The Proficient Pilot

Volume 1

Barry Schiff

The Proficient Pilot, Volume 1
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Chapter 1 The Miracle of Lift

This antiquated piece of philosophy is, of course, fallacious. Otherwise, so the rebuttal goes, if God had intended for man to drive upon the earth, man would have been provided with little wheels on his feet.

When man observed that birds had wings, he was jealous. But as centuries passed, jealousy evolved into curiosity and eventually into challenge.

It was natural for man to emulate the birds, and he contrived all manner of flapping-wing devices in a valiant effort to mimic his feathered friends. These contrivances were called ornithopters. None were successful.

Ornithopter proponents argued vehemently that "Nature must know best" and that experiments with flapping wings should continue. But these arguments were illogical; otherwise, the great sailing vessels would have spanned the seven seas by wiggling their rudders like fish, and stagecoaches would have had legs instead of wheels.

Nature's suggested method of flight was eventually and fortunately discarded in favor of the nonflappable wing.

The modern, fixed wing truly is the heart and soul of the airplane. Without it, flight as we know it would be impossible. It is ingeniously designed to produce awesome quantities of lift, yet it has no moving parts.

The shapely, sculptured lines of a wing perform miraculous feats, but only a handful of pilots can properly explain how lift is created. There are all manner of half-truths and concocted explanations to be heard, many of which unfortunately originate in some otherwise highly respected training manuals. Accuracy is sacrificed for simplicity.

There is, for example, this amusing fable: "Air flowing above the wing has a greater distance to travel (because of camber) than air flowing beneath the wing. Therefore, air above the wing must travel faster so as to arrive at the wing's trailing edge at the same time as air flowing underneath."

This is pure nonsense. How could the air molecules flowing above and below the wing gain the anthropomorphic intelligence to determine that they must arrive simultaneously at the trailing edge? The truth is that, because of viscosity, once the airflow divides at the wing's leading edge, the separated air particles never again meet (unless by coincidence in some typhoon over the South China Sea).

There are those who contend that a pilot doesn't need to know how a wing creates lift. They say that this knowledge is as useless to a pilot as a study of the laws of buoyancy is to a swimmer. But I disagree.

Pilots are a generally curious, intelligent breed who desire to learn as much as possible about the science of flight. This separates them from most automobile drivers, who don't know and couldn't care less about the difference between a distributor and a differential.

Pilots use lift; their lives depend on it. They read and talk about it, are quizzed about it, and even try explaining this miracle of flight to their lay friends. The problem is that most pilots really don't know how lift is created; they only think they do.

Early pioneers did learn something from the birds—with the help of Sir Isaac Newton and his third law of motion: "To every action there is an equal and opposite reaction." Experimenters realized quite early in their studies that birds created lift (a reaction) by beating down air (the action). The principle is very much like what happens when a rifle is fired. The bullet is propelled from the barrel (an action) causing kickback (or recoil), an equal and opposite reaction.

Ornithopter devotees were on the right track. They tried every possible way to design a pair of wings that could flap sufficiently to force down enough air to lift a man and his machine.

The modern wing, working silently and much more efficiently than any ornithopter ever did, does much the same thing. It is designed to force down great quantities of air, which in turn causes the reaction called lift.

To learn how this is accomplished requires traveling a somewhat circuitous route. Our aerodynamic journey begins at a familiar location: the Venturi tube. It terminates in the Land of Crystal Clarity, an aeronautical Shangri-La where everything is easily understood.

Almost every pilot is familiar with a Venturi tube, that hollow chamber with the narrow throat (Figure 1).

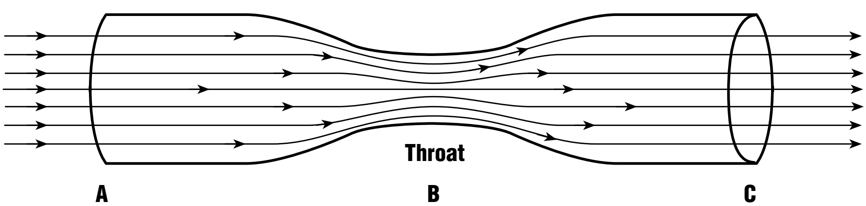

Figure 1. Venturi tube

"Aha!" you say. "I know all about that thing. Airspeed increases in the center of the tube causing a reduction in atmospheric pressure against the inside of the tube."

"And aha! to you," I say. "But do you know why the pressure against the inside of the tube decreases?"

The mysterious workings of the Venturi tube can be explained partially, using a flow of water as an example. It's easy to see that whatever amount of water enters the inlet (A) certainly must come out the other end (C). If this were not true, the water would have to bunch up in the throat (B) and become compressed. But since water is virtually incompressible, this simply cannot happen.

The same amount of water, therefore, must pass point B as passes points A and C. Since there is less room in the throat, the water is compelled, therefore, to accelerate and travel more rapidly.

A more graphic example is what happens when you partially block the outlet of a garden hose with your thumb or add a nozzle to the hose. In either case, a Venturi-type constriction (or throat) is created, and the water escapes much faster than it normally would.

What many do not fully appreciate is that air and water behave similarly; both are fluids. And since free-flowing subsonic air also is considered incompressible, the same thing happens to it when flowing through a constriction: it accelerates.

Up to this point, everything should seem quite plausible—nothing really new or exciting. But now the stinger, the question rarely answered except in sophisticated textbooks. Why does an increase in airspeed produce a decrease in pressure inside the Venturi tube? The answer, to be fully appreciated, requires a slight detour.

There are many different forms of energy, the most familiar being light, heat, sound, and electricity. Two other forms of energy are not quite so well known: kinetic and static.

Kinetic energy is a form of energy contained by an object in motion. An automobile speeding along the highway possesses kinetic energy; the faster it moves, the more kinetic energy it has. When the brakes are applied, this kinetic energy (of motion) does not simply disappear. Instead, it is converted to another form of energy, heat, which can be felt on the brake linings. Also, some of the kinetic energy is converted to heating the tires (and sometimes to melting the rubber).

The process of energy conversion works in reverse, too. A car at rest has no kinetic energy because it is not in motion. But when the driver depresses