**Sherwood Heights School**

2006 Science Project

# Wind Tunnel Testing

**Research Paper**

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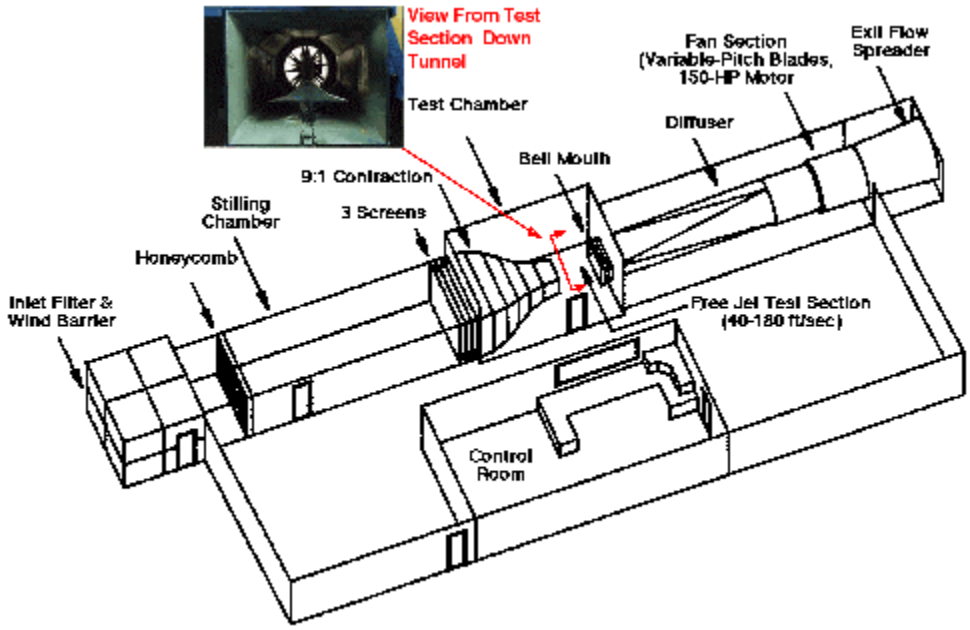
## Introduction

Wind tunnel testing is used to support many major development processes involving aerodynamics. It is used for aircraft, helicopters, cars, trains, and laboratory research.
A wind tunnel is a research tool developed to assist with studying the effects of air moving over or around solid objects. The wind tunnel provides the engineers with valuable data on scale models. The wind tunnel is important contribution of the Wright brothers to the science of aerodynamics.

## Wind Tunnel Structure

Main components of a wind tunnel are: Drive Section, Settling Chamber, Contraction Cone, Test Section and Diffuser. Flow straighteners, honeycomb layers for reduced turbulence, air exchangers and diffusers are other common features. Measurement equipment and testing procedures include instruments for the measurement of pressure, temperature, forces, moments, turbulence intensity, etc.



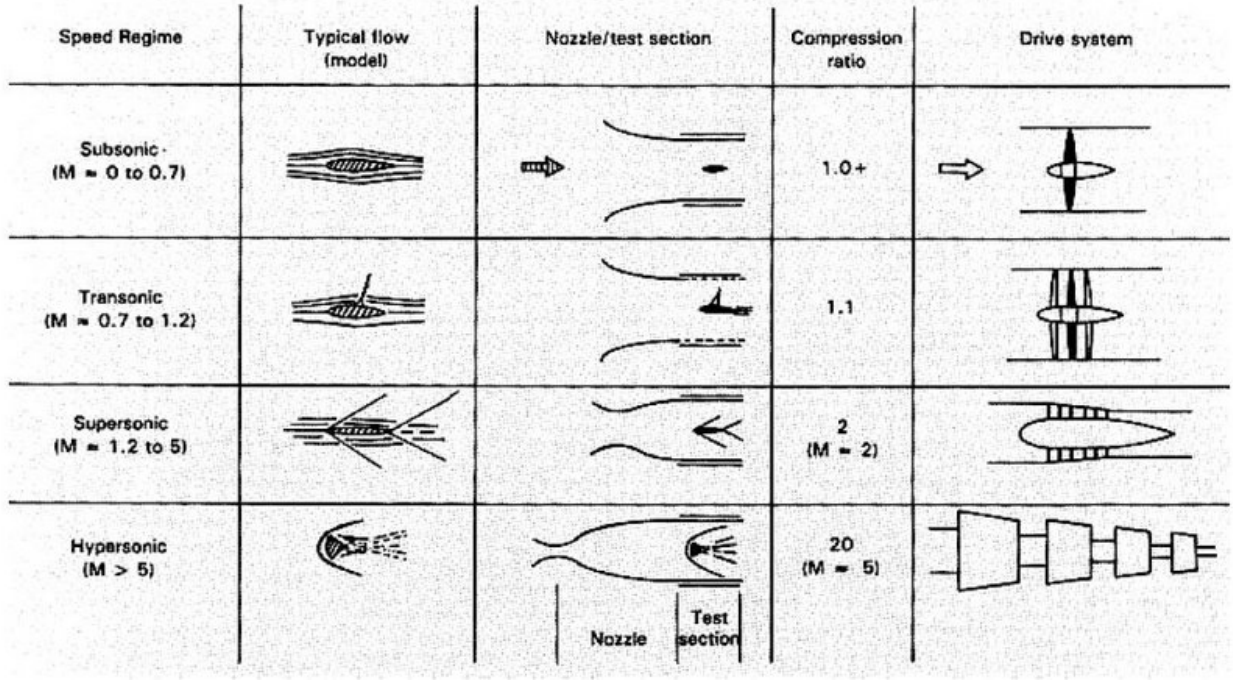

The ViGYAN Low Speed Wind Tunnel

**Drive Section** is the section of a wind tunnel that provides the force that causes the air to move through the tunnel. **Settling Chamber** is the section of a wind tunnel where the airflow is straightened and turbulence is reduced, normally prior to entering the contraction cone. **Contraction Cone** is the section of a wind tunnel where reducing the cross-sectional area of the tunnel reduces a large volume of low-velocity air to a small volume of high-velocity air. **Test Section** is the section of a wind tunnel where the model and sensors are placed. **Diffuser** is the section of a wind tunnel where the velocity of the airflow is reduced by flowing it into a part of the tunnel with increasing cross-sectional area.

## Wind Tunnel Classification

Wind tunnels may be classified according to their basic architecture (open-circuit, closed-circuit), according to their speed (subsonic, transonic, supersonic, hypersonic), according to the air pressure (atmospheric, variable- density), or their size (ordinary ones or full-scale). In an **open-loop** tunnel, the air flows in one end of the tunnel and out the other. In a **closed-loop** tunnel, the air is recirculated.

There are a number of special wind tunnels (metereologic tunnel, shock tunnel, plasma-jet tunnel, hot-shot tunnel).

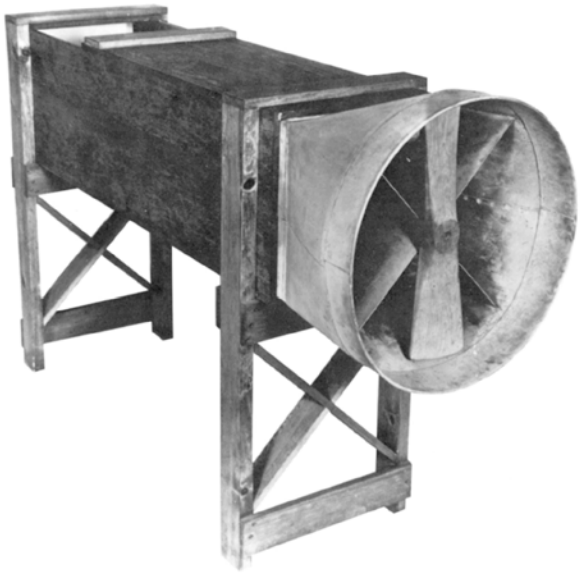


## Wind Tunnel Corrections

The test conditions are never the same as the operational conditions. Among the most well known effects there are the scale effects, the flow blockage, due to the presence of the model in the test section and wall boundary layers.
Other effects are dependent on the type of experiments performed, for example angle of attack corrections for a wing. Wind tunnel correction requires special analysis and processing techniques**.**

## Wind Tunnel History

The Wright brothers, working with Octave Chanute invented and built a simple wind tunnel in 1901 to study the effects of airflow over various shapes while developing their revolutionary Wright Flyer. Before building their own wind tunnel, the Wright brothers employed an unconventional testing machine: a bicycle with a third wheel mounted horizontally on the front of the frame. Two test shapes were mounted on the wheel, and the bicycle was pedaled rapidly up and down the streets of Dayton, Ohio. It is estimated that it took the Wright Brothers less than 20 hours of wind tunnel testing to produce their successful Flyer.



The Douglas DC-3, one of the most successful commercial aircraft ever built, required about 100 hours of wind tunnel testing. Wind tunnel time has been steadily increasing since: the Boeing 747 required over 1000 tunnel hours; the NASA Space Shuttle testing required nearly 10 years of time.

## Use of Wind Tunnels

Some tests performed in the wind tunnel include:

- Drag/Lift measurements on aircraft, helicopters, missiles, racing cars.
- Drag/Lift/Moment characteristics of airfoils and wings.
- Static stability of aircraft and missiles
- Dynamic stability of aircraft.
- Surface pressure distributions.
- Flow visualizations (with smoke, oil, talcum).
- Propeller performances (torque, thrust, power, efficiency, etc.).
- Performances of turbofan engines.
- Wind effects on buildings, towers, bridges, and cars.

## The Advantages Of Wind Tunnels

Advantages of wind tunnels include reliable and consistent airflow, low turbulence, ability to make precise measurements, and reproducible conditions and results. Many things can benefit from wind tunnel testing. For example, reduced aerodynamic drag reduces fuel costs for long-distance truckers and increases top speeds of racecars. Buildings can be tested in wind tunnels to help determine stresses from high winds.

## References

1. Wikipedia – Wind Tunnel
2. Advanced Topics in Aerodynamics – Wind Tunnel and Experimental Aerodynamics

## Note

Front Page Photo: NASA wind tunnel with the model of a plane