Fluid Mechanics - Aero Project

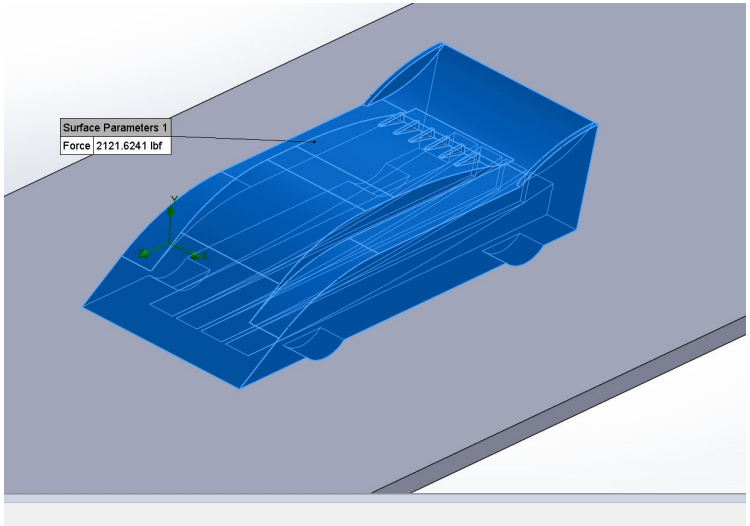
James Lee, Nicholas Stephan, Blake Viggiano

Executive Summary

(All Numbers Ran at 150 mph Benchmark)	
Drag Force (lbs)	712.6079
Lift Force (lbs)	-1998.1848
Lift to Drag Ratio	-2.804045

Flow Sim - Surface Parameters

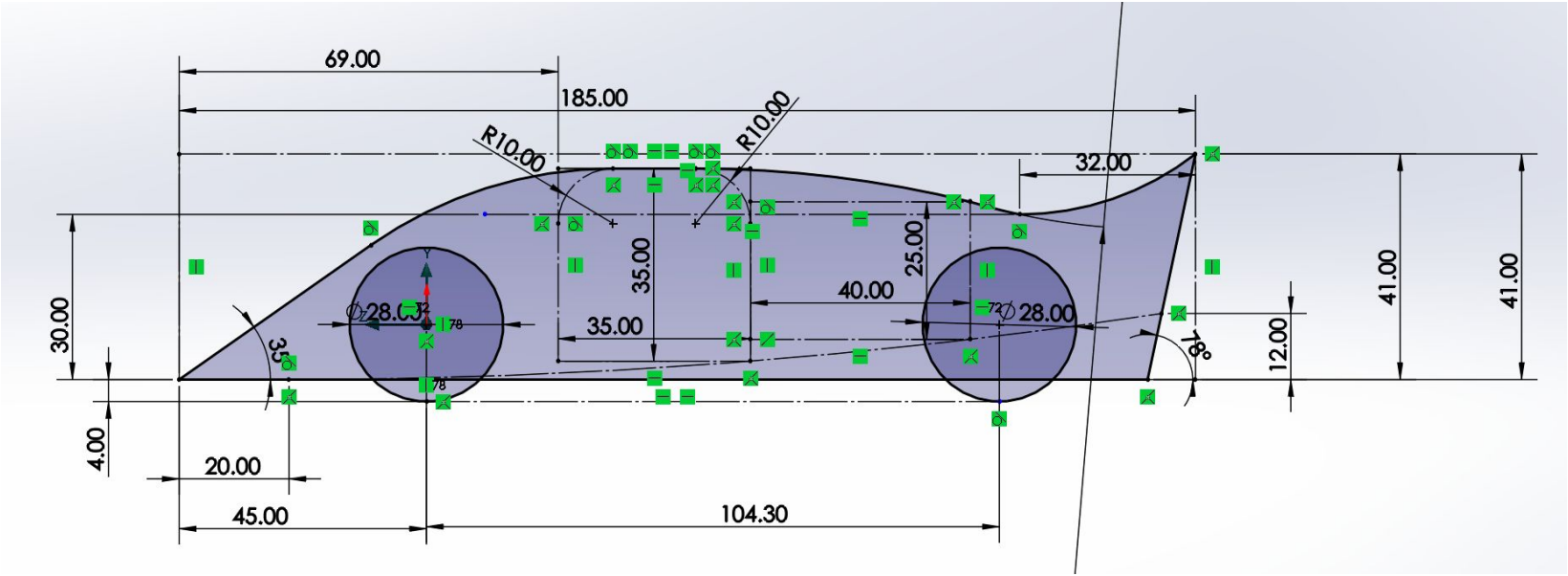
(Ran at 150 mph)



Integral Parameter	Value	X-component	Y-component	Z-component	Surface Area [ft^2]
Force [lbf]	2121.6241	-27.1321	-1998.1848	-712.6079	349.330

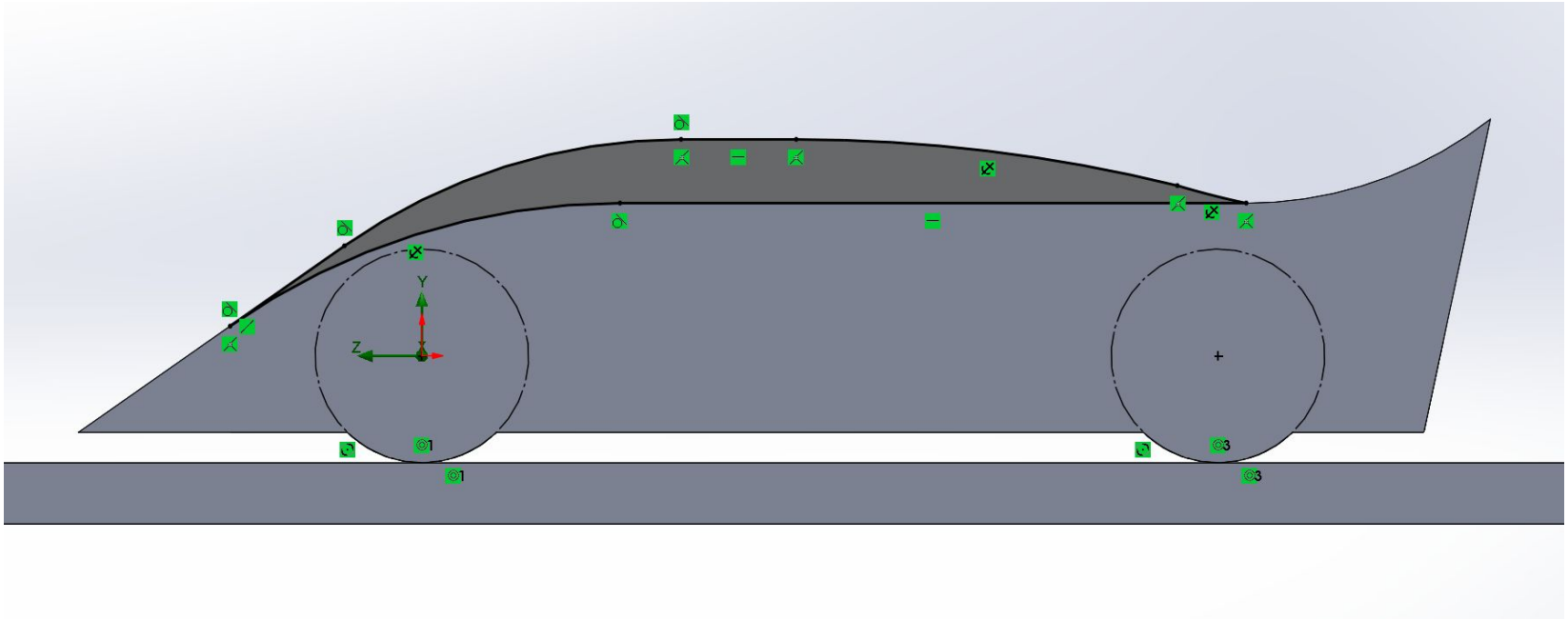
Dimensioned Images

Overall Side Profile



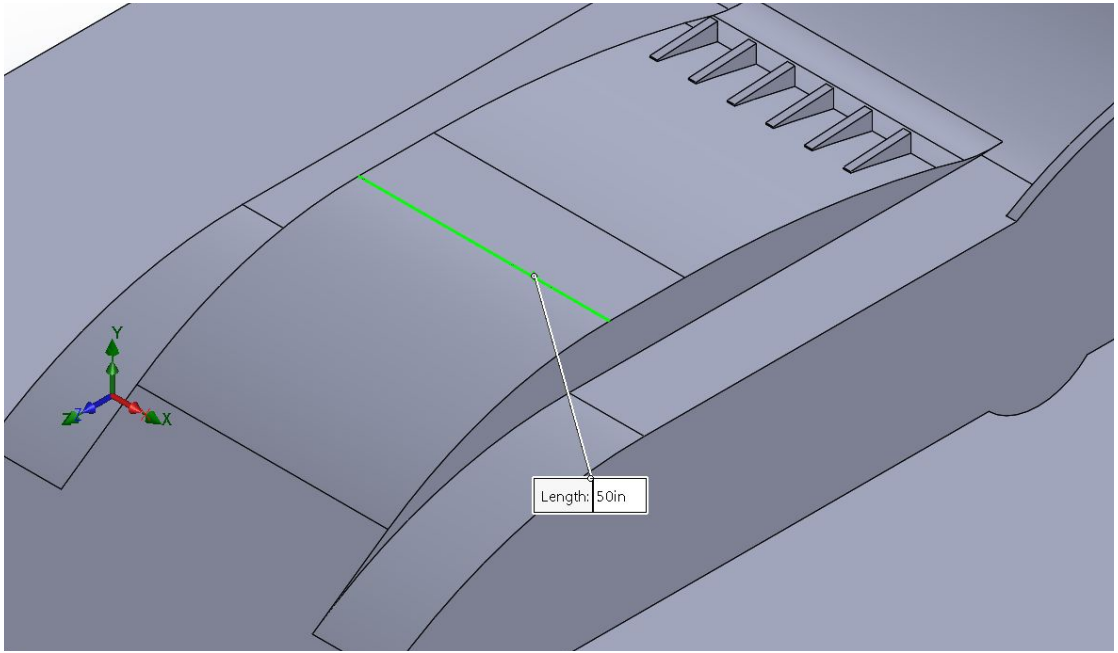
Dimensioned Images

Side Cuts - Maintaining Tire Integrity



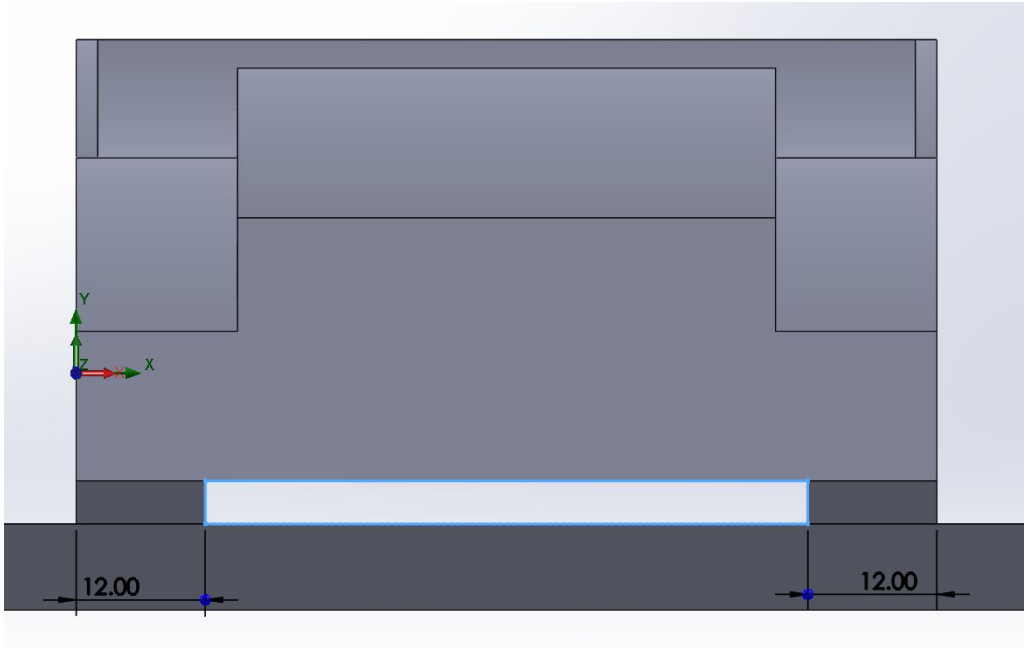
Dimensioned Images

Passenger Compartment Width



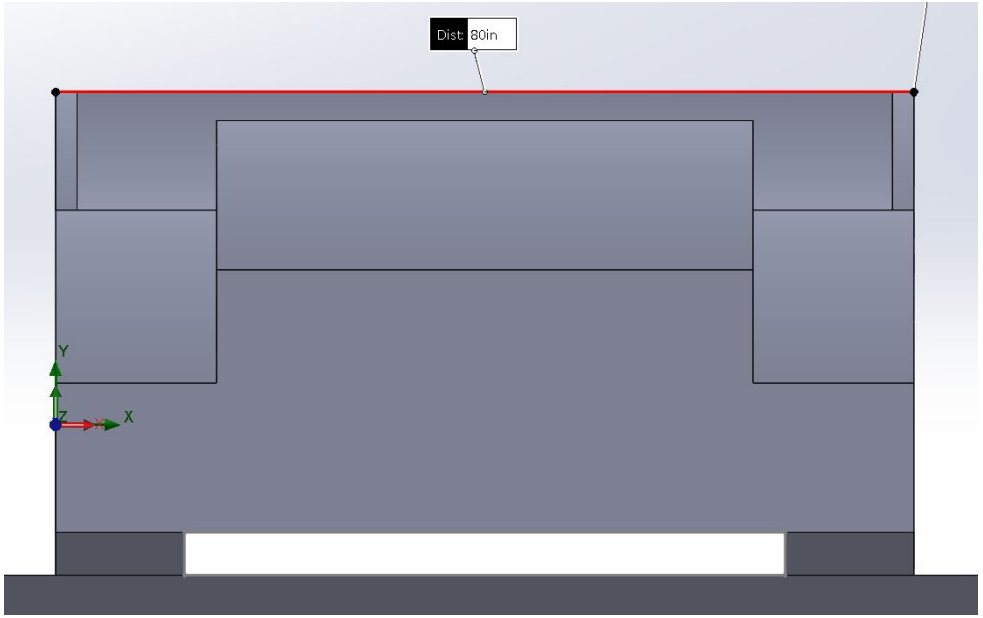
Dimensioned Images

Front View - Tire Width



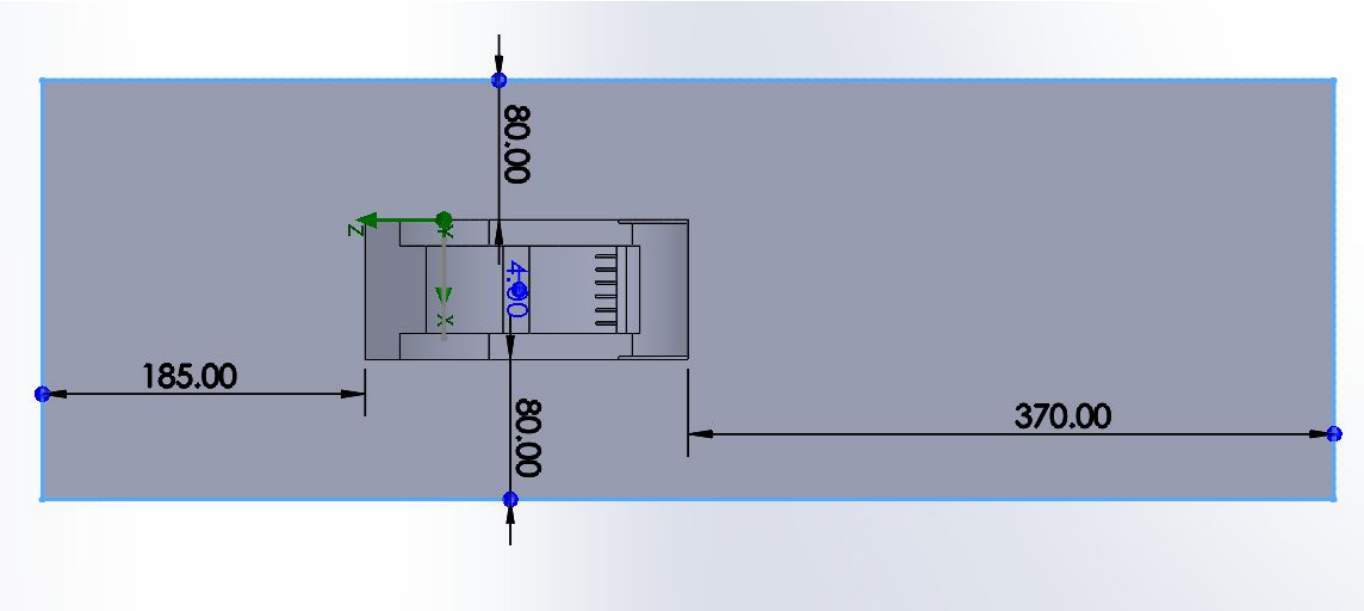
Dimensioned Images

Front View - Overall Width



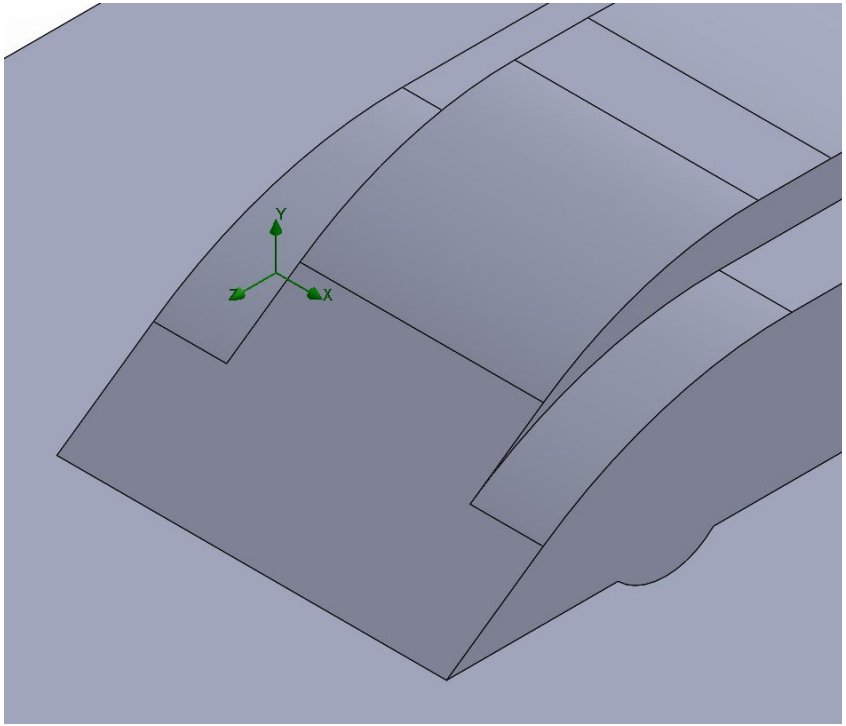
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Ground Plane



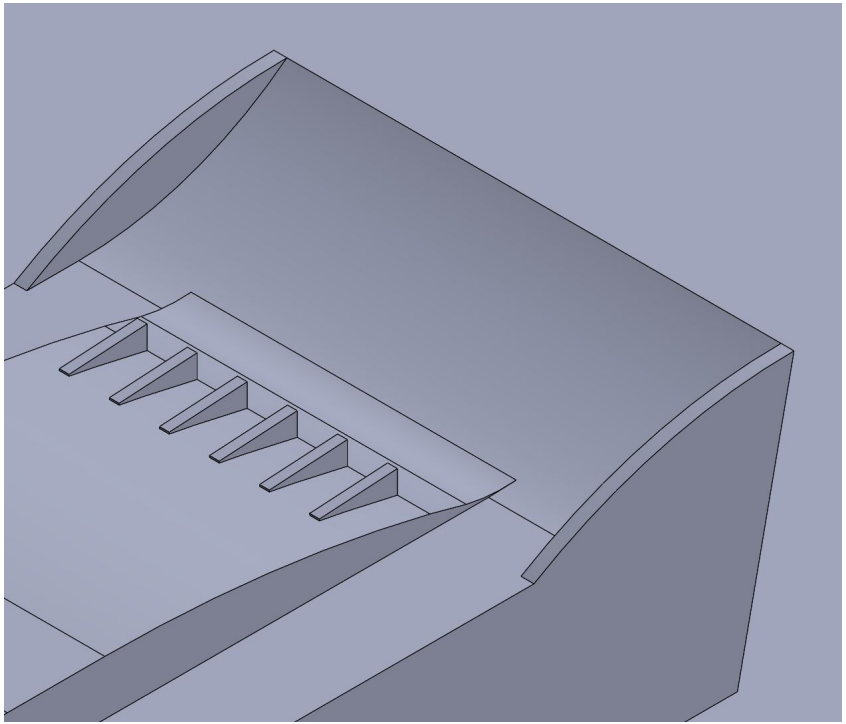
Design Approach - Front Profile

- Gentle, concave slope
  - Minimizes Drag on Front
- Areas adjacent to passenger compartment cut away
  - Provides gentler slope, even lower drag
- Gentler slope helps minimize low pressure over passenger compartment



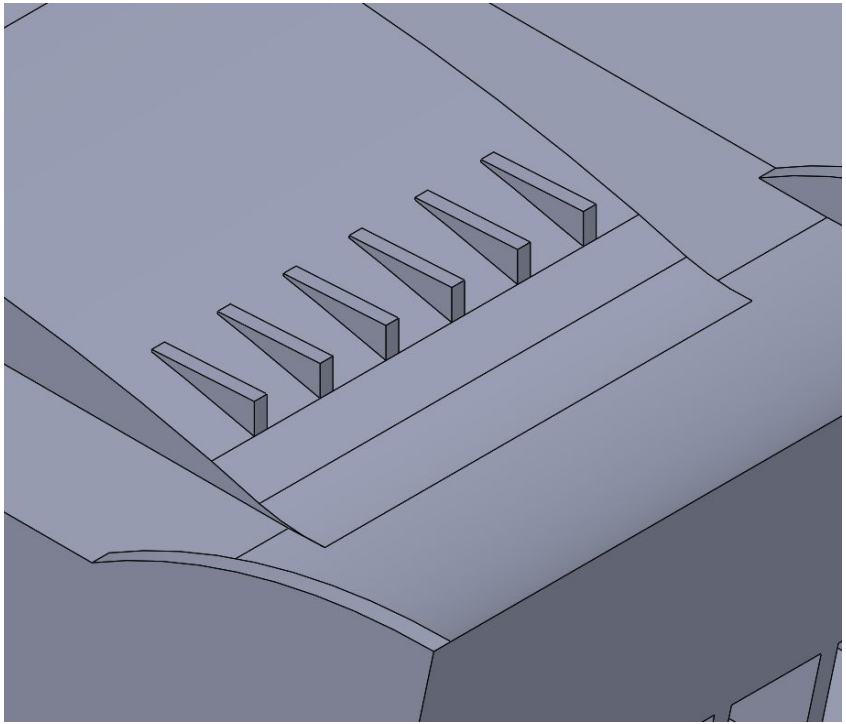
Design Approach - Rear Wing

- Gentle, concave upwards slope
  - Increases pressure on the back, pushes behind the car upwards (downforce)
- Side panels prevents air from shooting out the sides of the wing
  - Contains the air, disperses pressure and increases downforce



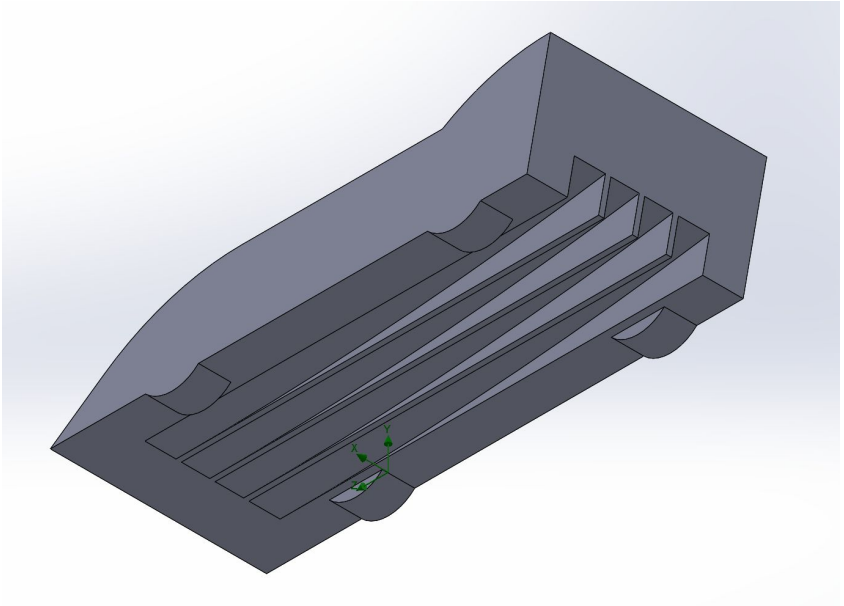
Design Approach - Vortex Generators

- Located on back of passenger compartment/engine block
- Helps prevent flow separation into rear wing
  - Increases laminar flow
- More air will hit rear wing, increasing downforce

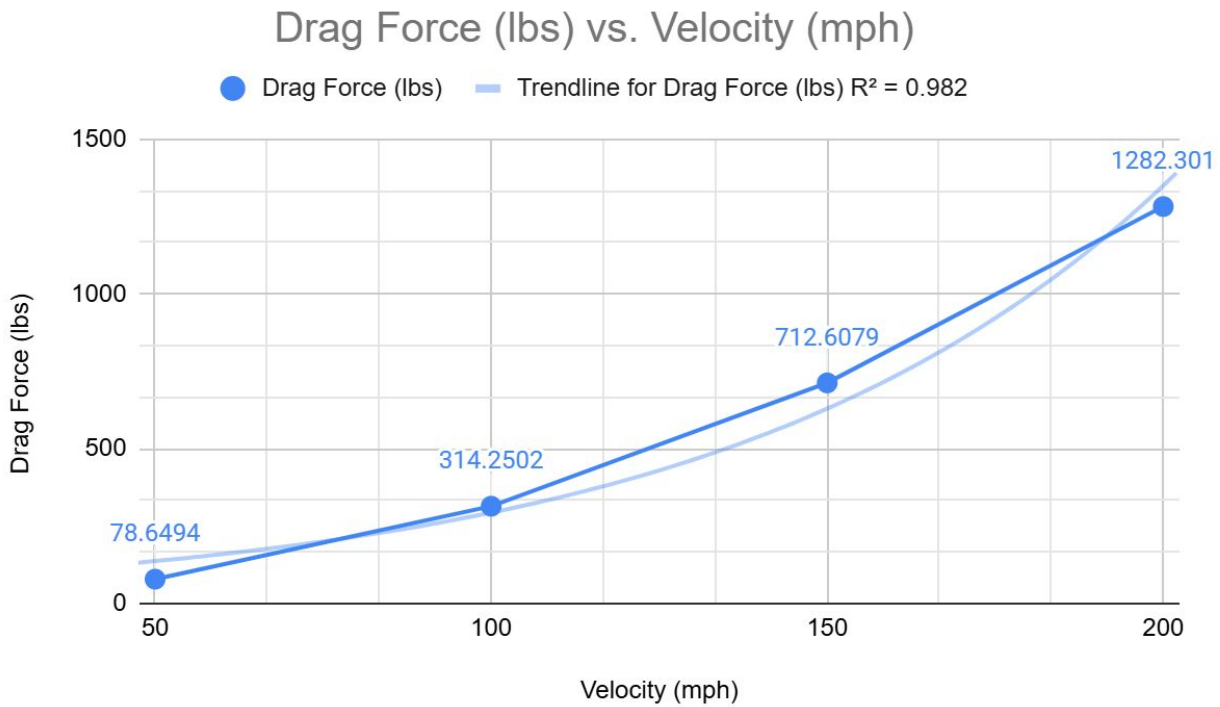


Design Approach - Rear Diffuser

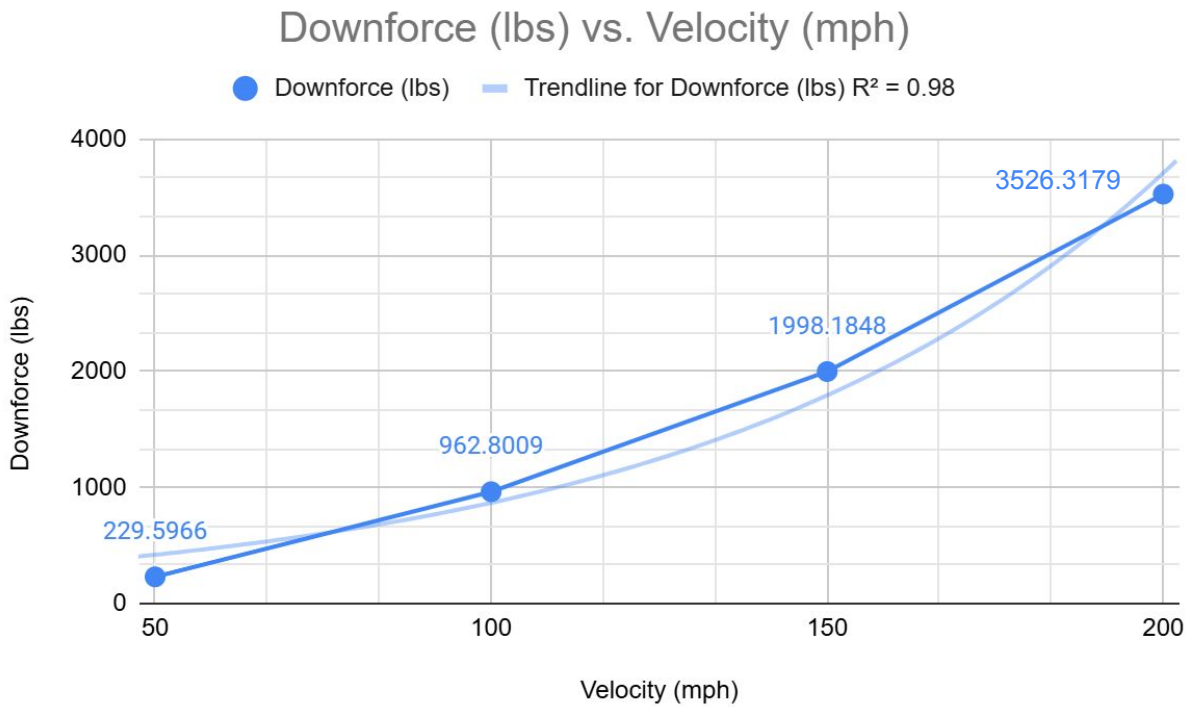
- Funnels air and launches air behind car, providing downforce
- Separate channels help to prolong laminar flow
- Extensive testing resulted in current design– length, proportions, no rear fillet



Plots - Drag Force vs. Velocity

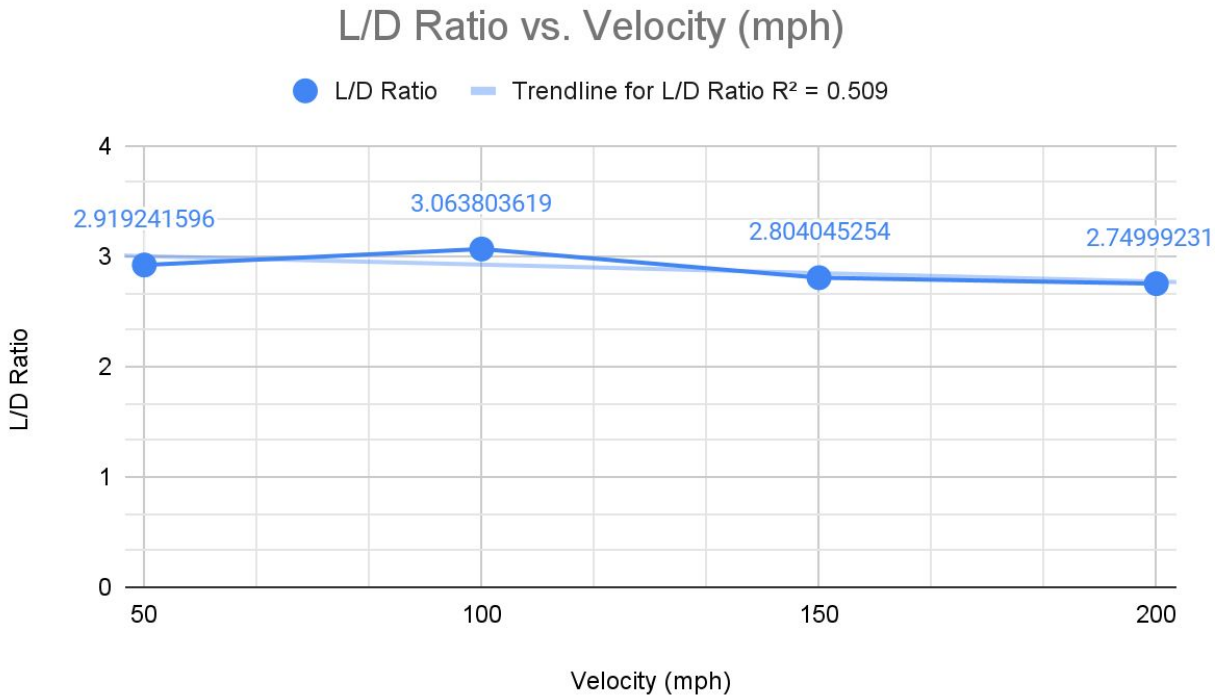


Plots - Downforce vs. Velocity

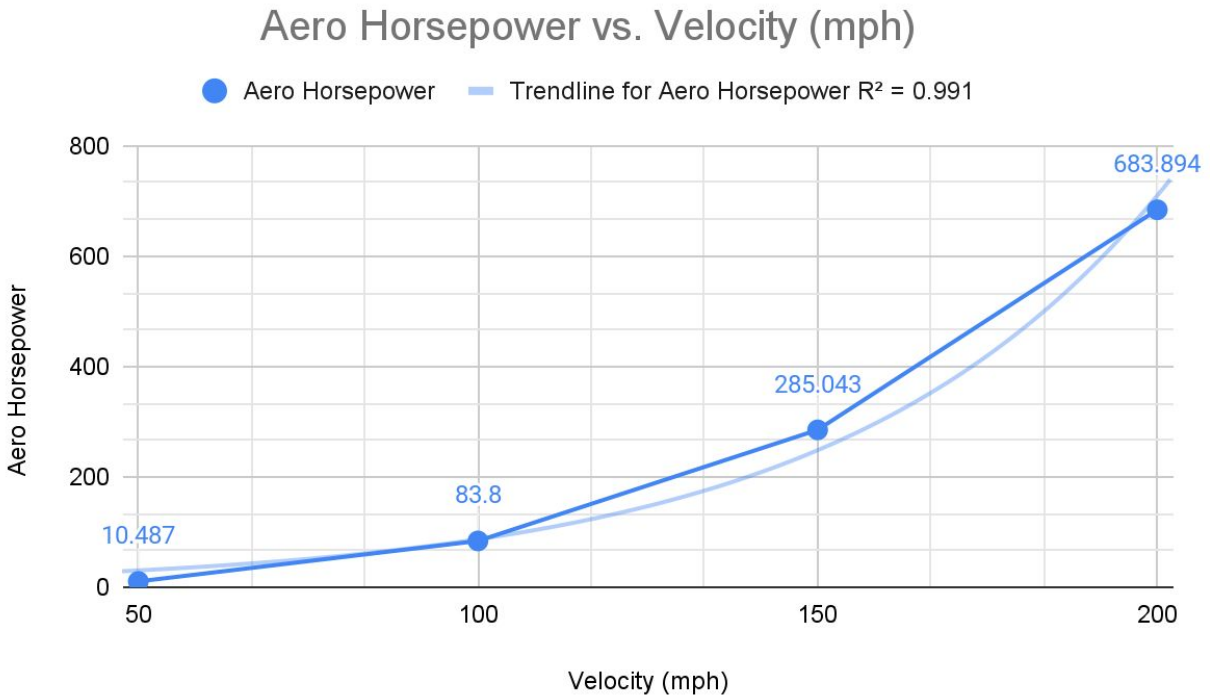


Plots - L/D Ratio vs. Velocity

Velocity (mph)	L/D Ratio
50	2.919241596
100	3.063803619
150	2.804045254
200	2.749992318
STDEV	**0.1389506369**



Plots - Aerodynamic Horsepower vs. Velocity



1/20 Scale Testing in Water Tunnel

Lift and Drag Coefficient Calculations @ 150 MPH

$Force_{lift} = 1998.1848\ lb = 8888.366\ N$

$Force_{drag} = 712.6079\ lb = 3169.837\ N$

$A_{front} = 80\ in * 45\ in = 2.323\ m^2$

$V_{air} = 67.056\ \frac{m}{s}$

$$Force_{lift} = \frac{\rho_{air} * \left(67.056\ \frac{m}{s}\right)^2 * A_{front} * C_L}{2}$$

$C_L = 1.418$

$$Force_{drag} = \frac{\rho_{air} * \left(67.056\ \frac{m}{s}\right)^2 * A_{front} * C_D}{2}$$

$C_D = 0.506$

Full-Size Model Testing in a Wind Tunnel:

$\rho_{air} = 1.2\ \frac{kg}{m^3}$ $V_{air} = 150\ mph$ $L_{FS} = 80\ in$ $\mu_{air} = 0.000018\ \frac{kg}{m * s}$

$$Re\ \# = \frac{\rho_{air} * V_{air} * L_{FS}}{\mu_{air}} = 9083852.8$$ (Ratio of inertia to viscous forces)

To obtain accurate results in scale model testing, the Re # must remain the same.

1/20 Scale Model Testing in a Water Tunnel:

$\rho_{water} = 998\ \frac{kg}{m^3}$ $L_{model} = 4\ in$ $\mu_{water} = 0.001\ \frac{kg}{m * s}$

$$V_{water} = \frac{Re\ \# * \mu_{water}}{\rho_{water} * L_{model}} = 89.587\ \frac{m}{s}$$ $V_{water} = 200.401\ mph$

$A_{front\ model} = 2.25\ in * 4\ in = 0.00581\ m^2$

$F_{drag} = \rho_{water} * V_{water}^2 * A_{front\ model} * C_D = 5289.155\ lb$

$F_{lift} = \rho_{water} * V_{water}^2 * A_{front\ model} * C_L = 14831.031\ lb$

Fuel Pump Sizing

