

4 Drag

Forces of Flight

Four forces push and pull an airplane in flight. The force of **gravity** pulls the airplane downward. The airplane's wings produce an upward force called **lift** that counteracts gravity. A force called **drag**, caused by air resistance, slows the airplane down. To fight drag, the airplane uses a propeller or jet engine to produce a forward force called **thrust**.

The Basics

Drag is the force of resistance caused by air or liquid pressure. If you have ever put your hand out the window of a moving car and felt the wind pushing against it, or walked into the wind on a breezy day and noticed how hard it is to move forward, you have experienced drag.

Drag affects an object's ability to travel through air or fluid in several ways. Drag slows an object down. It forces a powered object to use more fuel. Drag can even pull an object apart if it is not designed to withstand the force of drag.

Aerodynamic drag, which affects objects in flight, comes from two primary sources: form drag and friction drag.



Stearman Kaydet



P-51 Mustang



Unlike this Boeing 767 airplane, a parachute is designed to increase drag to slow its descent.

Form Drag
The force needed to separate the air or liquid stream so it can go around an object is a source of drag. This is called form drag or pressure drag. The less streamlined an object is, the more force the air will exert; streamlined objects are less affected.



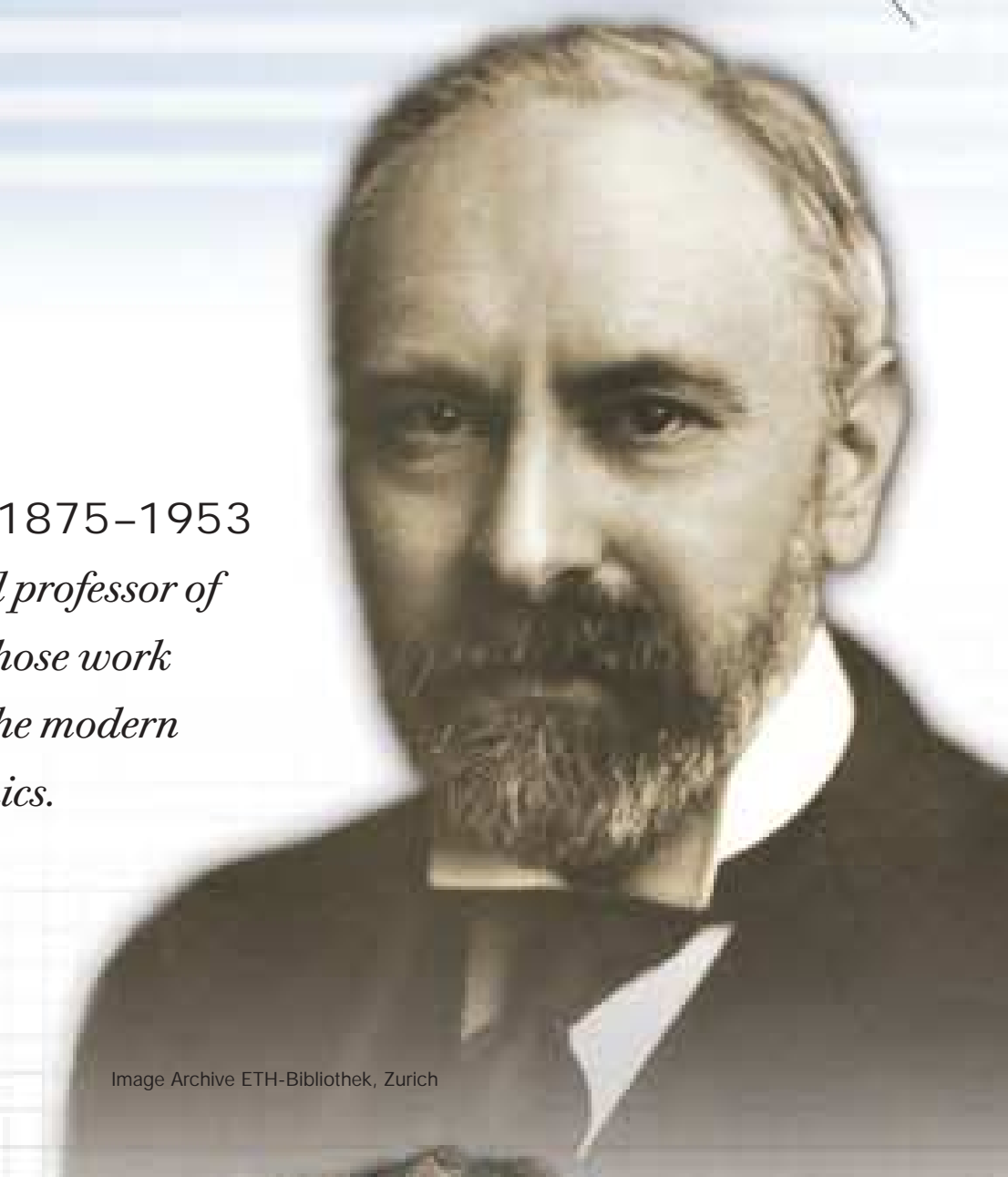
Friction Drag
One source of drag is friction created by the movement of air or liquid as it crosses the surface of an object. This is called friction drag or surface drag. Rough surfaces create more drag than smooth surfaces. This is why engineers design aircraft with smooth, sleek surfaces.



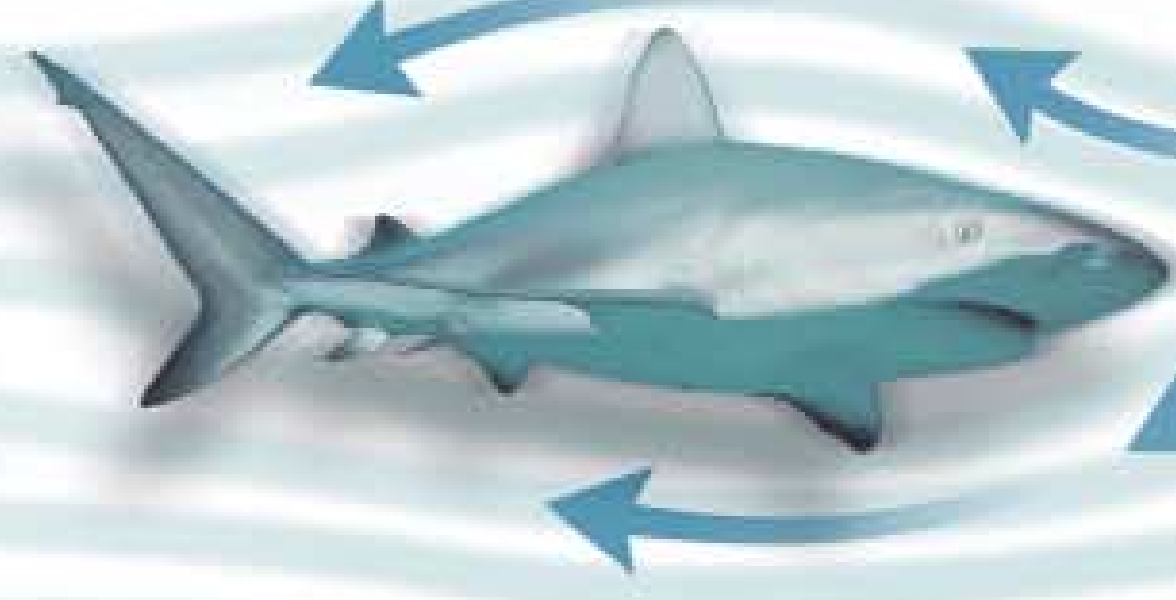
F/A-18E Super Hornet



X-45A Unmanned Combat Air Vehicle



Ludwig Prandtl, 1875–1953
German engineer and professor of applied mechanics whose work formed the basis for the modern science of aerodynamics.



A shark has a smooth, streamlined shape that reduces drag as it swims through the water, much like a jet flying through the air.

