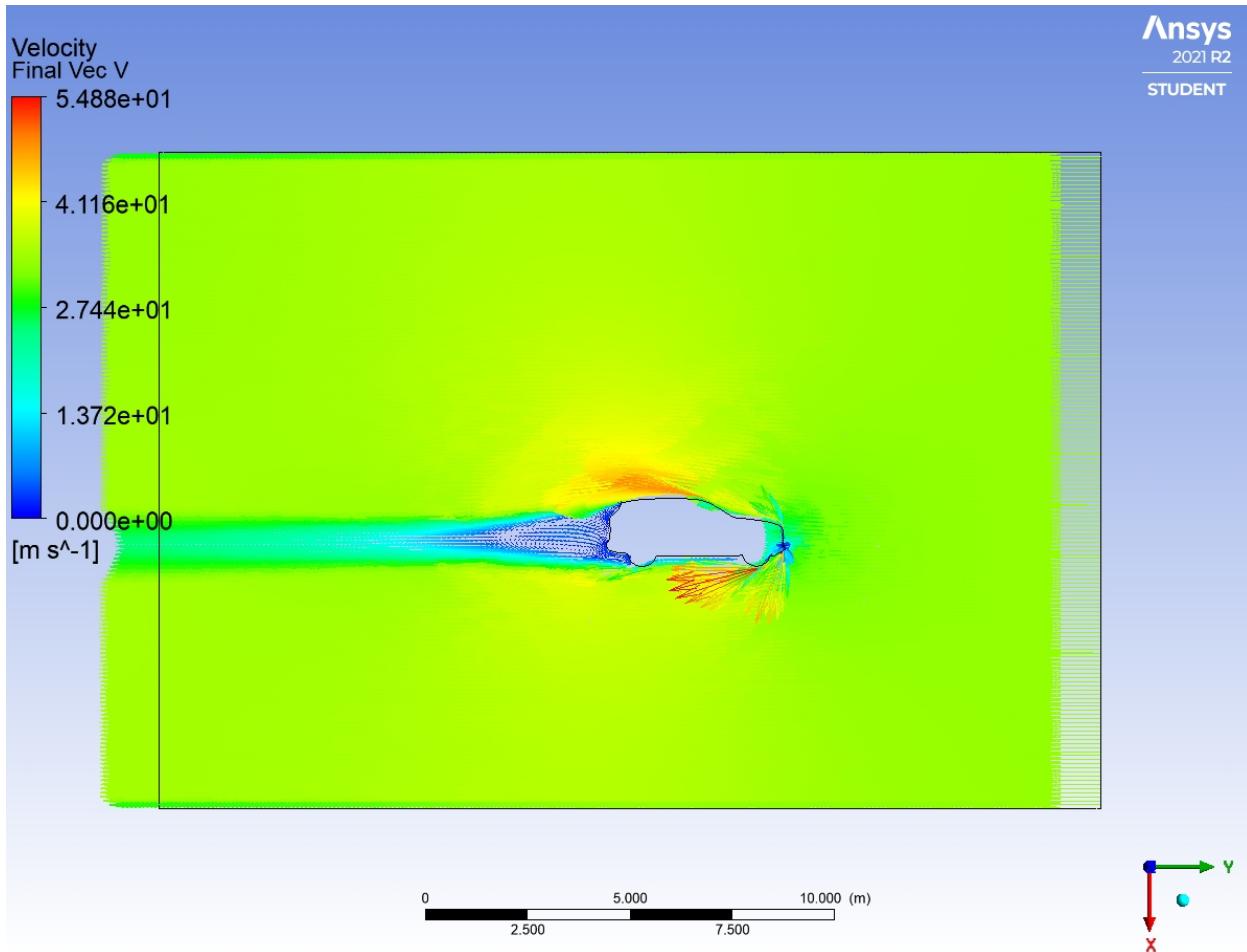
Velocity contour:



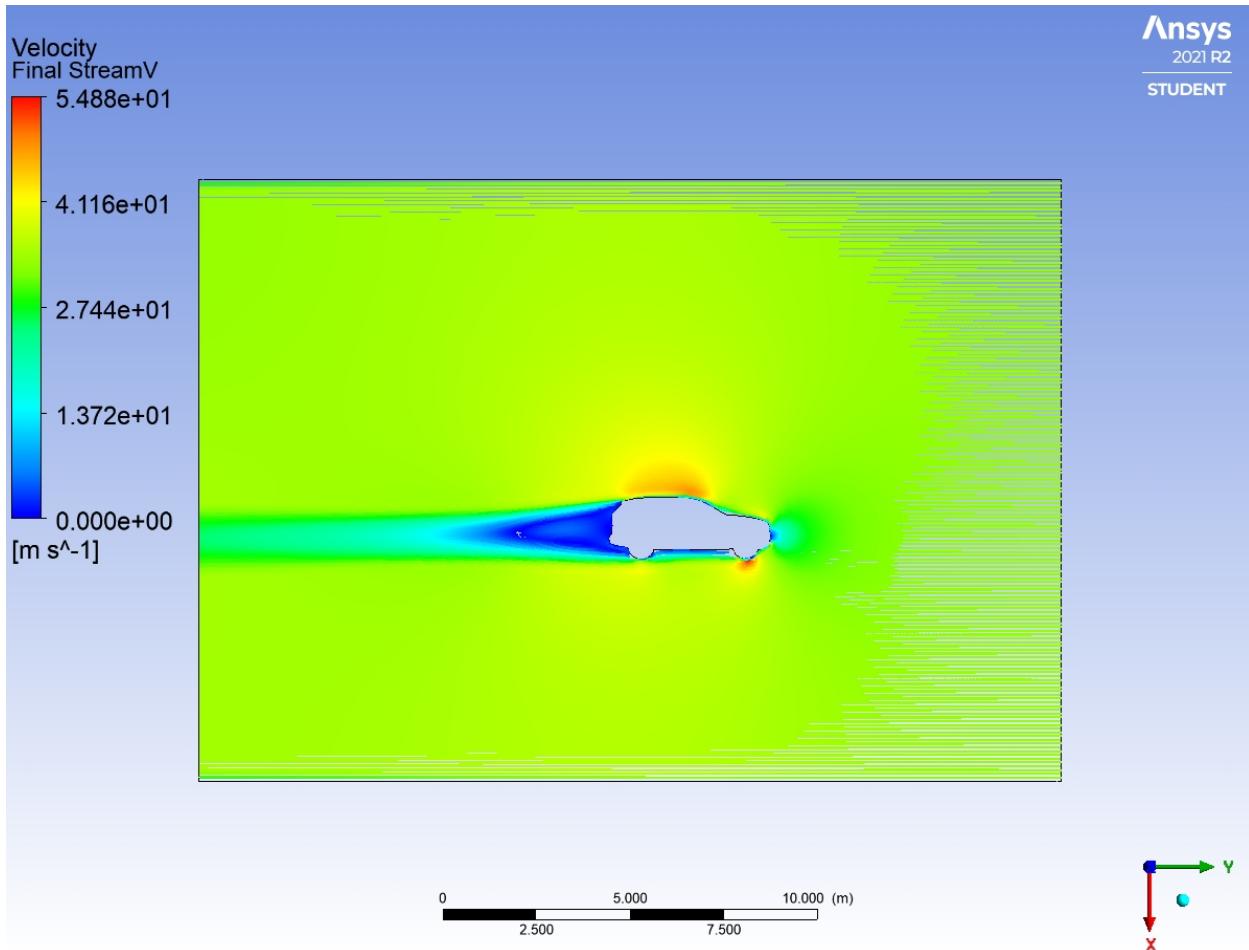
Pressure Contour:



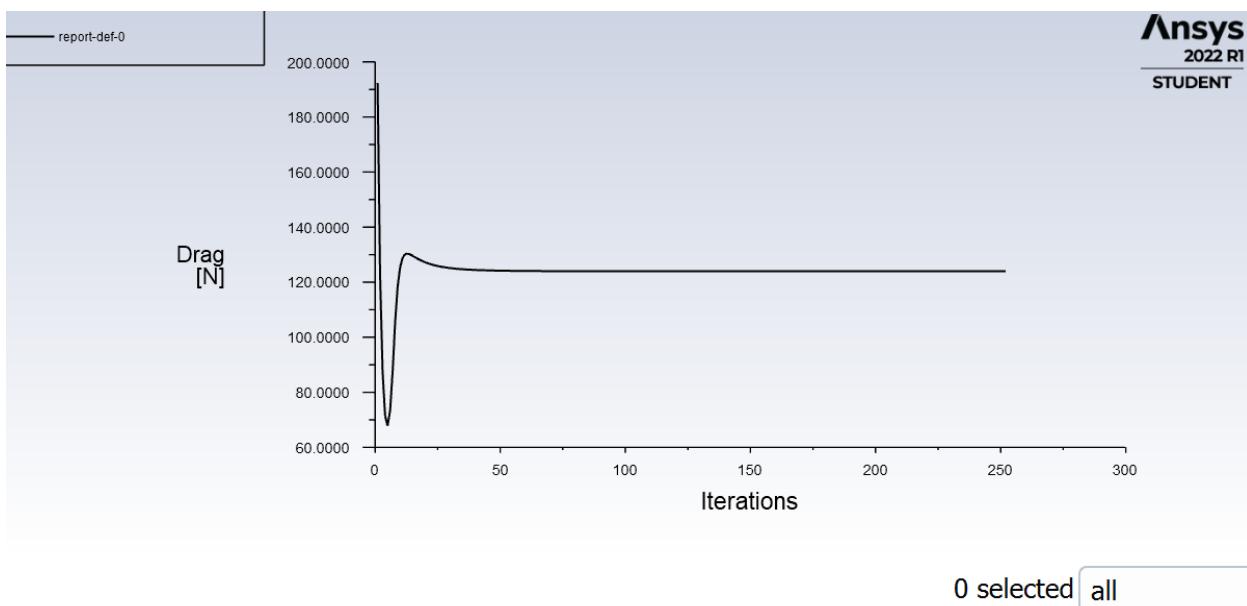
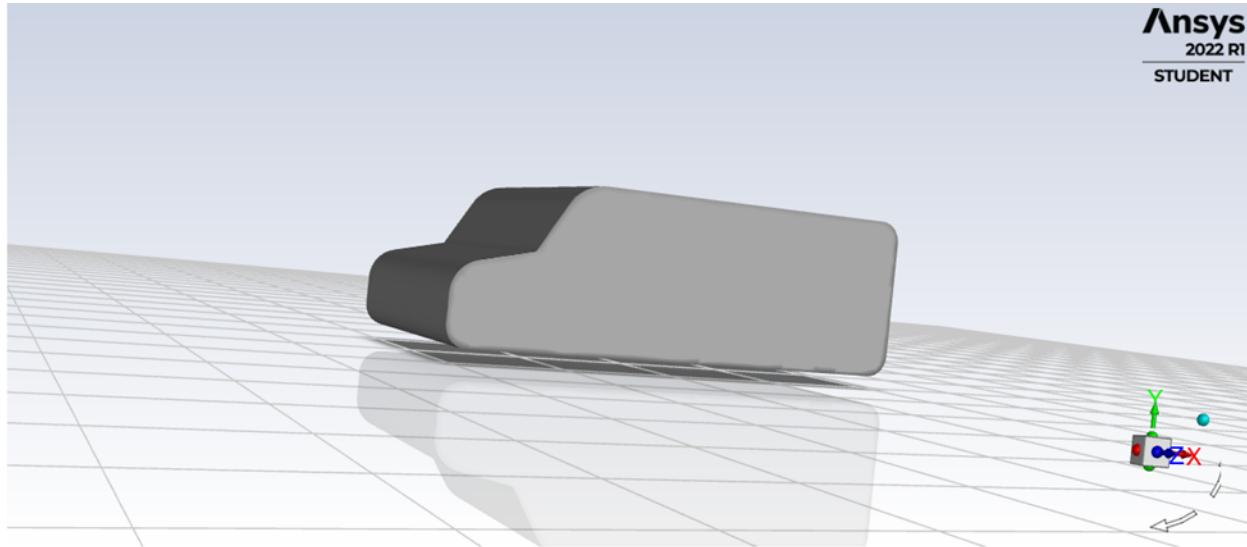
Velocity Vector:

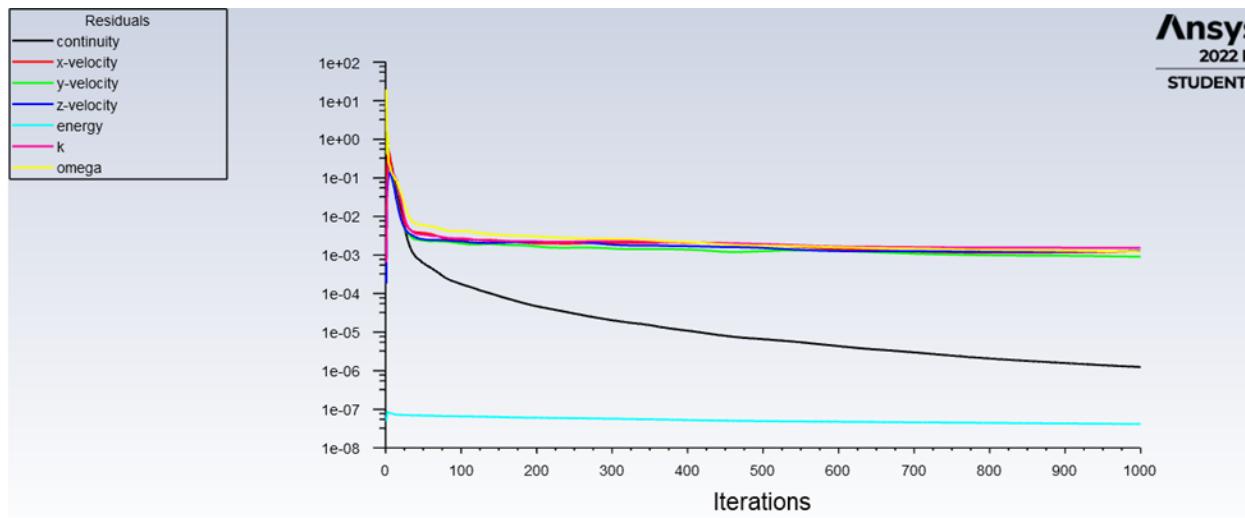
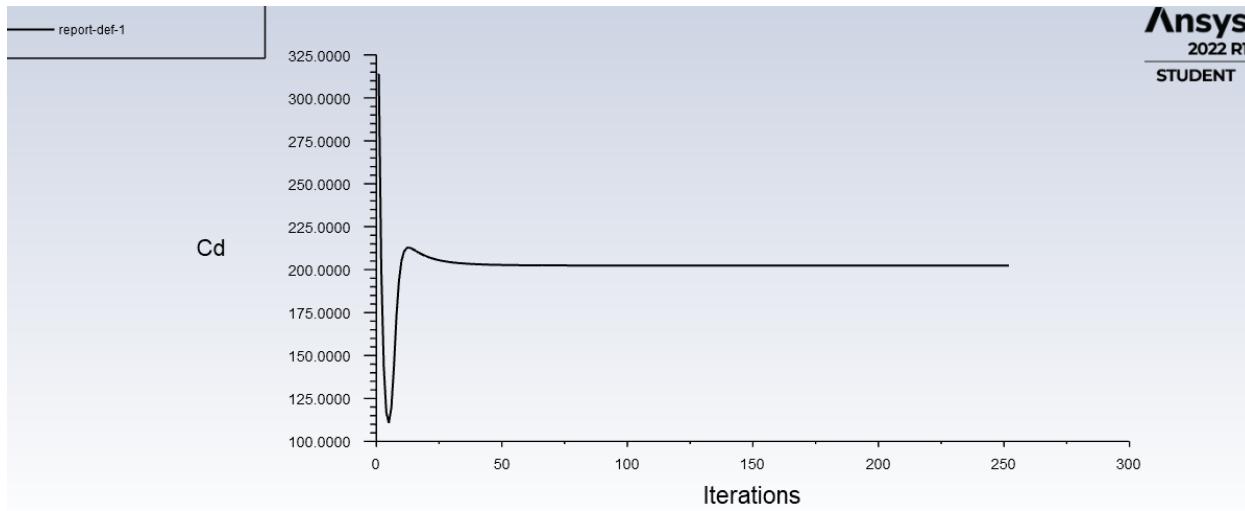


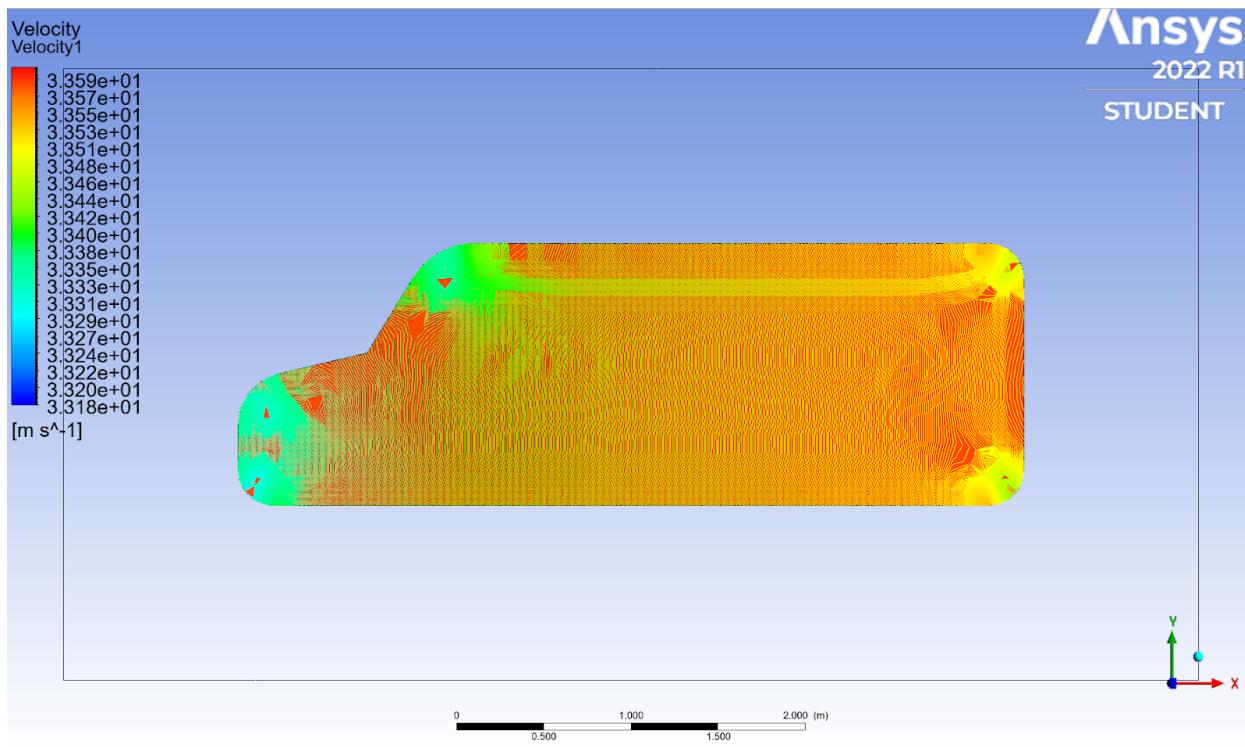
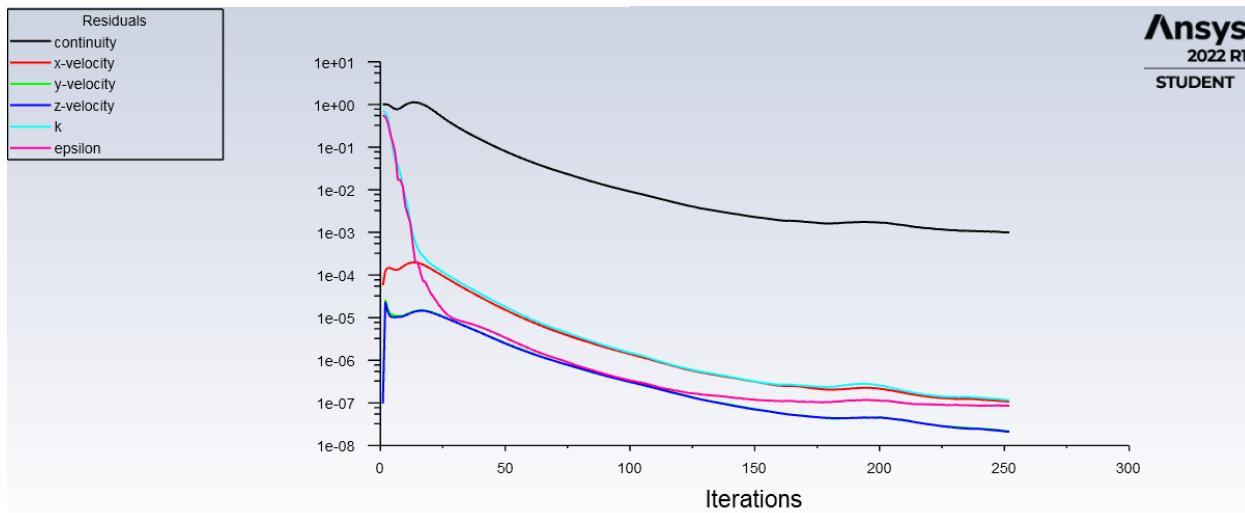
Velocity Pathline:

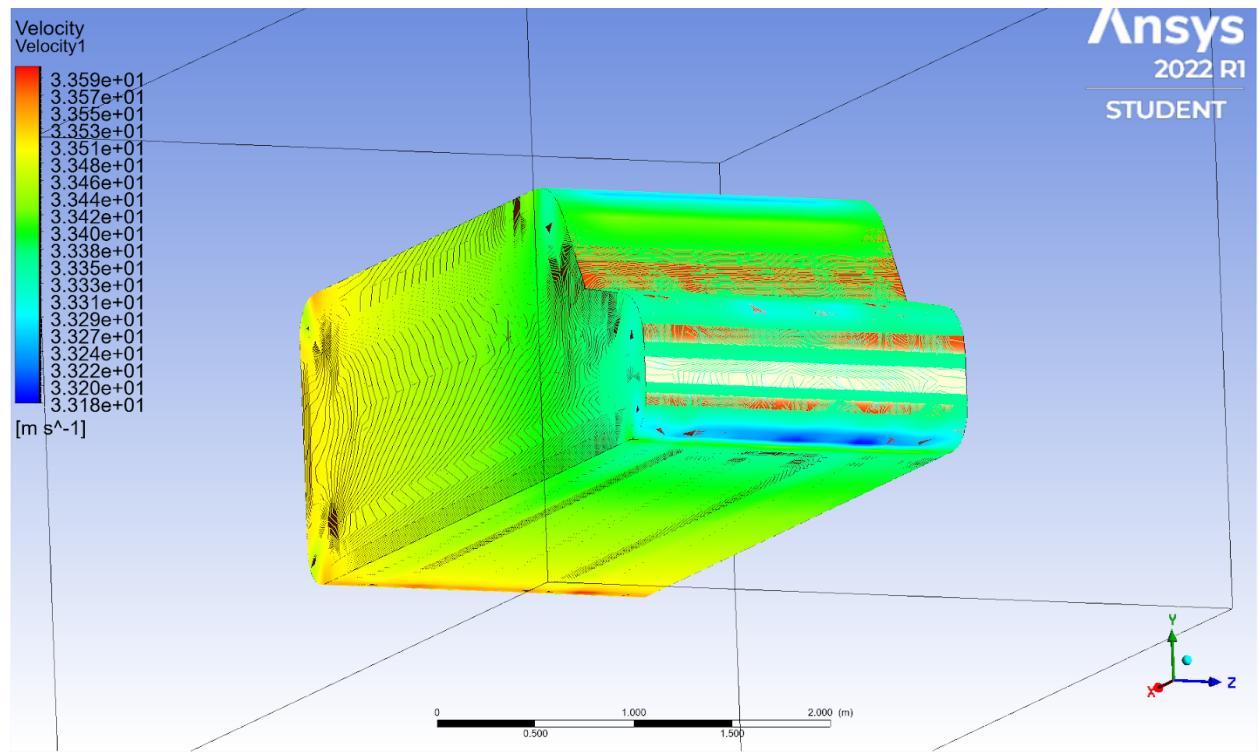
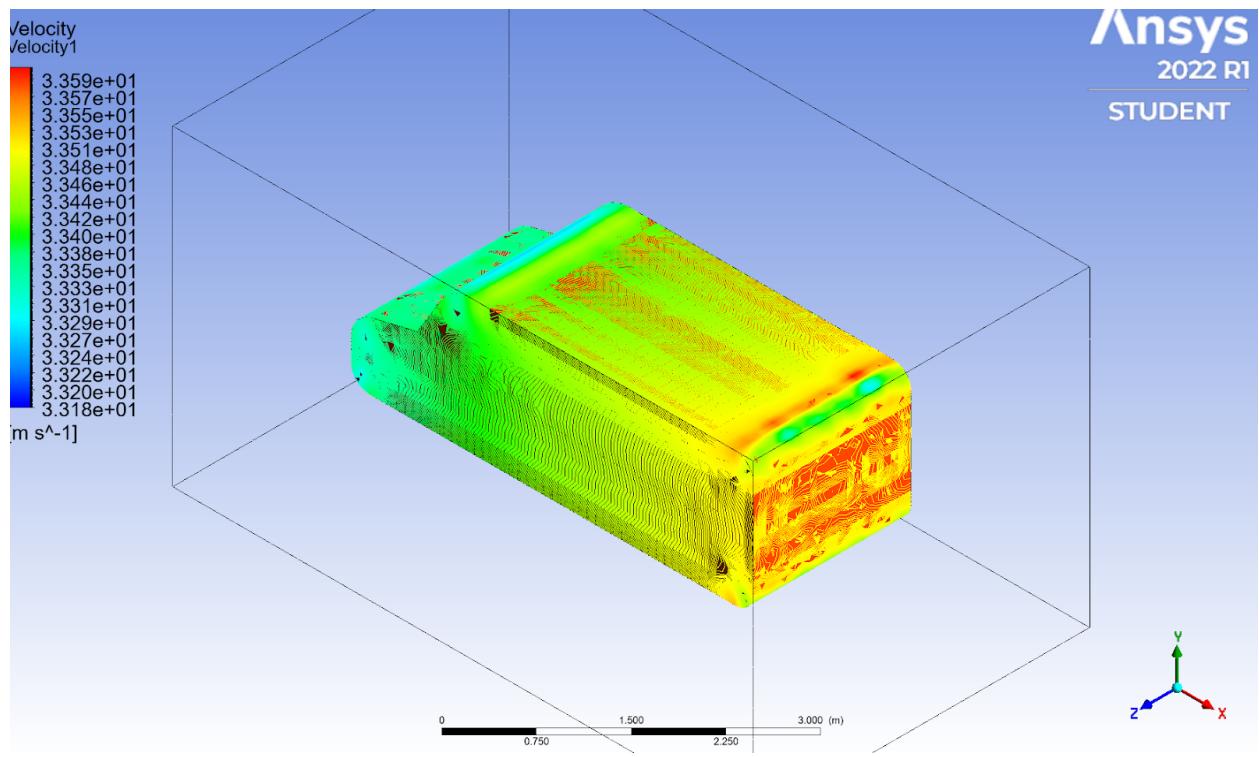


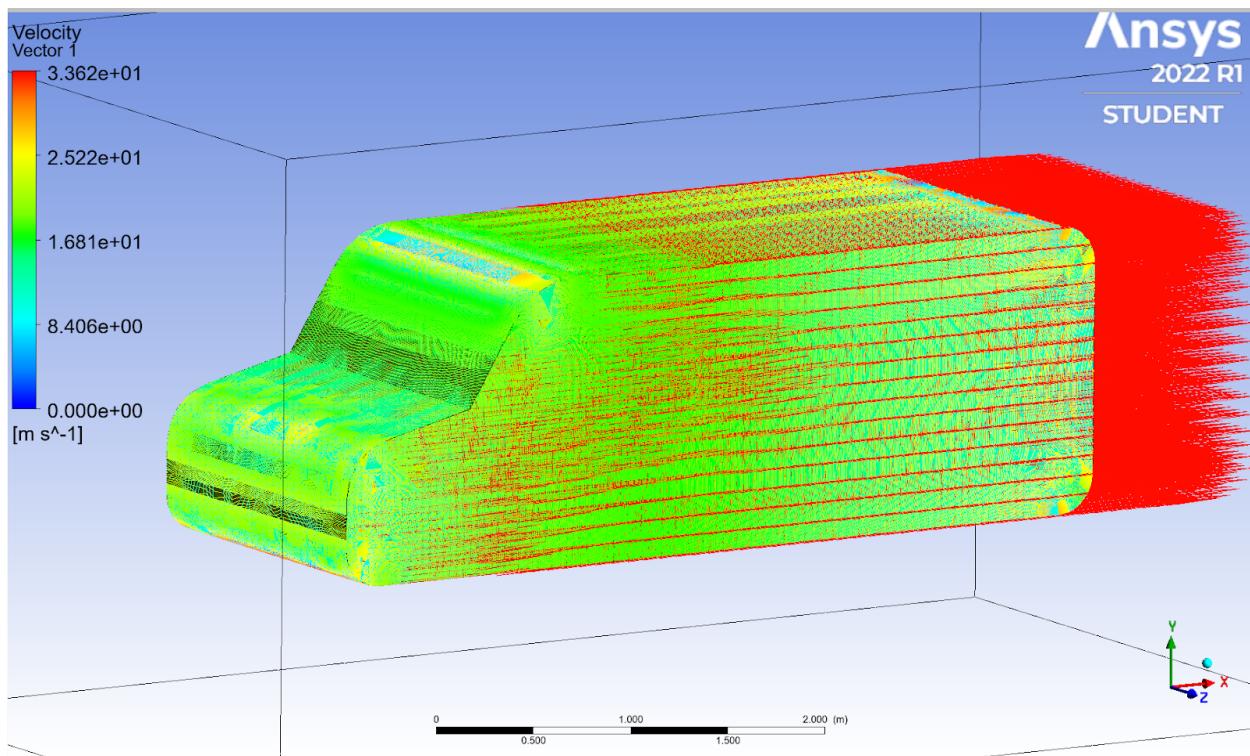
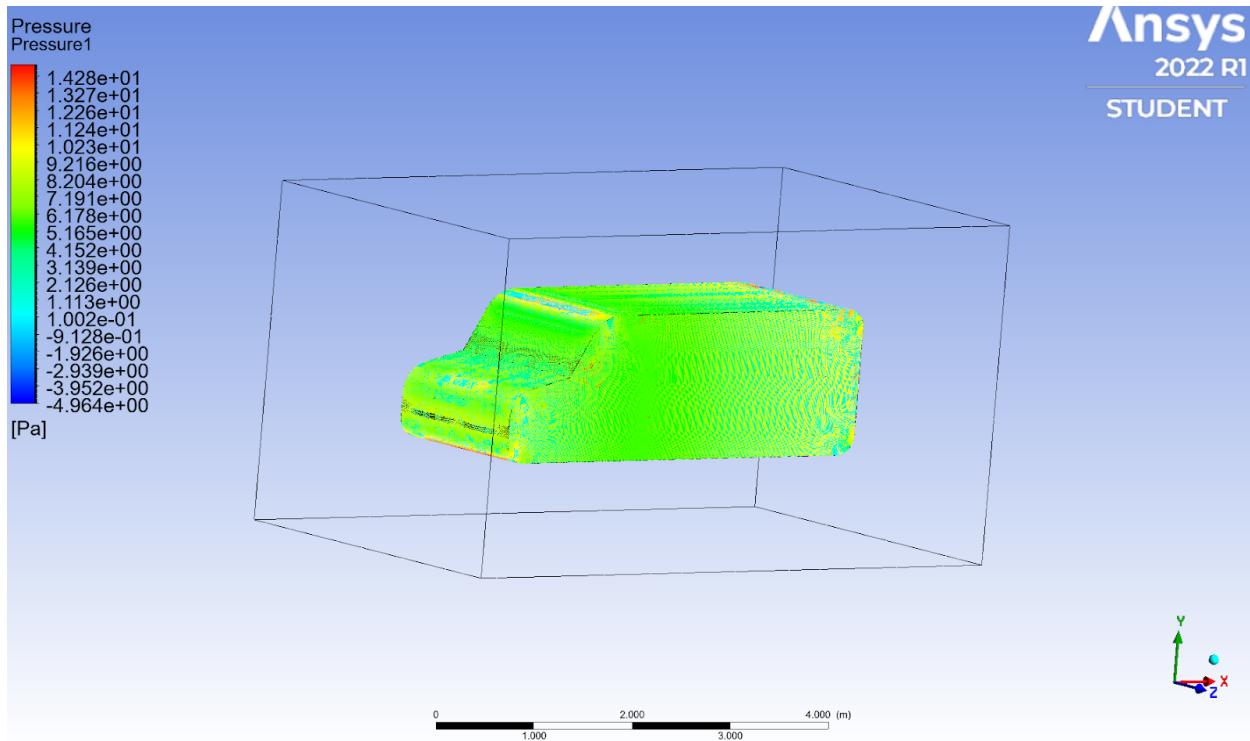
Dane's Design

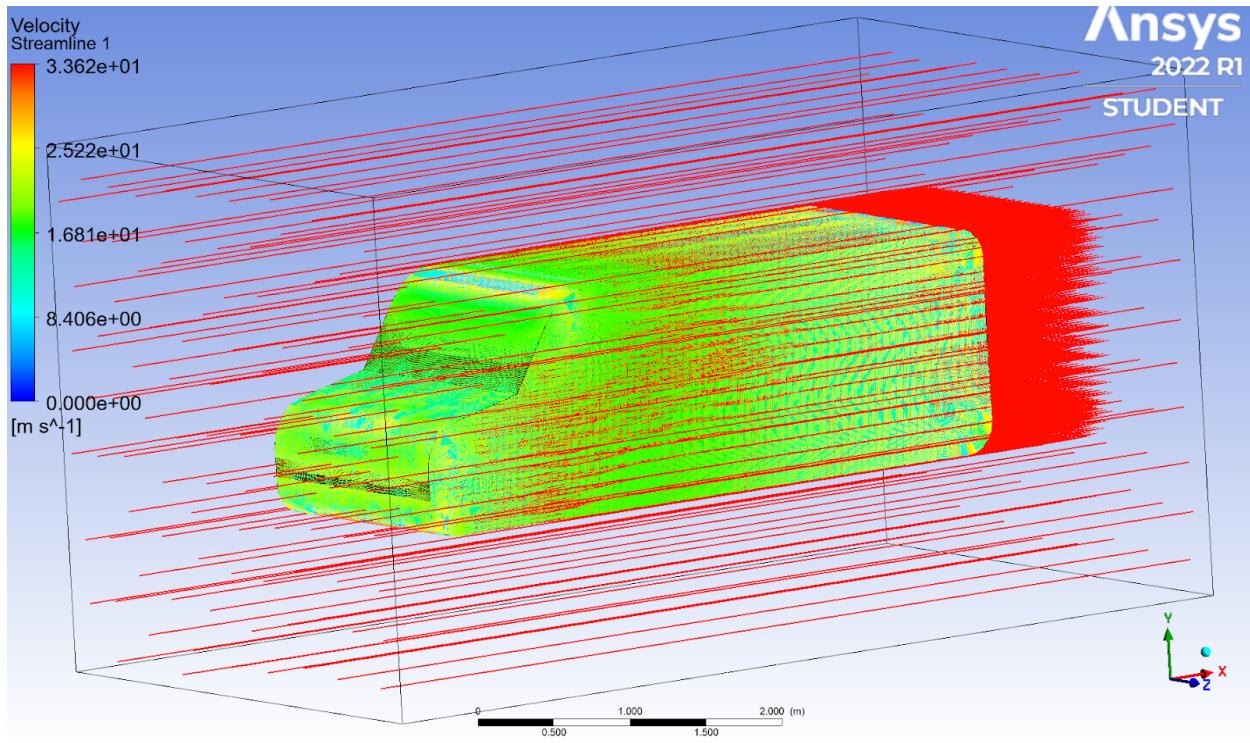






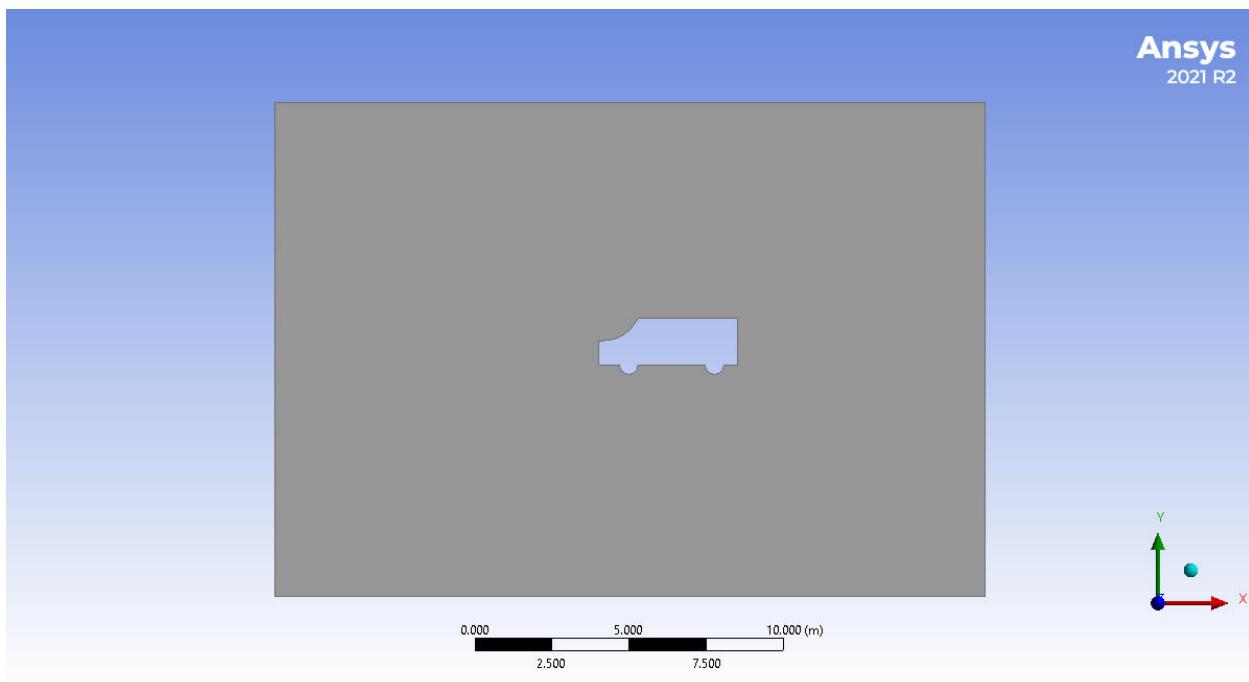
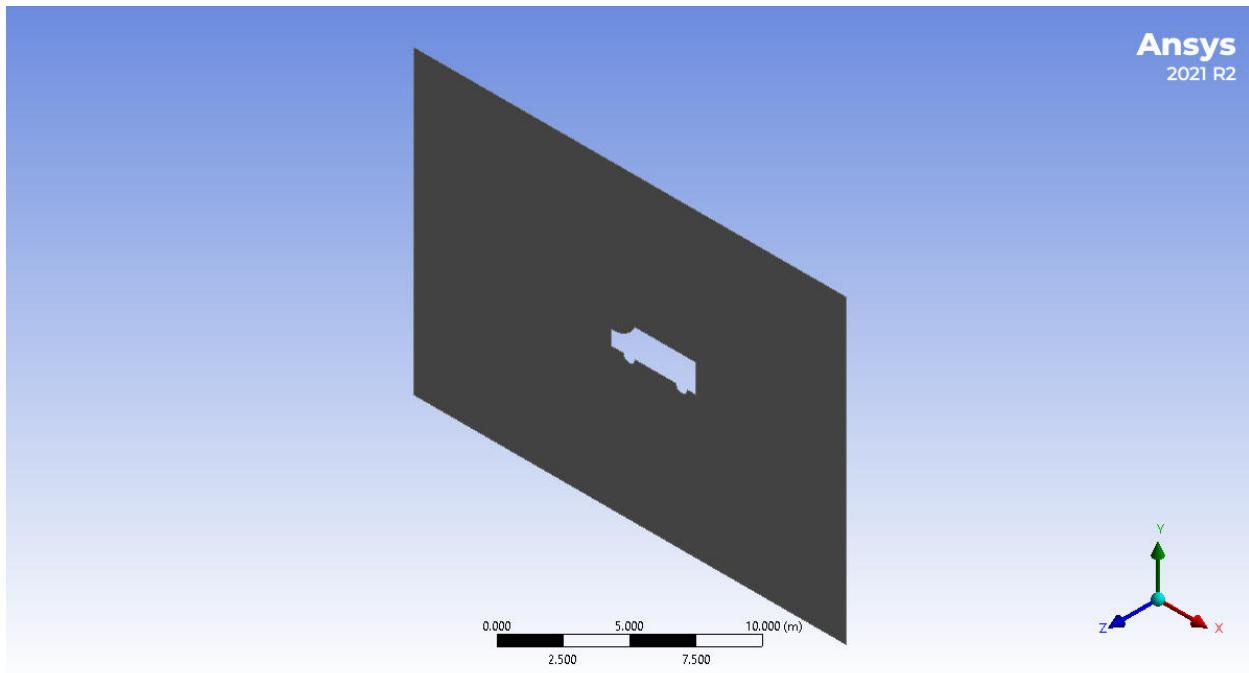






Intermediate design 4: Dawson Abernethy

Geometry:

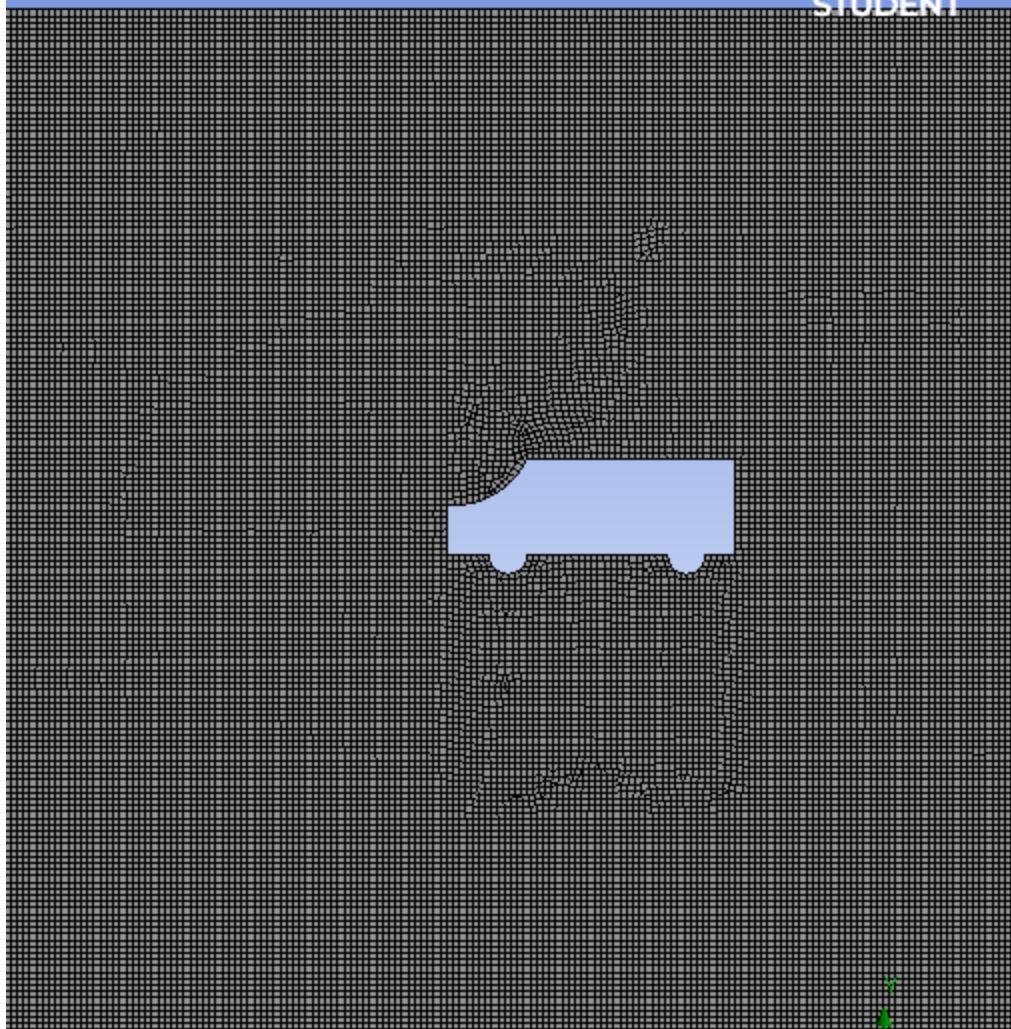


Mesh:

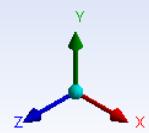
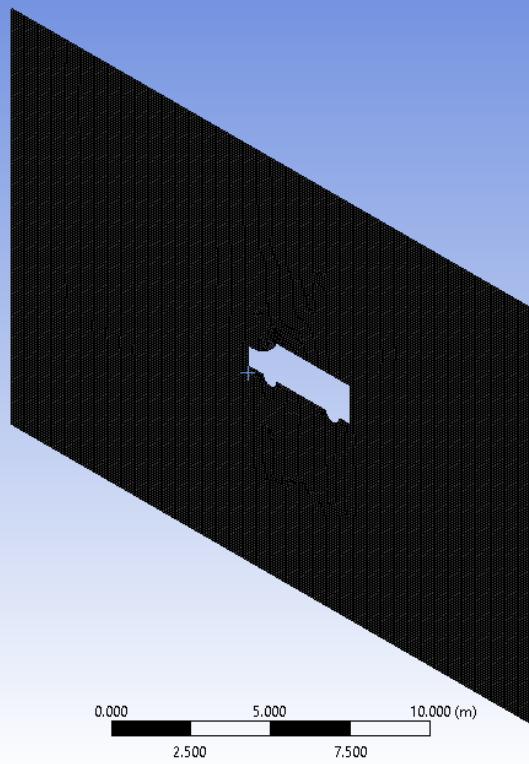
Ansys

2021 R2

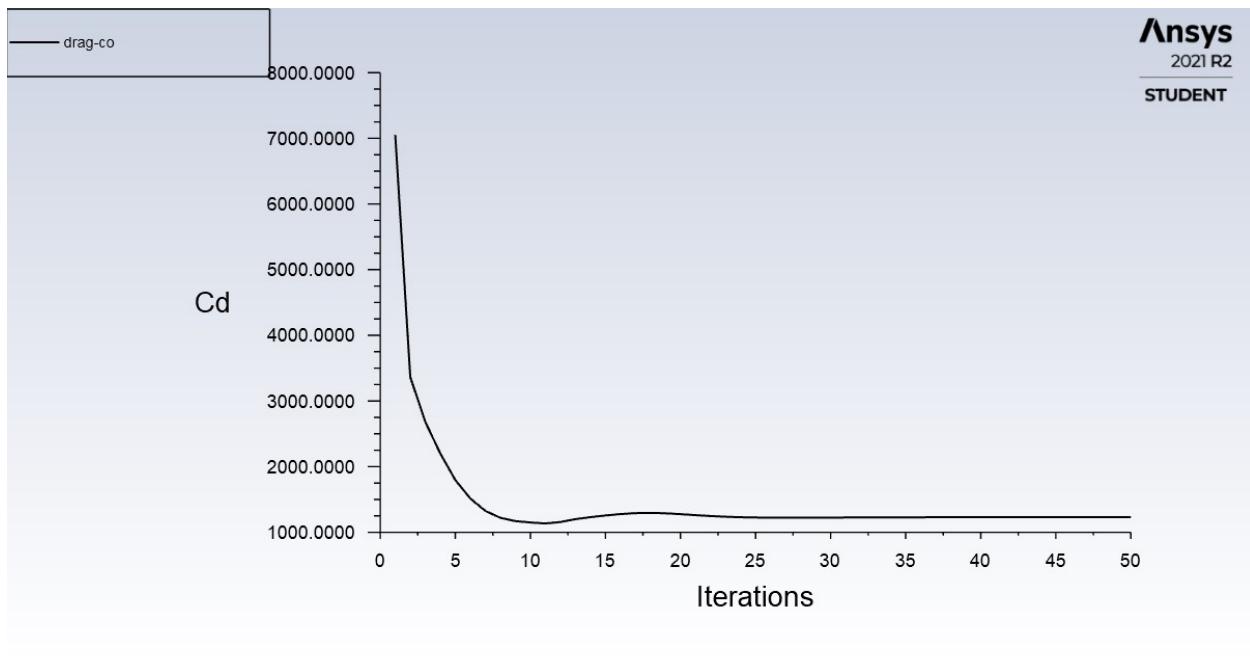
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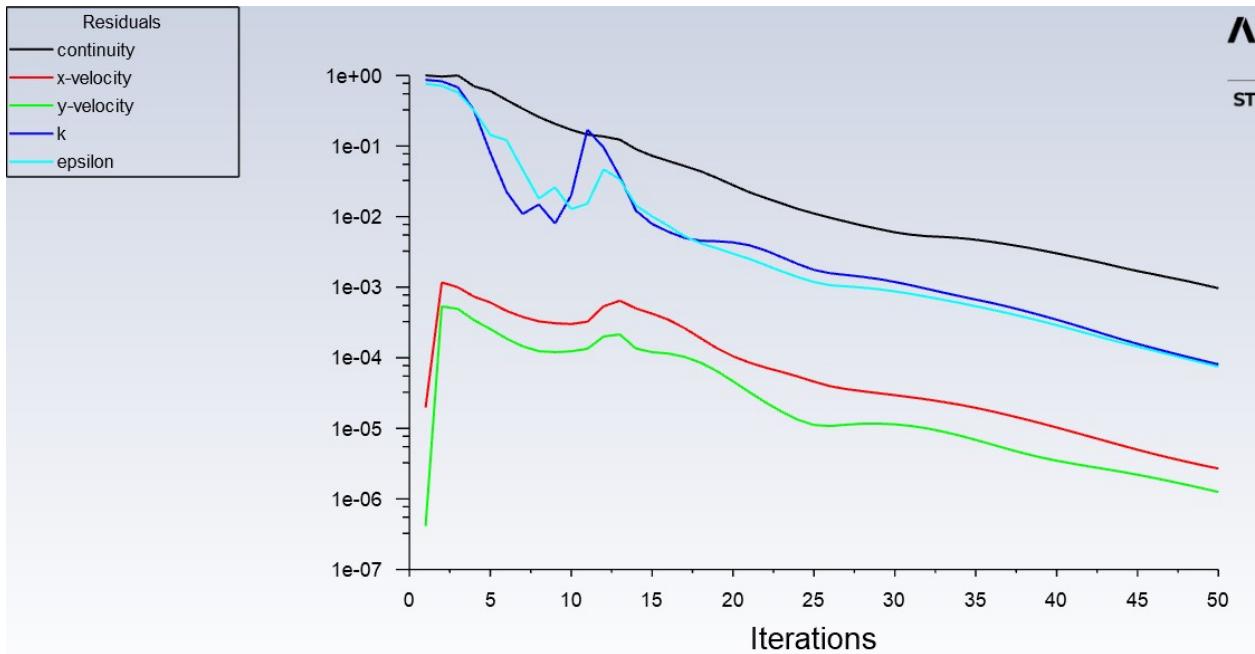


Ansys
2021 R2
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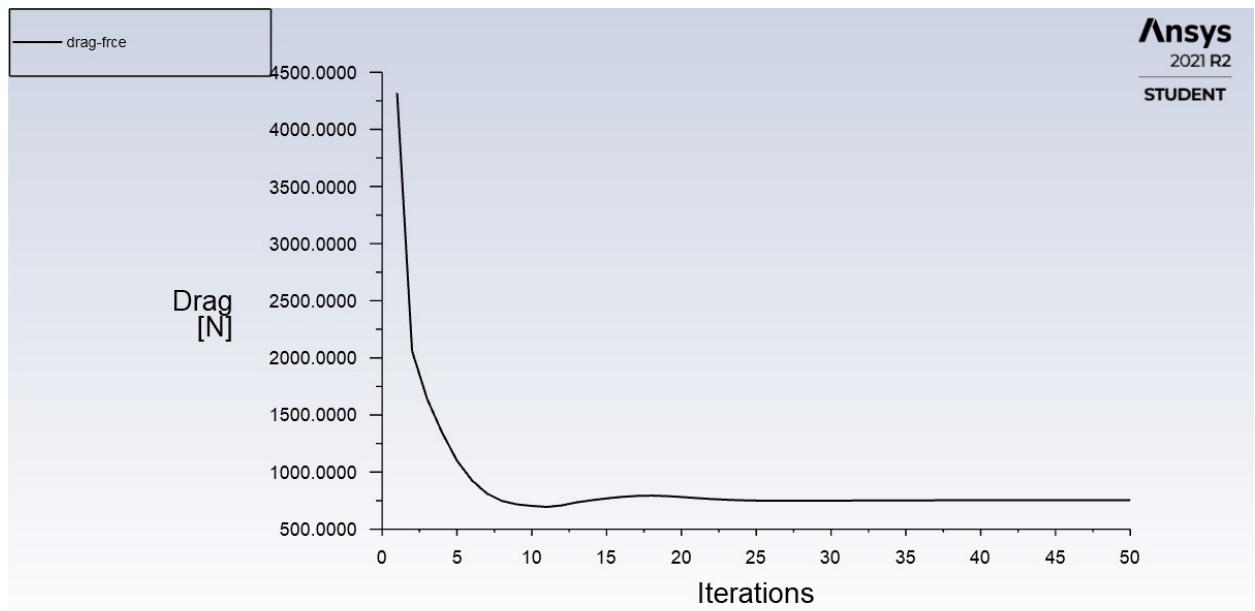
For velocity 120km/hr: Drag Force= 755.1366N, Draf Coefficient=1.23287



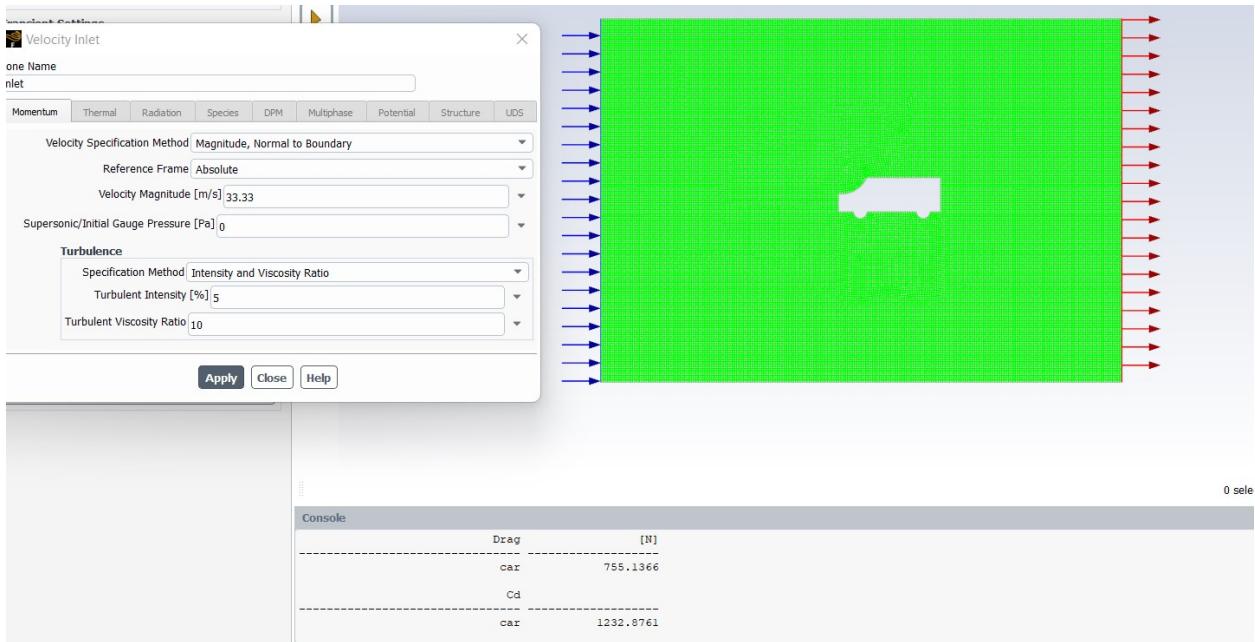


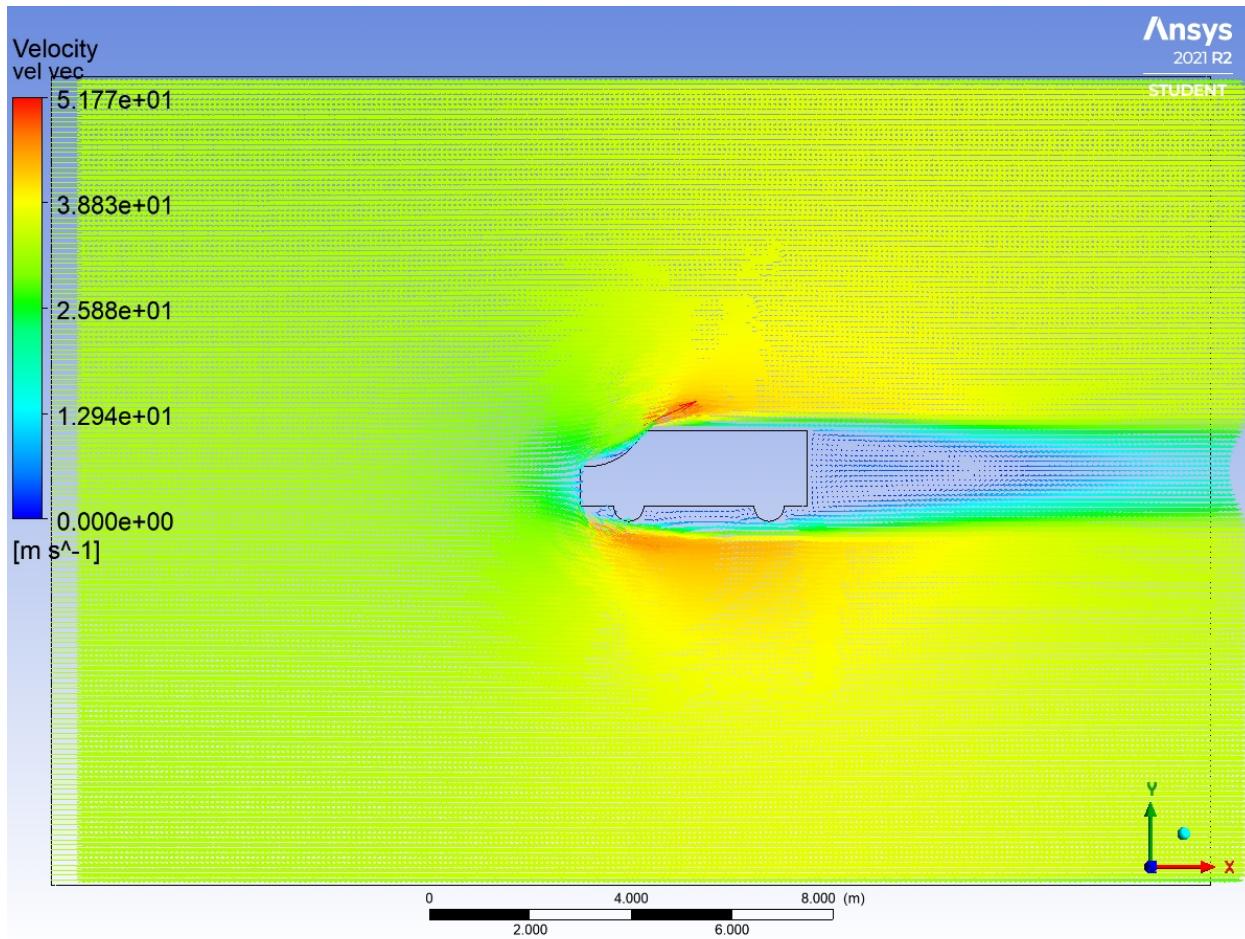
0 selected all

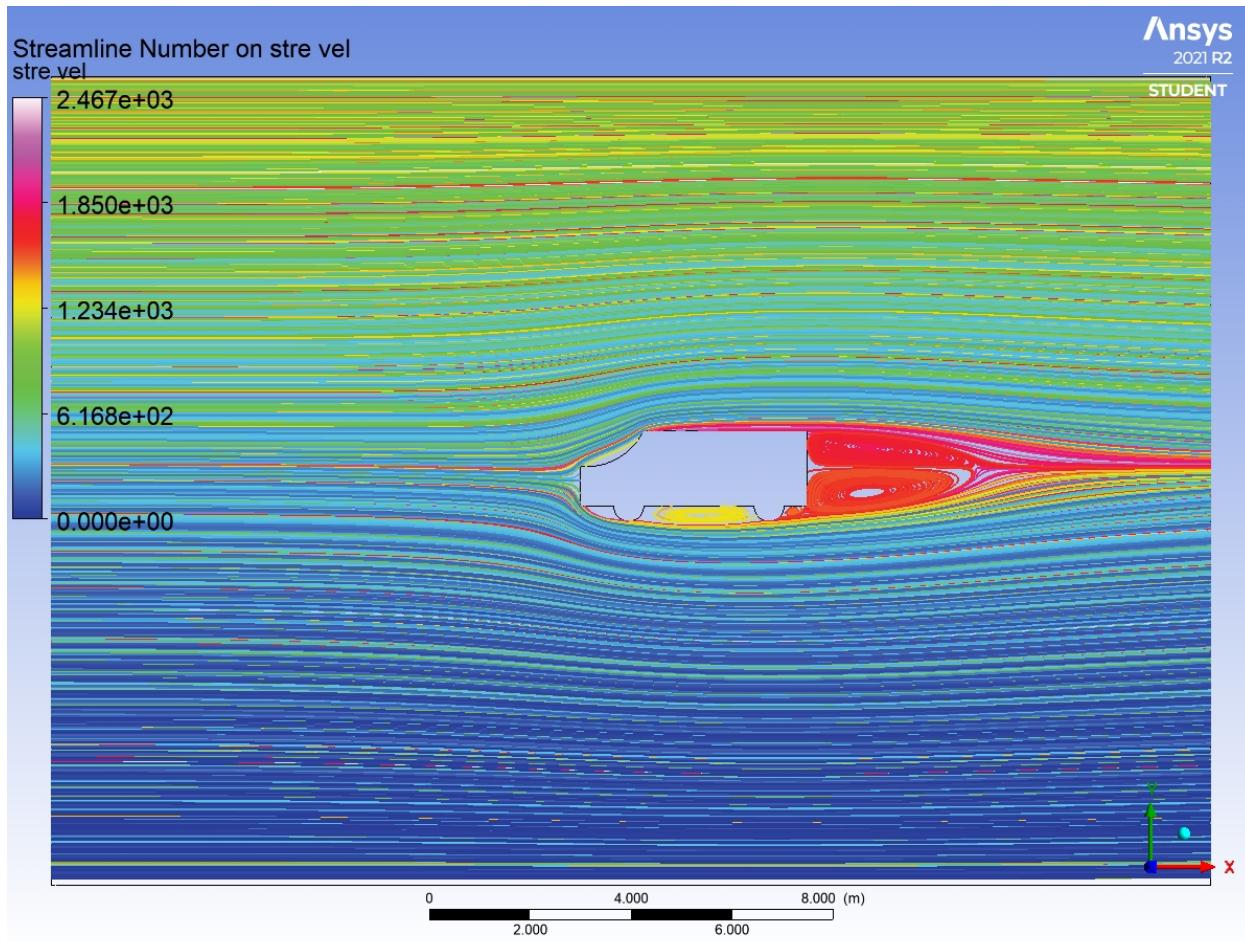
Drag [N]	
car	755.1366
Cd	
car	1232.8761

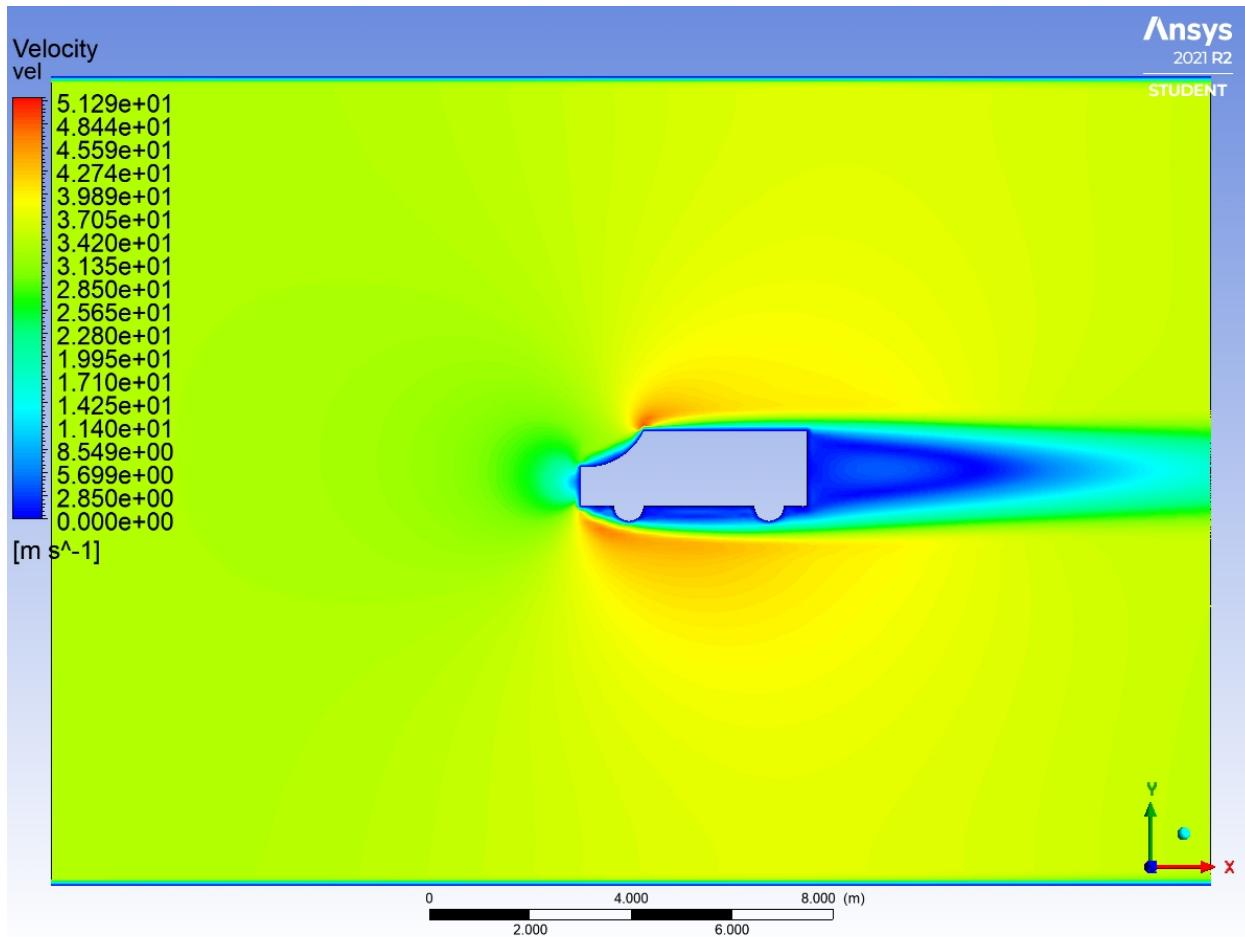


Velocity:

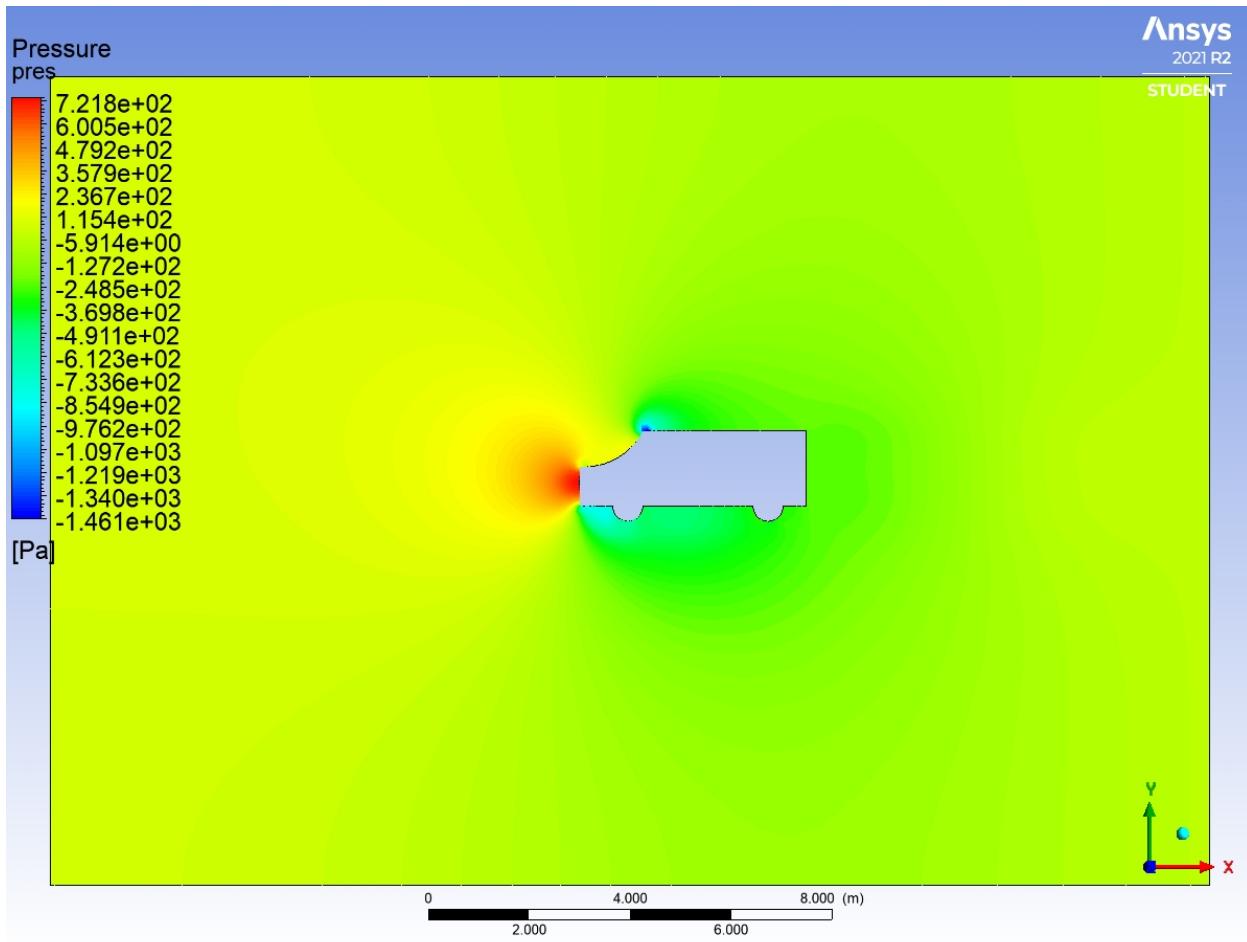


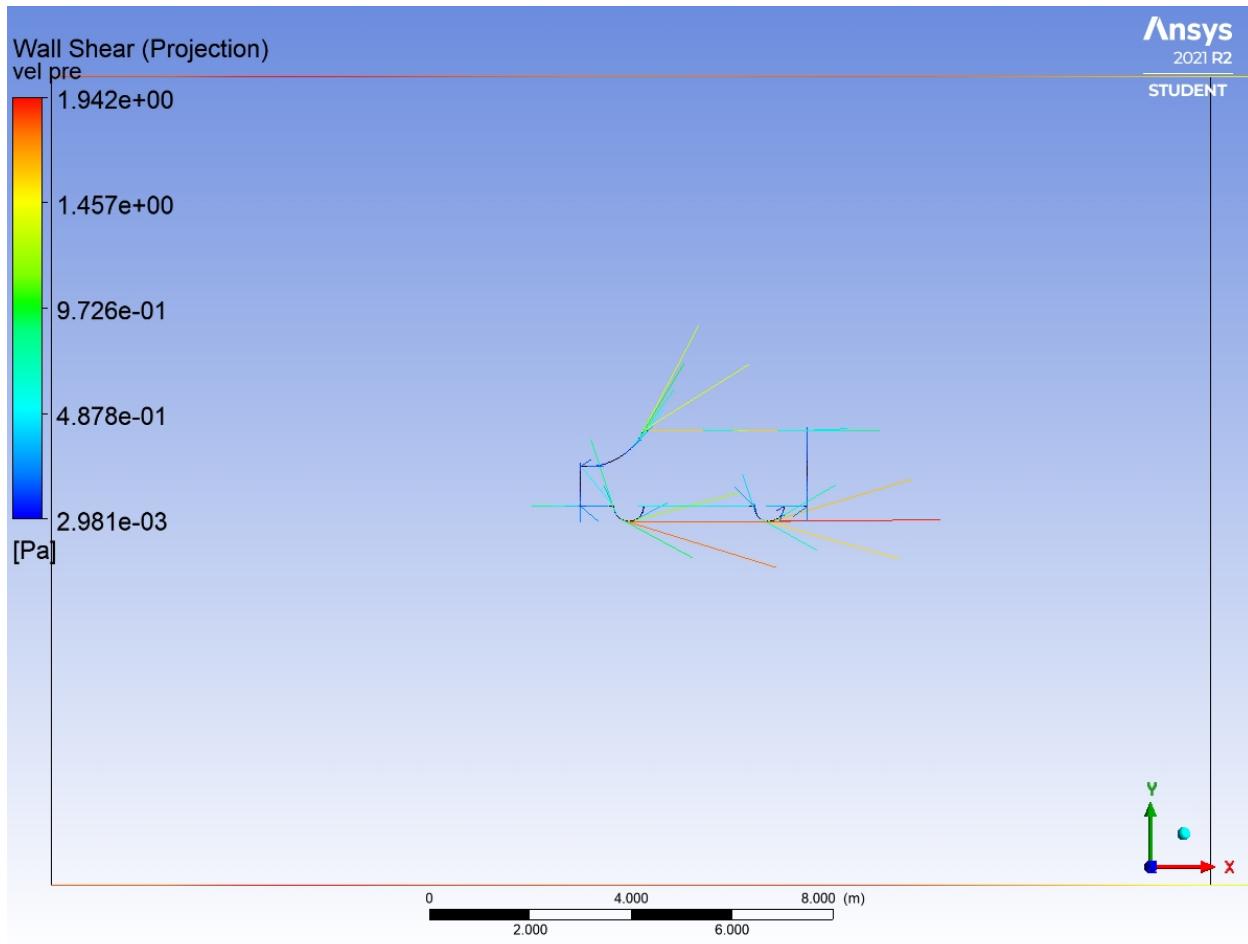






Pressure:





Declaration :

Trey Vela - Intermediate Design 1

Pinak Bhuban - Initial Design, Intermediate Design 2

Dane McMahon - Intermediate Design 3

Dawson Abernathy - Intermediate Design 4