WASHINGTON PILOTS ASSOCIATION
Washington Pilots Association *Promoting General Aviation Since 1960*

Spring 2014

Hanger Talk – North Sound

INSIDE THIS ISSUE:

Member Profile: Robert Powell

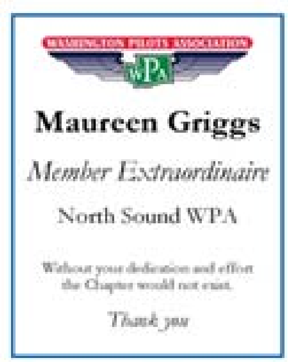
You may have met him at a recent WPA North-Sound Chapter meeting. If you haven't, you'll likely want to meet him. Robert Powell is a recent retiree from California who has fallen in love with Bellingham and flying in the NW. After a ten-year hiatus, he was re-introduced to flying by the good folks at Command Aviation, Bellingham Aviation Services, and the Chuckanut Flying Club.

Robert was raised in a farm-town in Northern California and grew up listening to his uncles' tales of their WW II experiences and dreaming of far off places. So after graduating from university in the early 60s, he joined the Marine Corps to "see the world" and live some of his own exciting adventures. As you might guess, Robert experienced the old saying: "Be careful what you wish for." After joining the Marines, his "wildest dreams came true!"

Cont'd on page 2

Maureen Griggs Honored

Maureen, award & Chip LaPlante



North Sound Chapter honored Maureen Griggs during the April meeting by awarding her with the Chapter's first ever "Member Extraordinaire" award (see side bars).

For many years (we won't say exactly how many, just that it is in the double digits) Maureen has served the Chapter not only as a Board Member, but as its Program Director as well. Across those many years, it has been due solely to her continued efforts that we have had the pleasure of hearing the many aviation related presentations given at our monthly meetings. Maureen has been so dedicated to the Chapter and her duties that she has even found and arranged our speakers while on vacations in other parts of the world, most recently, New Zealand. To reiterate: "without her dedication and effort, the Chapter would not exist." Thanks again Maureen. ■

Powell, cont'd

Powell (rt.) and his F-8

Robert with his daughter, the newly minted pilot.

First, Robert got to learn how to be a Marine; then he was sent to Navy flight schools in Pensacola, Mississippi and Texas where he learned to fly a number of planes, including: the T-34 Mentor (a tandem seat acrobatic version on the Bonanza), the T-2 Buckeye (a basic jet trainer), the F-9 Panther (straight wing), the F-9 Cougar (swept-wing), and finally the F-11 Tiger (a swept-wing fighter with afterburner). After receiving his wings, it was off to Fleet-training for a year on the East coast as a fighter pilot flying the F-8 Crusader (an "incredible" plane in his mind).

How much better could life be for a small town kid looking for excitement than that? Well he soon got his answer; he was off to Vietnam for: the Siege of Ke Sahn, the A Shau Valley inter-dictions, the Tet Offensive, and the Battle for Hue City! He relates his combat tour was not a "Top Gun" type of experience; instead, as Marine pilot he mainly flew in support of ground troops and outposts. He was more like "flying artillery" than a Tom Cruise (too bad for Robert). Robert got a "split-tour." In addition to flying the F-8s and A4s mostly in dive bombing, rockets and cannon modes, Robert's split tour found him flying C-117s (DC-3s) and S-2s ("Stoofs" -- a relatively small Grumman aircraft with two big radial engines). He hauled troops and equipment around I-Corps during the day and dropped flares over beleaguered outposts at night.

Having survived his "adventure" in Vietnam, before he knew it, he was back home, married, and blessed with a set of twins. He soon found himself working in state government and attending law school at night. For many years, Robert flew a Piper Arrow, but as will happen, he got busy with family and a career, so flying slipped away.

Now retired, Robert is back in the pilot's seat and loving it. He is acquainting himself with GPS systems and working on getting his IFR rating current. Over Christmas he had the wonderful experience of flying with his adult daughter who has just received her private pilot's license. For Robert, flying in the beautiful Pacific Northwest has recaptured the enjoyment of flying he felt when he was younger.

Robert is a board member of the Chuckanut Flying Club and is the club's Safety Officer for its two terrific airplanes, a Cherokee and a Skylane -- both hangared, well maintained, and fully IFR equipped. The Chuckanut Flying Club's membership could use a few more pilots, so aircraft availability is excellent (tell your friends!). Robert reports he is constantly impressed at the level of experience and professionalism of our aviators. The pilots of the NSC and CFC remind me of the camaraderie experienced in a Marine Fighter Squadron. It makes him feel at home again! ■

Commissioner McAuley meets with pilots

Mike MacKay shows Comm. McAuley his RV-9A

There was a good turn out when the Port & WPA hosted an "Airport Social" on April 26th. About 30 pilots got to spend time discussing aviation at BLI with port managers and Port Commissioner Mike McAuley. It was a positive meeting, with information freely flowing both ways. Pilots learned more about BLI's growth plans, and Port officials listened to the pilots' concerns. Commissioner McAuley looked at our GA aircraft, toured our hangers, and learned that not all of us fly Lear jets (some even build their own, see photo). McAuley left with a greater knowledge of GA at BLI. Another social, hopefully with Comm. Robbins, is being planned for this summer. ■

Don Muir Update

As you may recall, Don Muir was injured this winter piloting a Pterodactyl Ultralight. Well Don is now back home in Blaine. Unfortunately, he won't be piloting anything real soon as he is still using a walker, but Don relates he is progressing well towards walking unassisted. Given his progress and attitude he said he was pronounced "tough as nails," by his surgery team doctors. He has kept his sense of humor about the accident and today is still laughing at his predicament.

Don remembers how pilots coped with the stresses of their missions with laughter upon their return to the ship, so Don's still laughing at himself about his mishap.

Don served 10 years in the Navy in the VQ1 squadron (which is now based out of Navy Whidbey). He was a flight crew member in the Navy's P4M, P5M and A3D aircraft. He was deployed off the coast of Vietnam for 5 years.

Before he left for his Arizona "vacation" and his Ultralight accident, he had taxi tested the RV-7 he is building down in Arlington. Once he gets going again, he intends to finish up that project. He's already found a test pilot to do his flight testing for him.

He's working hard at his physical therapy and looks forward to getting fully back on his feet (literally) and joining us once again at WPA monthly meetings. If you live near Blaine, Don would appreciate a ride, as he is not driving yet.

Don thanks us for our best wishes, and he is extremely grateful to all those who have come to his aid and helping him along with his rehabilitation. Fortunately for Don, he has a group of close friends who have made his return home possible. ■

The Pterodactyl Ultralight

Angle of Attack Indicators come to GA

Military and commercial pilots have been using them for decades, and recently Angle of Attack (AOA) indicators have made their way down in cost and availability so that us GA pilots can install them in our planes. This is largely due to organizations like WPA www.wpaflys.org and AOPA getting our US Congress to legislatively pressure the FAA to change their policies to allow for quicker adoption of new technologies that make flying safer. Thank you Congress! "These devices have been identified . . . as the most effective system available for reducing loss-of-control accidents [the cause of 40 % of fatal accidents between 2001 and 2110], and low-cost models have been installed by experimental aircraft operators for many years." writes AOPA. Learn more at http://www.aopa.org/News-and-Video/All-News/2014/February/06/aoa-policy.aspx

The nuts and bolts of AOA and how flying AOA can make your flying safer is examined in the attached articles from the August 2013 edition of the EAA's "Sport Aviation." They are "reprinted" with the EAA's permission (thanks to the EAA).

Pictured right is the new Bendix-King AOA which can now be installed in certified aircraft via "letter of authorization" per FAA memorandum #AIR100-14-110-PM01. The KLR-10 sells for about $1,500 and per Jim Peake of Cannon Avionics, Arlington Airport, 360-435-0900, (www.cannonavionics.com) it will likely take around 4 to 6 hours labor for them to install the unit. For facts from Bendix-King see their website at: www.bendixking.com/Products/Flight-Controls-Indicators/Indicators/KLR-10 ■

Bendix King
KLR 10

Here's what's coming up.

"A look ahead."

We're on the Web!

www.wpaflys.org

Upcoming Meetings

MAY 8th: CHAPTER MEETING at WECU Bldg.
Doors open at 6pm, Meeting starts at 7pm
Tore Ofteness shares his aerial photograhy

MAY 8th: Airport Advisory Committee Meeting.
General Aviation Conference Room, 4201 Mitchell Way. 9:30 to 10:30 am

MAY 28th: Airport Master Plan Public Meeting
Port staff and consultants will present updated information about the Airport Master Plan. ***Want to help shape the face of BLI – better attend this meeting!***
Squalicum Boathouse, 2600 Harbor Loop, Bellingham,
5:30 PM - 7:30 PM
see: Port of Bellingham website at:
www.portofbellingham.com/index.aspx?NID=470

JUNE 12th: CHAPTER MEETING at WECU Bldg.
Doors open at 6pm, Meeting starts at 7pm
GPS FOR IFR AND VFR PILOTS by Bruce Williams of BRUCEAIR.COM
For Add'l info. visit: www.BRUCEAIR.COM

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A Special Thank You

A special thank you goes out to the Experimental Aircraft Association for allowing us to reprint the attached articles. See, www.eaa.org

Visit your WPA cabin on Stuart Island

As a member of the Washington Pilots Association, you are entitled to use our Stuart Island "rustic" cabin for weekend and weekday outings. This is a wonderful opportunity to get away from the hustle and bustle of our daily lives.

To reserve the cabin, please contact Tom Jensen at c180tom@skynetbb.com or call (360) 825-6777 .

See: http://www.wpaflys.org/stuartisland.html

Angle of Attack Indicators

Why they are vital, and why most of us don't use them

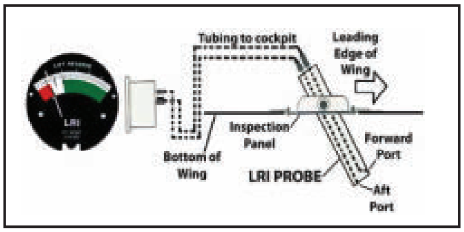
BY MARK PHELPS

I WAS CHATTING ABOUT flying the other day with my friend and colleague Matt Thurber, and the subject of angle of attack (AOA) indicators came up. He'd recently gone up with an instructor in a club airplane that had an AOA indicator and was amazed (and annoyed) the instructor ignored it the whole flight and confessed to not encouraging students to use it.

Most airplanes probably don't even have an AOA indicator (sometimes called a reserve lift indicator), and I wonder why. Full disclosure: I have never flown with one, so all my thinking on the subject is necessarily theoretical. But it seems to me that if every airplane had one (and pilots actually used them)—then we'd be flying with much greater precision, especially on landing approaches, but also at other times. It might not matter so much in everyday flying where a comfortable margin above stall speed is precise enough for safe maneuvering. But in an emergency, why not have the most precise indicator of how close the wing is to the stall?

It also seems to me that we could benefit by observing the AOA indication even during normal flight at airspeeds well above the

PHOTOGRAPHY BY GEORGEJURASEK@ISTOCKPHOTO.COM AND COPYRIGHT ALPHA SYSTEMS AOA



stall. We all sense the amount of lift the wing is producing through the seat of our pants. But having a clear digital representation of that feeling to look at and compare from one flight condition to another would certainly enhance the intuitive feel for "flying the wing"—the expression Wolfgang Langewiesche used in his iconic 1940 book *Stick and Rudder*.

The reason more airplanes don't have AOA indicators is probably the same reason people don't install shoulder harnesses in older airplanes. You don't have to by law, and there always seems to be something sexier and more fun to spend money on than a safety item.

After all, we have our airspeed indicator, right? And we have our stall warning horn, too. So that ought to cover us on stall awareness. Not really.

We all learned in our primary instruction to "watch your airspeed." In fact, many of us had those words tattooed into our eardrums by our instructors' strident urging. Getting too slow on final approach was a sin without forgiveness.

True, primary instructors also burn it into our brains that stall speed increases with bank angle. Lessons on steep turns also included the admonition to "watch your airspeed," except this time, the instruction was complicated by the fact that we knew stall speed increased with bank angle—but we really didn't know how much. Nor did we have any way to make a more precise guess. Just make sure you keep the airspeed indicator needle well above the yellow arc—the steeper the bank, the farther up the scale. That was about it.

Likewise, we knew that when the airplane was heavier, the stall speed would be higher. In most lightplanes, the difference was only a few knots, so it was easy to ignore and just fix that single stall speed number in our brains. More attention to precisely calculating exact stall speed would wait until a pilot got into larger, faster airplanes with wider ranges in gross weight.

That brings up another point—the other end of the safe airspeed range. When I was learning the intricacies of flying my V-tail Bonanza, the old bugaboo of in-flight structural failure raised its ugly head. In John Eckalbar's book *Flying the Beech Bonanza*, a lengthy portion of the text is devoted to what causes structural failure. In short (very short, actually), it comes down to the Bonanza's low stall speeds that can lead to problems. In turbulence (where up- or downdrafts can cause extreme changes in wing angle of attack) or extreme maneuvering (as when a pilot emerges from a cloud base in an unusual attitude and pulls back abruptly on the elevator control), most airplanes have a healthy protection from structural failure—the stall. The wing will stall and unload long before reaching a critical stress point. With enough altitude to recover from the stall, there ought to be no problem.

With the Bonanza wing's low stalling speed, however, it's much more likely to overstress before it stalls. Many homebuilts are also designed with slow stalling speeds. If the airplane is also capable of high speed flight, pilot technique is extremely important to safe operation in turbulence. Eckalbar's advice: When flying a Bonanza in turbulence, slow down. If you're light (therefore with lower stall speeds), fly even slower. It seems counterintuitive, but the airplane is actually safer from structural damage when it's heavier, since it will stall sooner and unload the wing.

As important as it is to focus on airspeed for both stall protection and overspeed issues in turbulence, using the airspeed indicator is far less precise than using an AOA indicator. The latter is measuring the direct airflow dynamic that affects the airplane. In a way, the airspeed indicator is only measuring one symptom of the current aerodynamic condition.

Ignoring the stall warning horn during slow flight becomes a habit.

You can add precise mental calculations for changes in gross weight, bank angle, and density altitude to estimate their effect on AOA, or you could just go straight to the horse's mouth and monitor an AOA indicator. Critical AOA does not change with any of those mitigating factors.

Many pilots feel comfort in having their stall warning horn to back up their airspeed scan. The limitations of the stall warning horn, however, start with its settings. They are usually calibrated to activate with a comfortable margin below the actual stall AOA. So ignoring the stall warning horn during slow flight becomes a habit. The warning horn is also binary—either on or off—while the AOA indicator is cumulative, showing you when you're getting close.

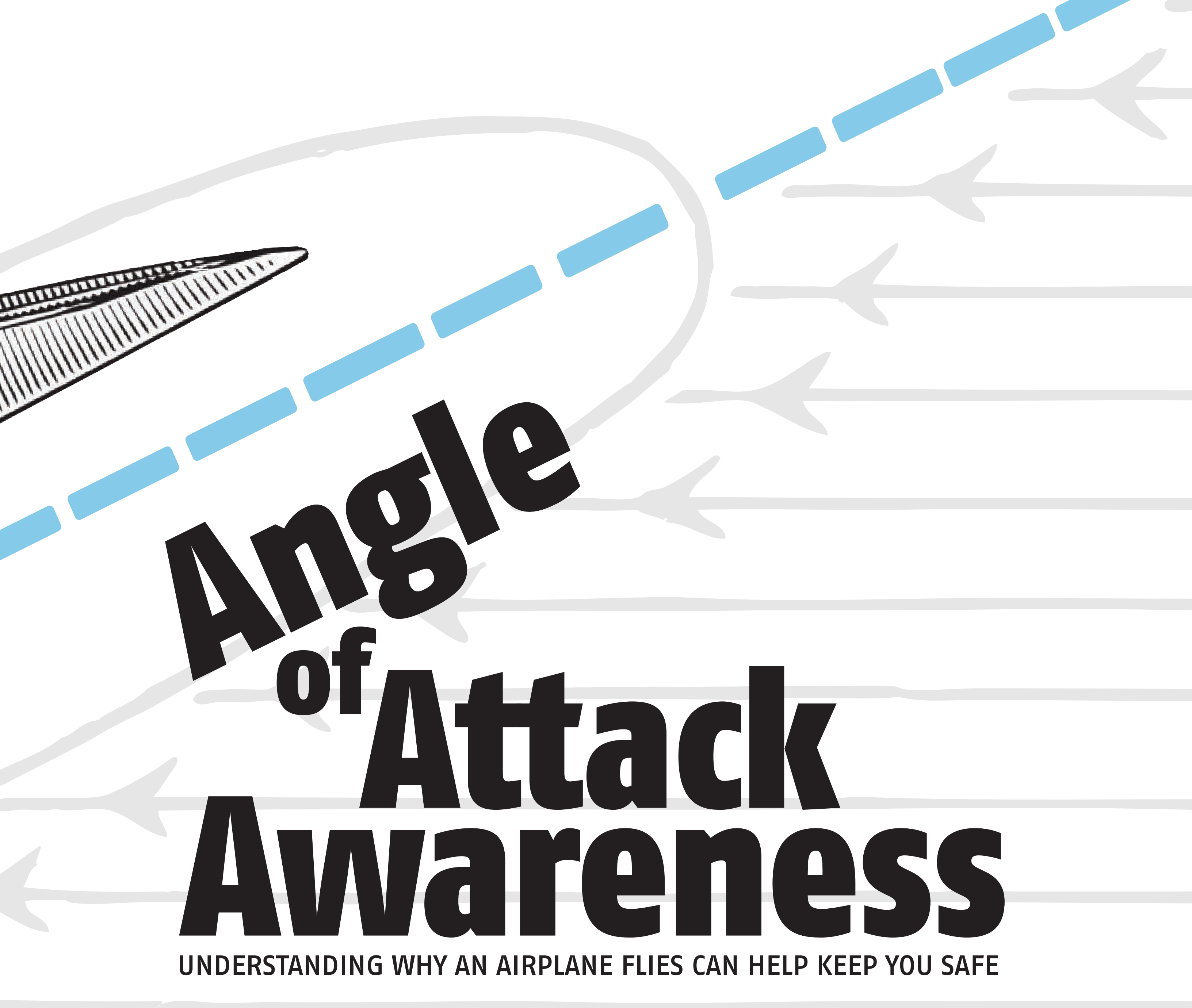
AOA indicators have been around since the 1930s, but today's technology allows for LED readouts rather than (or in addition to)

PHOTOGRAPHY COPYRIGHT **ALPHA SYSTEMS AOA** the swinging needle with its color-coded arc. The advantage of the LEDs is they can be placed in the panel outside the main area of instrument scan, but well within the pilot's peripheral vision. When the indication swings into the danger zone, the red lighting is sure to capture the pilot's attention. Of course, aural warnings are also available.

AOA indicators can be found at any of the aircraft building supply centers. They range in price from less than $350 to around $1,500. It would seem that in this technological age when we have increasingly precise instruments for engine monitoring, fuel flow, and satellite navigation to within a few meters, we ought to spend a little extra to have the most precise information on the relationship between the wing and the air it's flowing through.

After all, Wilbur and Orville's only "instrument" was a piece of yarn on a stick to monitor their angle of attack. You'd think we could learn that lesson from them. EAA

Mark Phelps, EAA 139610, is an aviation writer living in New Jersey. He is the former editor of EAA's *Vintage Airplane* magazine and the owner-pilot of a 1954 Beechcraft Bonanza.



Angle of Attack Awareness

UNDERSTANDING WHY AN AIRPLANE FLIES CAN HELP KEEP YOU SAFE

J. MAC MCCLELLAN

From our earliest days in flight training we hear about angle of attack, probably learn enough to answer a few questions correctly, but may never fully grasp the concept and its fundamental importance to flying. All too often pilots of general aviation airplanes—and of homebuilts at an even greater rate—exceed the critical angle of attack, stall, lose control, and crash with fatal results.

If all pilots had a complete understanding of the absolute importance of angle of attack (AOA) and avoided the high AOA that causes a stall, the safety record would improve immensely. But how can we achieve that goal? The available answers to that question are education and instrumentation.

ILLUSTRATION BY **GEORGEPETERS@ISTOCKPHOTO.COM**

FORGET BERNOULLI

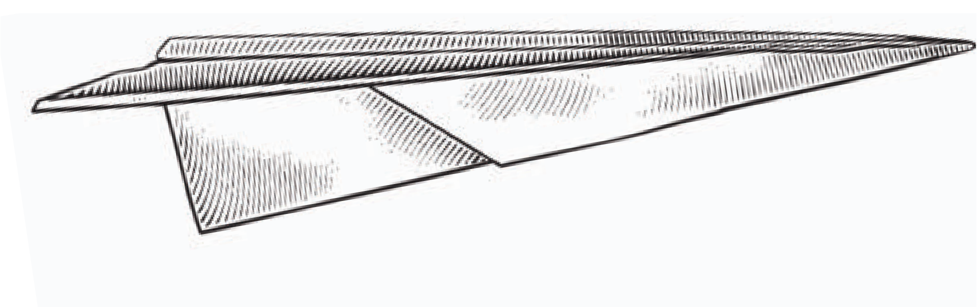
I believe a big reason so many pilots do not fully appreciate the importance of AOA is because we have mucked up the discussion of lift creation with Bernoulli's equation. You know the one. According to Bernoulli's math, a fluid—air in this case—becomes less dense as it speeds up. So, for a wing to create lift, the air needs to accelerate over the top of the wing, creating a lower pressure than the slower-flowing air below. The higher pressure, lower velocity air under the wing pushes the wing into the low pressure above, and that's lift. Some wags call this "the sky sucks" theory of lift.

Bernoulli was right, even though he developed his theories long before an airplane was possible, or maybe even thought of. But his equations that describe how air and other fluids behave are of little or no use to pilots. People who design wings and airfoils must consider Bernoulli, at least some, but when you and I are at the controls, that Swiss mathematician who did his work in the 18th century is of no consequence.

What we need to know instead is that a wing produces lift because it is operating at a positive AOA but below the stalling AOA. We can't do a thing about how those low- and high-pressure areas above and below the wing behave, but we do have control over AOA.

We have all experienced the lift generated by a positive AOA when as kids we stuck our hand out the window of a moving car. If we raised our fingertips, the rushing air lifted our hand. If the car was going fast and we raised the fingers a lot, the lift production was dramatic enough to nearly yank our arm out of the shoulder socket.

WHAT WE CAN AND MUST DO IS CONTROL THE ACTUAL AOA SO IT REMAINS IN A SAFE OPERATING RANGE NO MATTER HOW WELL, OR POORLY, THE ACTUAL WING IS DESIGNED.



That hand out the window experiment demonstrated the production of lift in the most essential way. The wing—our hand—planed the moving air and rode that plane up. You can also see the concept at work as a powerboat accelerates. The boat is floating at rest and low speed because it displaces more water than it weighs. But as the boat accelerates it climbs up on the plane and much of its hull is lifted out of the water. The boat is on a plane because its hull has a positive AOA compared to the water.

An airplane wing or a speed boat trades drag to create lift. By pushing the airstream or the water down, the wing or boat lift so long as there is enough speed and power to overcome the drag induced by creating lift. A boat can plane only with its bow up relative to the surface of the water, and a wing lifts by having a positive AOA compared to the airstream.

The reason we pilots have become so bogged down in lift explanations is that certain wing sections—airfoils—behave differently. The shape of the wing is crucial in determining how efficiently lift can be produced, at what AOA it will stall, and how the wing will behave as it stalls. All of that is important, even critical, when airplanes are being designed, but there isn't a thing a pilot can do about airfoil behavior from the cockpit. What we can and must do is control the actual AOA so it remains in a safe operating range no matter how well, or poorly, the actual wing is designed. Remember, just like your hand out the car window experiment, you are flying because the wing has a positive AOA, but not so steep of an angle that it stalls.

WHAT IS AOA?

The definition of AOA is straightforward. It is the angle between the chord line of the wing and the relative wind. The really hard part is to know where the relative wind is. We can see the wing, but the relative wind must be visualized, imagined, to estimate the actual AOA of the wing.

The relative wind is the airstream flowing over the airplane and is approximately parallel to the flight path—not the deck angle—of the airplane. In the hand out the car window test, the relative wind is easy to visualize because it is parallel to the road. On takeoff roll the relative wind is also easy to understand because it is parallel to the runway surface. But once the airplane lifts off it does not necessarily go where it is pointed, so the relative wind can be all over the place. That's why it's called "relative," because it depends on the flight path of the airplane.

ILLUSTRATION BY GEORGEPETERS@ISTOCKPHOTO.COM

Visualize an airplane flying a loop. The wing can be flying at a positive AOA all the way around the loop even though the nose has pointed at each of the 360 degrees necessary to complete the loop. To maintain positive *g* around the loop, the flight path of the airplane has a positive AOA compared to the constantly changing relative wind.

A loop, or other abrupt maneuvers such as steeply banked turns or abrupt changes in attitude, shows how complex it can be to visualize the actual AOA at any one instant in flight. That's why most of us use indicated airspeed as a proxy for actual AOA.

A wing can produce more lift at a lower AOA as airspeed increases. Think back to the hand out the car window again. If dad was driving slowly, you could pitch your fingers way up and still hold your arm down. But when dad put his foot into it, very small changes in the angle of your fingers sent your arm flying back.

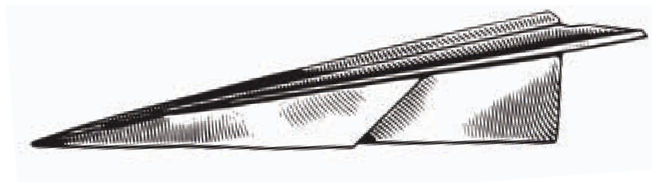
So, we know that if we have enough airspeed, the AOA will not rise to the stalling angle. As we slow down, the AOA must increase to produce the necessary amount of lift, and at too slow an airspeed the AOA reaches the stalling angle. We call it the stalling airspeed, but it is really too steep of an AOA that disrupts the flow of air over the upper wing surface and causes the airflow to stall.

MEASURING AOA, NOT AIRSPEED

All larger airplanes, particularly jets, have systems that measure the actual AOA constantly in all phases of flight. And nearly all general aviation airplanes also have such a system, but we call it stall warning, rather than an angle of attack indicator. Fundamentally the systems do the same thing, which is measure the actual AOA and warn the pilot of a critical AOA to avoid a stall.

The most common device for measuring AOA is a vane on the leading edge of the wing. The stall warning vane was invented by Leonard Greene, who patented stall warning and founded the Safe Flight Instrument Company. The Safe Flight leading edge vane is without a doubt the most produced piece of airplane equipment, and hundreds of thousands of them fly on airplanes all over the world.

The stall warning vane tracks the location of the stagnation point on the leading edge of the wing. Where the airstream divides to flow over and under the wing there is a stagnation point. This point moves up and down on the leading edge in direct relationship to the actual AOA. When the stagnation point rises too far, the airstream over the upper surface is being disrupted and a stall is about to happen.



IN TIME, FLYING WITH AN AOA INDICATION SYSTEM, WE COULD LEARN WHAT LOADS AND AIRSPEEDS INCREASE AOA TO A RISKY LEVEL AND LEARN TO AVOID THOSE SITUATIONS.

In most installations the Safe Flight vane is configured as an on-off toggle switch that is calibrated to sound a horn, light a light, or issue some other warning as the AOA increases to near stall. But the vane is actually in constant motion tracking changes in AOA as the stagnation point moves.

The other AOA sensing technique is to use a device that measures the free stream of air over the airplane. Some systems use a vane that aligns with the passing air and others use ports—small openings—that compare the pressure of the airstream as it changes angle across the ports. Imagine blowing over the top of a soda bottle and how small changes in the angle of your breath change the pitch of the sound. That's how the fixed port systems measure the angle of the airstream over the airplane.

The vane systems work very well on multiengine airplanes because they can be mounted on the nose and align with the air flowing past. But on singles the propwash totally disrupts the vane if it is mounted on the fuselage. The only way to use a vane system on a single is to mount them on masts ahead of the wing as the Pilatus PC-12 turboprop single does.

The port sensing systems work well on singles because they are designed to be located on the wing. A rudimentary port system was used as stall warning on basic Cessna singles. When air flowing over a small opening in the leading edge of the wing reached a critical angle it created a soda bottle-style whistle that was piped into the cockpit to warn of an impending stall.

Several companies, including Dynon and Garmin, have located a port on the pitot tube mast that can compare the differential pressure at two locations and then use electronics to calculate the angle of airflow past the mast. There are more basic systems that skip the electronics and use the differential pressure of the ports to drive an AOA gauge mounted in the cockpit.

DISPLAYING AOA

Many methods of displaying AOA sensed by a system have been devised over the years. Often the display is colored in green, yellow, and red to show the margin above stall. Some displays are round dials, others vertical, some point up or down showing the way to pitch the nose to change the AOA to a safe angle, and on flat glass PFDs the AOA display schemes are constrained only by the imagination of the display creators.

The baseline for an AOA display is one, or 100 percent, however you want to think about it. Every wing has a maximum AOA, where it produces the most lift but is operating below the stall. This is often called C_{Lmax}, the maximum lift coefficient of the wing. An easier way to visualize what one or 100 percent represents on an AOA display is that is all the lift there is. Increase the AOA from that point and lift goes away.

Through careful calculation one can come close to predicting at what AOA a given wing will stall, but in real life AOA measuring systems are calibrated in flight. You install the system, fly the airplane to a stall, and note the AOA the system measures. That is the baseline of one, or 100 percent. You then build in margins to show when AOA is approaching a stall.

As you can imagine, AOA can vary a lot and quickly due to maneuvering and turbulence. And the lighter the wing loading and lower the mass of the airplane, the quicker AOA can change. That's why on a gusty day you may hear the stall warning chirp during takeoff and landing even though the airspeed is well above stalling airspeed. The gusts are changing the relative wind angle, so the AOA is jumping around in response and the stall warning detects that momentary change.

CAN AN AOA SYSTEM HELP?

For decades production airplanes have had stall warning systems of one type or another. Have the systems added safety? There are still unintended stall accidents in standard certified production airplanes, but the stall-spin loss of control wreck is more common in E-AB. Few experimentals have AOA or stall warning systems, so it would appear the warning systems have helped in overall GA safety. Of course, E-AB designs span such an enormous range of configurations and flying characteristics that factors other than stall warning may contribute to the accident statistics, but it makes sense that a stall warning system has to help some.

Many in E-AB flying look down their nose at a typical stall warning system as nothing more than an "idiot light" that only warns of a threshold, not an overall AOA operating range. And that's true. Even though a stall warning system is measuring change in AOA to do its job, it only tells you what the AOA is for a single preset point.

Navy pilots making carrier landings are often pointed to as the most effective users of AOA indication. Landing on a carrier is flying on the edge, to say the least, so Navy pilots on approach carry the smallest airspeed margin possible, and AOA shows them the edges of their envelope more precisely than indicated airspeed.

But a Navy jet approaching a carrier is stabilized in speed, power, alignment, and sink rate. It is without a doubt the most precise flying imaginable. And that doesn't compare at all to circumstances surrounding a typical stall-spin loss of control situation in a light airplane. The pilot of an E-AB who stalls and spins is maneuvering, often abruptly, stretching a glide after a power failure, or not flying a stabilized straight-in approach.

Would an AOA indicating system save the light airplane pilot who is yanking and banking? I don't think so. A typical piston airplane can be pulled from an AOA that is safely below stall to the stall in just a very few seconds. Would pilots be looking inside at the AOA indicator as they steepen the bank or pull back hard on the stick? And if they did would they have time to react to the very rapid increase in AOA and unload the wing before a stall? I doubt it.

I believe it is angle of attack awareness that we need to learn. And an AOA system can help with that. When a pilot can see how AOA is changing in response to maneuvering, added *g*-load, and change in airspeed, he can better visualize what is happening. In time, flying with an AOA indication system, we could learn what loads and airspeeds increase AOA to a risky level and learn to avoid those situations.

To be effective an AOA system should also have preset thresholds just like a basic stall warning system. When the AOA increases close to a stall, the system can trigger horns, lights, aural spoken warnings, or a stick shaker to alert a pilot to lower the AOA. That's how the AOA systems work in larger airplanes. A pilot who unintentionally stalls an airplane is almost certainly distracted, so the warning needs to burst through whatever circumstance has diverted his attention from maintaining a safe AOA.

I'm sure you have heard many times that a wing always stalls at the same AOA no matter the attitude of the airplane or indicated airspeed. That is sort of true. But wings can and do stall at a lower AOA when the rate of AOA change is rapid. And the behavior of the wing when it stalls after a fast increase in AOA can be very different, and less tame, than when you fly into a steady 1*g* stall.

In order to improve the stall-spin accident record, we all need to increase our AOA awareness and stall an airplane only when we intend to. Visualizing the relative wind angle that is AOA is the hard part. Instruments can help, but we still must understand how our control inputs are changing AOA and know how much margin our particular airplane needs to keep AOA below the stalling angle. *EAA*

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