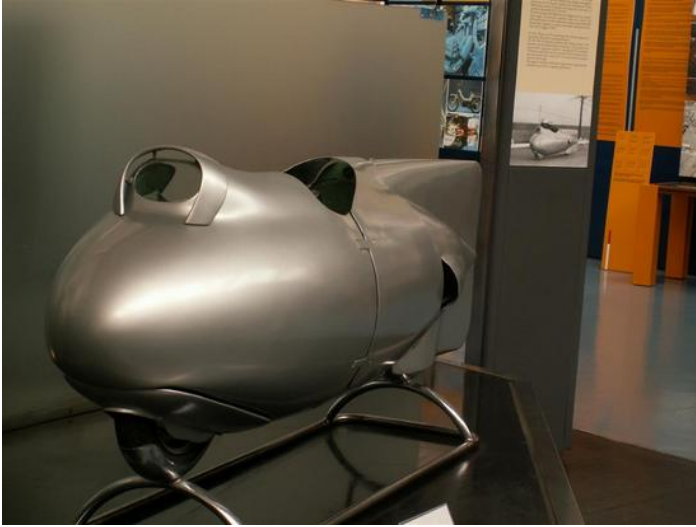


This page is dedicated to the thing that slows your scooter down the most. At higher speed, all the tuning effort you do is mostly aimed at overcoming the forces of pushing you and your scooter through air.



**Left** is the Vespa landspeed record scooter which set the world speed record for a flying kilometre at an average of 171.102 km/h. Scooter Magazine stated this had a 21 Hp engine (at the crank). **Right**, speed can be gained through a simple Cuppini Screen, this photo shows an aerodynamic shape compared to the less aerodynamic shape of the rider.

## Drag Coefficient and Drag Area

[http://en.wikipedia.org/wiki/Drag\\_coefficient](http://en.wikipedia.org/wiki/Drag_coefficient)

Drag Coefficient is a number that helps compare how easily things of various areas travel through air. This is one of the things that goes into working out how much drag, and therefore how much force required to overcome the drag, a surface has.

For example a man in an upright position has a drag coefficient of 1.0 - 1.3. Where as a Porsche has a drag coefficient of 0.3. So if you were the shape of a Porsche, you would require a 3rd the power to overcome drag. It is not hard to see why making yourself more porche like with a simple windscreen on a Vespa (or reducing your frontal area by ducking down), will increase the top speed noticeably.

[http://en.wikipedia.org/wiki/Automobile\\_drag\\_coefficient#Drag\\_area](http://en.wikipedia.org/wiki/Automobile_drag_coefficient#Drag_area)

Drag area is a variation of drag coefficient that allows you to directly compare drag including the effect of the frontal area. In the example above ducking down, as everyone knows, makes you go faster. This is not because you are a more aerodynamic shape (though you may be) it is because you are smaller (less frontal area). Drag area allows you to see the important factors as a single number and this tells you what vehicle will actually require less power to push through air.

Knowing about drag is important because it's impact is exponential. It is both the speed of the air that hits you and the quantity of air hitting that slows you down with a force. Then you have to overcome that force faster the faster your go (so Hp required is relative to velocity \* velocity \* velocity! [Power to overcome Drag](#)). So going twice as fast means twice as much air hitting you at twice the speed. A little improvement

in aerodynamics can be equivalent (and cheaper) than engine modifications as well as reducing the strain on drive components and fuel consumption.

## Vespa Drag Measurements

To calculate drag, one thing you need to know is the frontal area of what is being pushed through air. Here are some area measurements roughly taken from a front on photo of a Vespa PX (no screen).

Headset area =  $0.0711 \text{ m}^2$

Frame area =  $0.3173 \text{ m}^2$

Wheel area =  $0.0482 \text{ m}^2$

Fork area =  $0.0187 \text{ m}^2$

Mirror area (each) =  $0.0148 \text{ m}^2$

Engine and Exhaust =  $0.0440 \text{ m}^2$

Total Vespa area =  $0.5299 \text{ m}^2$

Rider area (Note this is very conservative - a big rider in full motorcycle gear would be more like  $0.5 \text{ m}^2$ )

Body area (above headset) =  $0.3 \text{ m}^2$

Head area (with helmet) =  $0.05 \text{ m}^2$

Total Rider area (without screen) =  $0.35 \text{ m}^2$

If you look at the above the first thing to note is that the rider makes up over one 3rd of the area presented to the oncoming air. The drag coefficient of a person wearing motorcycle gear, sitting upright, is at a guess = 1 (based on searching google for know things like bicycle riders, skiers, sky divers etc). So it is easy to see the a curved windshield, which could have a drag coefficient of less than half (based on what is expected for curved surfaces on cars), would have a noticeable effect on top speed. The HP required to overcome drag would instantly drop by one 6th (i.e. instead of requiring 14 HP to do 130Km/hr, you might only require 12 HP).

For more information see the simulated results when they are available at [Vespa CFD/3D Model](#), here the calculated frontal area of scooter and rider is  $0.81518 \text{ m}^2$

## Scientific Study

There is a 2002 scientific paper available called the [Aerodynamic Investigation of a Scooter in the University of Perugia Wind Tunnel Facility](#) by Stefano Ubertini - Univ. of Rome Tor Vergata and Umberto Desideri - Univ. of Perugia. The report is on a 460cc maxi scooter capable of 160 km/hr and some of the information is highly applicable to Vespa riders, especially those going fast. Below is a summary of the important points:

- scooters are normally road tested and not measured in wind tunnels
- *'A considerable influence on the aerodynamic behaviour of a motorcycle is exerted by the rider, which contributes to the frontal area of the vehicle'*
- Considering the scooter by itself (i.e. no rider) the drag is low (which is good) and comparable to a motorbike

- At speed a scooter tends to lift more due to having less weight at the front. [Vespa Labs Note: The scooter tested had 39% load at the front, a Vespa PX has only ~20% with which means even less stability at high speed!]
- It is possible to use a NACA aerofoil to reduce the lift at the front

The paper references a few other interesting papers. These have not been read fully but the abstracts provide some clues:

[The Effect of Handlebar Fairings on Motorcycle Aerodynamics](#) states '*cross-wind response may be reduced with a fairing or windshield mounted*'.

## Useful Links

<http://www.tonyfoale.com/Articles/Aerodynamics/AERO.htm>

[http://www.sae.org/technical/papers/ground\\_vehicle/AERDY](http://www.sae.org/technical/papers/ground_vehicle/AERDY)

[Motorcycle Workshop. Part 2: Aerodynamics](#)

Tunnel Vision [http://www.sportrider.com/tech/146\\_0106\\_aero/index.html](http://www.sportrider.com/tech/146_0106_aero/index.html)

*What makes the Suzuki Hayabusa faster than the more powerful Kawasaki ZX-12R? A visit to the National Research Council wind tunnel provides the answer - From the June, 2010 issue of Sport Rider. By Bruce Reeve*