DEBUNKING 8 COMMON AVIATION MYTHS
by Austin S. Collins

MYTH #1: Airfoils (such as wings, rotor blades, propeller blades and stabilizers) produce lift because they have a curved (cambered) upper surface and a flat lower surface; the air traveling over the top must move faster to reach the trailing edge at the same time as the air traveling under the bottom, and this acceleration causes a low-pressure area. The wing is then “sucked” upwards into this low-pressure area.

REALITY: This completely false explanation of lift is fairly easy to disprove with a few quick and simple examples, so you wonder why it has remained such a persistent one. (It’s even in most of the aviation textbooks!) If you want a detailed and technical breakdown of why it isn’t true, there is an excellent book with the humorous title Stop Abusing Bernoulli! by Gale M. Craig (Regenerative Press, ISBN 0964680629) in which Mr. Craig clearly shows, through a series of experiments and demonstrations, how Bernoulli’s famous principle has almost nothing to do with why airplanes fly. Here is a much shorter account:

1) Almost anything with wings – from a glider to a jet – can be made to fly upside-down. (Airplanes with gravity-fed fuel, cooling or lubrication systems cannot sustain inverted flight for long without losing power, but this has nothing to do with the wings.) If Myth #1 were true, this would not be possible.

2) Many airfoils are symmetrical. They have equal camber on top and bottom. Examples include many helicopter rotor blades as well as the wings of some high-performance aerobatic airplanes. Yet they fly just fine.

3) Many ultralights and hang gliders have single-surface wings. Yet they fly just fine, too.

4) There is no law of physics that says an air molecule passing over the top of the wing has to arrive at the trailing edge at the same time as an air molecule passing under the bottom of the wing. Those two air molecules never have to meet again!

5) Even a perfectly flat “wing,” such as a board, will generate lift. All you need is a relative wind of sufficient speed and a positive angle of attack within the correct range.

When you look at these five facts, it’s easy to see why this explanation is wrong. So then why do so many wings have a moderately curved upper surface and a relatively flat lower surface? It’s because a perfectly flat airfoil has a very narrow range of angles of attack at which it can generate lift. Although a flat wing will produce a large amount of lift within that very narrow range, any angle of attack below it will produce no lift at all and any angle of attack above it will produce an abrupt and total stall. The asymmetrical design is a compromise between the maximum air deflection associated with a flat surface and the wider range of usable angles of attack associated with a curved surface.

Okay, then how does an airfoil work? It’s very plain and straightforward indeed. For every action, Newton’s Second Law of Motion tells us, there is an equal and opposite reaction. An airfoil works by deflecting air – continuously displacing a mass of air the same as or greater than the mass of the aircraft. A fixed wing does this by moving forward through the atmosphere and a rotary wing does this by spinning around. The result is the same. If your aircraft weighs five thousand pounds and you can bounce air downward with five thousand pounds of force, you fly. That’s all there is to it. (If you aim a powerful enough propeller or jet engine directly at the ground, you can accomplish the same thing, albeit in a much less efficient and stable manner.)
MYTH #2:  Ground effect is caused by a “cushion” of compressed air under the wings.

REALITY:  Free-flowing, subsonic air is incompressible.  “Free-flowing” means uncontained.  “Subsonic” means moving at less than the speed of sound.  The only way two ways to compress air are to either contain it in a sealed vessel or force it to exceed Mach 1.

When an airplane flies one wingspan above the ground or lower, the upwash ahead of the wing and the downwash behind the wing are both reduced because the surface of the earth gets in the way.  This means that an airfoil can produce the same amount of lift with a lower angle of attack (and therefore less induced drag).  An airplane (or helicopter) can float along in ground effect at a reduced power setting.  Ground effect works on all heavier-than-air flying machines, including gyroplanes and gliders.
MYTH #3: Most of the noise produced by light, general-aviation airplanes comes from the engine.

REALITY: We’ve all heard the window-rattling, ear-piercing drone of a Cessna 210 Centurion taking off. But that sound is primarily being produced by the propeller, not the engine.

Air that is forced to exceed Mach 1 (about 760 MPH or 661 knots at sea level under standard atmospheric conditions) creates a shock wave which is heard as a sonic boom. (You can create a small sonic boom by clapping your hands. If you “clap” with the edges of your hands instead of your palms, notice that there is no loud sound anymore. That’s because you are no longer trapping air between two surfaces.)

When an airplane’s propeller spins fast enough to cause the blade tips to exceed the speed of sound it creates an extremely rapid series of sonic booms heard as a loud, continuous – and to most people rather irritating – whine. At 2,850 RPM, for instance, what you are actually hearing is “bang bang bang bang bang bang” . . . at a rate of 47.5 “bangs” per second!

Let’s do the math . . .

A 210’s propeller is about 80 inches in diameter – that means its hub-to-tip radius is about 40 inches and its circumference is about 251 inches (C=πD). The maximum rated takeoff power of a Teledyne Continental IO-520-L engine is achieved at 2,850 RPM. Imagine an object spinning around an axis 40 inches away 47.5 times per second. 251 inches x 47.5 revolutions per second = 11,922.5 inches per second, which means that every second that object is traveling 11,922.5 inches, or 993.5 feet (11,922.5 / 12 ≈ 993.5). 993.5 feet x 60 seconds in a minute = 59,610 feet per minute x 60 minutes in an hour = 3,576,600 feet per hour. 3,576,600 / 5,280 feet in a statute mile ≈ 677 MPH. The propeller accelerates air, of course – that’s what makes the airplane move forward. When you add the speed of the air to the speed of the prop tip you get a total speed. The propeller only has to accelerate the air by about 83 MPH over some part of the propeller blade surface to exceed the sea-level speed of sound in standard atmospheric conditions. When that happens, as it does during the takeoff and initial climb, the airspeed of part of the prop tips (the part with the greatest camber) is faster than the speed of sound. Hence the noise.

NOTE: A clever person recently faxed me to helpfully point out that the total airspeed of the propeller tip is equal to the square root of the sum of the rotational speed squared and the forward speed squared (A² + B² = C² where A = the rotational speed, B = the forward speed and C = the total airspeed of the propeller tip). This is true. The statements above are still correct, but you have to remember that the greatest airspeed achieved by any part of the surface of the propeller blade is not the same thing as the absolute airspeed of the prop tip. Local airspeeds are both much faster and much slower at various points along the chord and span. Accelerating the air 83 MPH, in other words, is not meant to mean the same thing as flying forward through the air at 83 MPH. Depending on the angle of attack and atmospheric conditions, a local acceleration of airflow on some part of the propeller blade to supersonic velocity may occur at a measured forward airspeed of 60 MPH, 70 MPH, 80 MPH, 90 MPH or at a wide range of other speeds. To put it another way, it’s the air that’s being accelerated past Mach 1 here, not the prop. If you, the reader, were confused about this, you may thank this very kind (and very smart) person for helping me to clear it up. (I was flattered and pleased to discover that someone was paying such close attention to what I wrote! Sometimes I wonder.)
Now let’s consider what happens at a typical cruise power setting of 2,400 RPM. That’s only 40 revolutions per second, or 10,040 inches per second. \(10,040 / 12 \text{ inches in a foot} = 837 \text{ feet}\). \(837 \times 60 \text{ seconds in a minute} = 50,220 \text{ feet per minute} \times 60 \text{ minutes in an hour} = 3,013,200 \text{ feet per hour}\). Divide that by 5,280 feet in a statute mile to get about 571 MPH. Now the propeller would have to accelerate the air a full 189 MPH to reach the speed of sound under the same conditions. The propeller cannot do that in level flight, so the penetrating hum is muted.

(It is worth re-emphasizing that altitude, barometric pressure, humidity, temperature and the relative concentrations of atmospheric gasses all greatly change the speed of sound. It may be a very different number from one situation to another.)

As a courtesy, the pilot can drastically reduce his noise emissions by pulling back the prop governor as soon as safe and practical after takeoff and waiting as long as possible to bring it all the way forward again before landing. This reduces complaints from the neighbors!
**MYTH #4:** An airplane will cruise faster when it is “on the step.” To get “on the step,” climb to a slightly higher altitude and then descend back down to your cruising altitude. This will set up an aerodynamic effect which makes the airflow more efficient, increasing lift and reducing drag.

**REALITY:** There is no truth to this whatsoever. While your cruising airspeed will *initially* be a little bit faster following a descent, it will quickly stabilize back to normal. The airflow over, under and around a wing is a constant and instantaneous phenomenon. It has absolutely nothing to do with the airflow pattern which existed five or ten or thirty minutes ago.

An easy way to disprove this is with a demonstration. First, descend to 3,000 feet and level off. Wait five minutes and then note your airspeed. Now descend to 2,000 feet, climb back up to 3,000 feet and level off once more. Wait five minutes and then note your airspeed again. It will be the same assuming all the other conditions (airplane weight, center of gravity, temperature, barometric pressure, humidity, power setting etc.) are the same as they were before.
MYTH #5: If you inflate your pneumatic de-ice boots “too soon,” a “bridge” or “shell” of ice will form over them, causing subsequent inflation cycles to have no effect.

REALITY: Long ago, pneumatic de-ice systems which inflated with less force and had fewer “lobes” on their surface were less effective at cracking and shedding ice layers. To some limited extent, this “ice bridging” theory was true back then. Modern systems, however, do not have this problem. NASA and the FAA, along with airplane and ice equipment manufacturers, have done years of extensive scientific testing in wind tunnels and in actual flight and have never experienced “ice bridging.” What pilots will frequently see, on the other hand, is residual ice. Residual ice is ice which is left over after an inflation cycle. Not all ice will be cleanly shed during every inflation cycle – some ice will sometimes remain. It often takes two, three or more cycles to get rid of it all. Many pilots see residual ice and then think that they are seeing ice bridging. This tends to perpetuate the myth.

Some pilots believe that you should wait until a certain amount of ice has accumulated on the wings before cycling the boots in order to avoid ice bridging. (That bad advice even appears in many older pilot’s operating handbooks and approved flight manuals.) DO NOT DO THIS. Cycle the boots at the first sign of ice and continue to cycle them as frequently as necessary to keep the ice off. Even a small amount of ice can cause a drastic erosion of control and performance.

A hair-raising example occurred on January 9th, 1997, when an Embraer EMB-120 Brasilia operated by Comair out of Cincinnati/Northern Kentucky International Airport as Flight 3272, suddenly fell into a dive and crashed into a field 18 miles short of the Detroit Metropolitan Airport.

Acting according to the Comair Flight Standards Manual, the flight crew, Captain Dann Carlsen and First Officer Kenneth Reece, had not yet begun to cycle the pneumatic de-ice boots.

The manual warned against activating the boots until ¼ to ½ an inch of ice had formed on the wings, apparently out of concern for "ice bridging."

In fact, Embraer, in a revised version of its Aircraft Flight Manual, advised that the boots be activated at the first hint of icing. But Comair failed to include that provision in its own manual, the one the crew would use for reference.

Interestingly, the NTSB found the probable cause of that accident to be the FAA’s failure to establish adequate aircraft certification standards for flight in icing conditions, the FAA’s failure to ensure that a Centro Tecnico Aeroespacial/FAA-approved procedure for the accident airplane’s deice system operation was implemented by U.S.-based air carriers and the FAA’s failure to require the establishment of adequate minimum airspeeds for icing conditions, which led to the loss of control when the airplane accumulated a thin, rough accretion of ice on its lifting surfaces.

It’s too late for the 29 people who died in that crash, but it’s not too late for you. Activate your boots early and often to keep your wings clean.
MYTH #6: You should never operate any normally aspirated engine “over squared,” with the number of inches of mercury of manifold pressure higher than the number of revolutions per minute in thousands.

REALITY: There is no magical, universal significance to those numbers; they are arbitrary measurements. Some engines will operate just fine “over squared.” Others won’t. Refer to your Pilot’s Operating Handbook to find out what you can and cannot safely do with your power settings.

In the case of the Cessna 210 Centurion, for example, as long as you do not exceed 20 inches of manifold pressure with the prop set below 2200 RPM you’re okay. 25” MP / 2200 RPM is perfectly acceptable according to the manual. (The cruise performance chart on page 17 of section 5 gives the predicted figures of 61% power, 152 KIAS and 77 PPH at 2000 feet for a 25” MP / 2200 RPM setting.)

Some pilots will always adjust the RPM first when increasing power and the throttle first when decreasing power. There is nothing wrong with this habit, but for small changes it is unnecessary. When going from the Flight Express company standard climb configuration (25” MP / 2500 RPM) to the company standard cruise configuration (24” MP / 2400 RPM), it won’t hurt anything at all to reduce the throttle first.
**MYTH #7:** Multi-engine airplanes are safer than single-engine airplanes.

**REALITY:** Although it seems reasonable, the statistics clearly suggest that this is not only false, it is actually *backwards*. Other factors being equal, multi-engine airplanes of the same general performance range seem to be significantly more dangerous. It’s difficult to compare apples to apples and oranges to oranges when it comes to aviation accidents, but in very broad strokes the fleet of piston-powered, general aviation, multi-engine retractable-gear airplanes has a fatal accident rate of about 2 per 100,000 flight hours. In contrast, the fleet of piston-powered, general aviation, single-engine retractable-gear airplanes has a fatal accident rate of about 1 per 100,000 flight hours. There is tremendous variation from type to type, of course, but almost all twins seem to have higher fatal accident rates than almost all singles. Why?

One likely explanation has to do with the outcome of an engine failure. In a single-engine airplane, if the engine fails for some reason the pilot has no choice but to glide to an emergency landing. Most GA airplanes are very crashworthy and if they are flown under control all the way down to the ground the pilot has a decent chance of survival. On the other hand, if an engine fails in a multi-engine airplane the pilot must *immediately* and *correctly* respond to the situation by identifying the failed engine and feathering its prop. If the pilot does not quickly feather the prop – or worse, feathers the *wrong* prop – the airplane will “V_{MC}” and spin out of control. The resulting crash has a near-zero survivability factor. When you add to this the fact that an engine failure is twice as likely when you have two of them (not counting fuel exhaustion) you can see where the statistics come from. Those of us who fly twins on a regular basis should think very seriously about this. Are we absolutely, positively, rock-solidly *proficient* on our engine-failure procedures for all likely scenarios?
**MYTH #8:** Multi-engine airplanes are about twice as fast as single-engine airplanes with comparable engines.

**REALITY:** It seems intuitively right that an airplane with a pair of 285-horsepower engines will go about twice as fast as an airplane with one 285-horsepower engine. But it doesn’t. Let’s use the Beechcraft 58 Baron and the Cessna 210 Centurion as an example.

A Baron’s maximum gross takeoff weight is 5,400 pounds. A 210’s maximum gross takeoff weight is 3,800 pounds. A Baron has two Teledyne Continental IO-520 engines, each rated at a maximum continuous 285 brake horsepower. A 210 has one Teledyne Continental IO-520 engine, also rated at a maximum continuous 285 brake horsepower.

The Baron has 100% more power than a 210 . . . but also 42% more weight than a 210. The maximum continuous power-to-weight ratio for a Baron is 1 horsepower to 9.5 pounds. The maximum continuous power-to-weight ratio for a 210 is 1 horsepower to 13.3 pounds.

So the Baron’s continuous power-to-weight ratio is really only 40% greater, not 100% greater as one might think.

Moreover, top airspeed does not increase in a linear manner with increases in power. Because drag increases with the square of airspeed, you have to produce four times as much power to go twice as fast – all other factors being equal. In reality, the Baron, with a 190-knot cruise, is only about 27% faster than a 210 with a 150-knot cruise.

Look at the price of a Baron versus the price of a 210 and ask yourself how badly you need to go 27% faster!