Aerodynamic Summary of Design Concept

This Nosecone-under tray model was motivated largely by a combination of the venturi effect and pressure gradients to negate lift and provide downforce. To start, the venturi effect occurs when air moving at a constant mass airflow passes through a smaller cross sectional area of a tube, and due to the speed of the moving air, the air pressure at that choke point is lower. It is most effective when air is gradually sped up by avoiding sudden shrinking of the cross sectional area of the aforementioned tube. From an automotive standpoint, this effect is put into use by the usage of an underbody and side skirts to form the top half of the tube, and using the ground as the bottom side of the tube. This structure is known as a Venturi tunnel. In cars, venture tunnels are often accompanied by diffusers. This is because at the end of a venturi tunnel the air pressure is still low and the air speed is still high: likely to be higher than air passing over and around the car. Without a diffuser, the air that’s moving quickly is slowed from the higher pressure of the outside air hindering its escape. To remedy this, a diffuser is used to first use the venturi effect (Bernoulli’s principle) to slow down this air so that the outside air actually aids in evacuating the underbody air. Overall this increases the airspeed under the car and thus its lift cancellation. As a bonus, because the airspeeds are much more similar between the outer air and the underbody air, there is less turbulent drag.

This model has one rather long venturi tunnel down the center of the chassis, which gradually slopes towards the ground to keep drag low while increasing the airspeed of the underbody air. At the rear, it diffuses air right behind the side-pods (in front of the rear wheels) and in between the rear wheels with the central diffuser. The shape of the diffuser’s top side is intentional in order to provide a pressure differential to aid extraction of under-body air from the under tray. It is also shaped in this way to allow suspension and wheel/tire clearance.

The nosecone of this model is fairly generic of formula nosecones with a gentle top slope to reduce pressure buildup (and thus reduce drag). However it does have a pseudo airfoil shape on the bottom left and right edges. These edges curve downwards at the front and then sweep upwards along the side of the nosecone, guiding air upwards: the very slight jutting of the nosecone edges causes a pressure differential that extracts the air that is following these wide grooves in underside of the nose. The central underside of the nose is intentionally arched open to allow air to pass freely under the nose, and feed the venturi tunnel further back in the aero package.  
  
CFD on the nose has revealed a drag on the nose of approximately 8.8 Newtons and a vertical force of 4.2 Newtons upwards (prior to lowering the angle of attack on the nose and adding the pseudo-airfoils). While we haven’t run CFD on this newest iteration, It is likely to have similar drag characteristics (slightly higher drag) with a lowered upward force (better lift-negation). Factoring in the ground for the under tray, I am confident that CFD will reveal appreciable gains in lift-negation for a reasonable drag tradeoff.  
  
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