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 simply not be possible – that faster-moving air on the earthward side of the airfoil would suck the aircraft straight into the ground!

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; there *is* no flat lower surface! 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. In fact, they never have to be *anywhere* at the same time. Those two air molecules never have to meet again!

5) The actual "suction" across the upper surface of a wing is quite small – only a few pounds per square foot – so although it does exist it is totally inadequate to lift an airplane into the air by itself.

6) 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. A worker carrying a large sheet of metal or plywood, for example, could easily get picked up off his feet and carried over the side of a building by a strong gust of wind that hits the flat surface at the right (or, in this case, wrong) angle.

When you look at these five facts, it's easy to see why this explanation is wrong. So then why do so many common airplane wing designs 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 an aerodynamic engineering 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. Moreover, because most common airplanes spend most of their time flying right-side up, it makes sense to put the flat side on the bottom (for maximum air deflection) and the curved side on the top (for the greatest range of effective angles of attack).

Okay, so then how *does* an airfoil work? It's really very plain and straightforward. For every action, Newton's Third 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. A perfectly flat wing of sufficient size, set at the correct angle of attack with a sufficient source of thrust to create sufficient relative wind, will also lift a payload. (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. The Harrier is an excellent demonstration of this principle.)

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 – essentially, 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. You may recall that induced drag is proportional to angle of attack, which is why induced drag decreases as airspeed increases. 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 approaches Mach 1 (about 760 MPH or 661 knots at sea level under standard atmospheric conditions) creates a shock wave of compressed air which is heard as a sonic boom. You can create a modest example of a shock wave 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 approach the speed of sound it creates an extremely rapid series of sonic booms heard as a loud, continuous – and to most non-pilot types 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 ($C=\pi D$). 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's job is to accelerates air, of course – that's what makes the airplane move forward. The engine creates *power* and the propeller converts that power into *thrust*. 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.

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 ($A^2 + B^2 = C^2$ where A = the rotational speed, B = the forward speed and C = the total airspeed of the propeller tip).

As some of you may already know, as an aircraft approaches the speed of sound, it reaches a point at which the air flowing over the wings (which, as you recall, substantially accelerates as it does so) reaches supersonic speeds – *even though the plane itself is still moving slower than the speed of sound.* This causes a significant increase in total drag. Well, exactly the same thing happens with a propeller blade.

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 inches in a foot = 837 feet. 837 x 60 seconds in a minute = 50,220 feet per minute x 60 minutes in an hour = 3,013,200 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.

Or we could use a rock in a stream as an example. Observe the steady, continuous flow pattern of the water around the rock. Now momentarily obstruct the water flow with your hand. Notice the new pattern which emerges. Next, remove your hand. The flow will change, then eventually return to exactly the same flow pattern (including eddies and standing waves) which existed before. The water flowing around the rock NOW doesn't know and doesn't care what the water flowing around the rock one minute ago, five minutes ago or ten minutes ago was doing.

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, at the advent of de-ice and anti-ice systems, pneumatic wing-mounted ice-protection devices 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 may have been at least partially founded in reality back then. Modern systems, however (those designed in the 1950s and onward), simply do not have this problem. NASA and the FAA, along with airplane and ice equipment manufacturers, have done many years of extensive scientific testing both in wind tunnels and in actual flight and have never experienced "ice bridging." What both researchers and pilots *will* frequently see, on the other hand, are related phenomena known as **residual ice** and **intercycle 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 often remain. It frequently takes two, three or more cycles to get rid of it all. Intercycle ice is ice which forms *between* activations. Between residual ice and intercycle ice, the wing may never be completely clean while the airplane is in active icing conditions. Many pilots see residual ice and/or intercycle 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.) To put it in very strong terms: **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, even catastrophic, erosion of control and performance. Don't wait.

A hair-raising example of this deadly situation 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 rolled over, plunged into a dive and crashed in a field 18 miles from 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."

Now, here's where it gets morbidly interesting. In fact, Embraer, in a *revised* version of its Aircraft Flight Manual that took all the most recent research into consideration, mandated that the boots be activated *at the first sign of icing*. But Comair failed to include that provision in its own manual, the one the crew would use for reference. In other words, the crew was just following their company procedure – an *incorrect* and *unsafe* procedure, as it turns out, which was contrary to the manufacturer's instructions.

Interestingly, the NTSB found the probable cause of that accident not to be the crew's error, which is somewhat unusual. Instead they found the probable cause to be:

1) The FAA's failure to establish adequate aircraft certification standards for flight in icing conditions.

2) The FAA's failure to require the establishment of adequate minimum airspeeds for icing conditions.

3) The FAA's failure to ensure that a CTA* / FAA-approved procedure for the accident airplane's deice system operation was implemented by U.S.-based air carriers. In other words, the FAA recognized that the flight crewmembers were just doing what they had been trained to do – they had been trained to wait. But that training was wrong, and the NTSB found the FAA culpable for not stepping in to correct this problem.

** Centro Tecnico Aeroespacial*

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. At my company, Flight Express, for example, when transitioning from the approved nominal cruise configuration (24" MP / 2400 RPM) to the approved nominal cruise-climb configuration (25" MP / 2500 RPM), it won't hurt anything at all to increase the throttle first. I don't require my pilots to adjust the prop control before increasing the power. For a large power change, however, such as a go-around (in which the airplane goes from near-idle to full throttle), it is advisable to have the prop already in the full-forward position, which is why company procedure calls for putting it there when commencing the final approach.

MYTH #7: Multi-engine airplanes are inherently 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, mutli-engine airplanes of the same general performance range seem to be *more* dangerous. It's difficult to compare apples to apples and oranges to oranges when it comes to aviation accidents since there are so many variables, but in very broad strokes the fleet of piston-powered, general aviation, multi-engine retractable-gear airplanes has a fatal accident rate of (very roughly) 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 (very roughly) 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 enter a flat, unrecoverable spin. 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, obviously) 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?

Engines have a funny way of failing at the worst possible moment. One of my pilots was taking off from runway 7 out of Marathon (in the Florida Keys) last year when his left prop governor failed. When governors fail in multi-engine airplanes, they tend to default to feather – meaning that a governor failure is, effectively, an engine failure. Well, he did a great job of maintaining control of the airplane and he successfully maneuvered back around and landed with no damage and no injuries. He had several factors working in his favor. First, the same governor failure that had caused the thrust loss had also already feathered the prop for him, saving him that step. Even so, if he had reacted improperly by feathering the *other* engine, the situation would have rapidly deteriorated into a disaster. Second, he was at sea level. Third, there was no high terrain and no large obstacles. Fourth, he was relatively light, with the tanks only about half full and very little cargo on board. And fifth, it was good VFR. Change any of those factors, and the odds of a happy ending begin to decrease.

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 parasitic 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 purchase price and operating costs of a Baron a 210 and ask yourself how badly you need to go 27% faster! (Incidentally, my company operates both types.)