ANGLE OF ATTACK—and ALPHA SYSTEMS

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This article started out to showcase yet another Minnesota aviation manufacturer—Alpha Systems—but in the process of obtaining information about the *company*, I became caught up in the *cause*. The folks at Alpha Systems not only believe in their product, but would like to change the way we think about flying our aircraft. I couldn't agree more!

I have been aware of Alpha Systems for some time—years ago, we installed a system on a Maule aircraft. Regular readers of this magazine will recognize that I've been attempting to point out just how many manufacturers are involved in producing products right here in Minnesota. I also wanted to talk to them about using AOA for better cruise information (see "Cruise Control"—*Minnesota Flyer*). Jets use AOA not only for takeoff, climb, and landing information, but for efficient cruising, as well.

As a flight instructor, I've always been leery of the FAA's somewhat bipolar teaching of stalls. The very first sentence on the subject in the FAA's "Airplane Flying Handbook" says *"The maintenance of lift and control of an airplane in flight requires a certain minimum airspeed."* It later defines a stall as occurring "when the wing exceeds its critical angle of attack. This can occur at *any airspeed"* (emphasis mine), *"in any attitude, with any power setting."* The manual contradicts itself yet again by *stating "vision is useful in detecting a stall condition by noting the attitude of the airplane. This sense can only be relied on when the stall is the result of an unusual attitude of the airplane."* How in the world does that square with the preceding sentence—"at any attitude"? When checking out a new pilot in a turboprop, I always give them stalls in a landing configuration—props forward, power levers at flight idle. In this case, I tell them that those big props become "9-foot rotating air brakes"—and that the aircraft will stall with the nose well below the horizon. Even with this warning, new pilots invariably fail to get the nose down far enough to preclude the stall. Vision can NOT be relied upon for stall recovery.

The FAA then abandons Angle of Attack when it talks about stall recovery. It mentions "reducing the angle of attack"—but then transfers to "lowering the nose as necessary to regain flying speed." How does that square with stalling "at any speed?" I've done accelerated stalls in a T-38—entry speed was 300 knots indicated, and it unhooked at 250 indicated. Speed didn't help—it was unloading the aircraft (reducing the angle of attack) that enabled the stall recovery.

FAA further abandons AOA when it comes to discussing takeoff, climb, approach, and landing SPEEDS. Aircraft manufacturers are similarly guilty—they reference SPEEDS for takeoff, climb,

stall, and landing—often without regard to gross weight or density altitude. Airspeed indicators are known liars—they have built-in errors (enough so that the FAA requires a chart for conversion from *indicated* to *calibrated* airspeed—hardly useful when you **really need it**). They are notoriously inaccurate at the low end of the dial—how often have you seen an aircraft stall at "20 mph indicated airspeed"—when the manufacturer says the aircraft stalls at 46? It hardly gives you a feeling of confidence when doing short-field approaches, does it? In fact, pilots often use **excess** indicated airspeed "in order to provide a stall margin", causing the aircraft to land long.

I don't know about you, but **I don't like being lied to** *(perhaps it is overload from this election season).* I would rather have the truth, and let me deal with it in my own way. The only way to know just how close to the stall you are is NOT the position of the nose relative to the horizon, and it is NOT an indicated airspeed—only AOA indication gives you this vital information. Angle of Attack indicators are hardly new—the only flight instrument on the 1908 version of the Wright Flyer was a simple string left to flutter in the breeze in full view of the pilot. The pilot knew where the "relative wind" was coming from—if the string were displaced left or right, the aircraft was slipping or skidding. If it came up from below, the wind relative to the airfoil (AOA) was increased. This same "high-tech device" is often used in gliders today—in multi-engine training aircraft to assure that the aircraft is going straight even with an engine out—and in flight-test aircraft.

Like most modern machinery, the Angle of Attack Indicator benefits from modern electronics. Some of the first general aviation AOAs used a simple vane on the leading edge of the wing that sensed the stagnation point of the passing air. They were effective—Beechcraft included them on early King Airs due to the aforementioned need to tell the pilot what was actually happening to the aircraft during steep descents. Like so many consumer electronics, they were initially VERY expensive—over $20,000 in today's dollars. Also like so many consumer electronics, they've become cheaper and more effective over the years.

With the advent of the jet age, almost every military and civil jet sports an AOA. AOAs are necessary due to the high power to weight ratio of jets, the wide variance in approach speeds required due to complex lift-enhancement devices and weight differences in jets, and the "clean" configuration of jets requiring the spot-on minimum speed approaches required. AOA's were also used by manufacturers to meet FAA aircraft certification requirements. In addition to providing pilot information, AOAs were use to activate stick *shakers* in large aircraft to alert pilots to an impending stall, and stick *pushers* to physically move the control column forward to reduce the angle of attack. For these same reasons, every Navy carrier-based aircraft uses AOA as a primary instrument on carrier landings, rather than indicated airspeed. Unlike the primitive AOAs, these primary instruments and aircraft control units used either a rotating conical

cylinder or a free-flying vane mounted on the side of the fuselage. They are VERY expensive, as they are a required FAA-certified primary flight instrument and control activator. (Note: Alpha Systems builds components for high-end AOAs.) Because of this FAA certification and high-end sophistication, AOAs were prohibitively expensive for General Aviation.

"A Game-Changer"

Alpha System discovered their niche in serving the General Aviation community as an ADVISORY system, rather than as a primary system. Electronics had brought the size, weight, and most important, the COST of AOAs down to a tiny fraction of the high-end systems. Like most consumer electronics, they became simpler to use, easier to install, and more trouble-free. The FAA recognized the safety of having an AOA on board General Aviation aircraft, and found a way to cut through its own bureaucratic red tape by calling it "Non-required" equipment. Here is an excerpt from the authorization letter from the FAA, dated December 11, 2011.

"This letter is in regards to the installation of your Alpha Systems-AOA system on Normal, Utility, Acrobatic, and Commuter Category Airplanes. The installation of any component on an aircraft must be evaluated for its affect (sic) on weight, balance, structural strength, performance, powerplant operation, flight characteristics, or other qualities affecting airworthiness. The Small Airplane Directorate views your system as non-required equipment that provides a safety benefit."

This letter from the FAA is a HUGE step in making affordable aircraft performance information through AOA available to general aviation pilots! With this tacit approval by the FAA, good AOA systems need not cost as much as our airplanes—AOA systems are available for as little as $700.

VISITING ALPHA SYSTEMS

Alpha Systems is a division of DepotStar—located in Ramsey—a suburb of Minneapolis located in the northwest side of the Metro. DepotStar is a multi-faceted company operating from a 22,000 square foot facility--making many products for the medical, computer, banking, defense, petroleum, and aerospace industry. Though their Angle of Attack business is a relatively small part of corporate sales, a walk through their office shows that the AOA business is where their heart is. There are Angle of Attack (AOA) displays and aeronautical photos all through the offices.

On arrival at DepotStar's offices, I was immediately met by President Mark Korin and AOA Program Manager Chris Crosby. I had asked for about 45 minutes of their time, but we

became so engrossed in AOA information that we talked for over two hours—until Mark had to excuse himself for another meeting. I told them that they didn't have to "sell" me on the advantages of an AOA system—I've flown gliders that "learn" the best AOA for best glide—King Air's with the simplified old "speed to fly" system that sensed the stagnation point on the leading edge of the wing (much like the "stall vane" seen on some aircraft), and the AOA system on every bizjet. I've been on the Landing Signal Officer's platform on an aircraft carrier as the pilot worked with the LSO on night carrier landings (there is a light system on the nose gear of carrier-based aircraft that tells the LSO whether the landing aircraft is fast, slow, or on-target). I have long been a believer!

I asked what differentiated the Alpha Systems units from the $100,000+ certified units. Mark quickly ticked off the differences:

- "Our units are not certified as a primary display. You still need to have an airspeed indicator. Our units provide supplemental information."
- "We use a differential pressure device to calculate AOA. The expensive units have vanes on the side of the fuselage, or a rotating sensor." I asked if the probes are de-iced—they are.
- "Our units cannot provide input to FAA-mandated stick shakers and stick pushers, autothrottles, or over-rides on heavy aircraft—those are systems FAA-mandated for specific airplanes, and as such, the cost of certification is VERY expensive."
- "By going the non-certified route, our units are very inexpensive and are available for almost any General Aviation aircraft."

I asked about installation, and Mark moved quickly to the demonstrator. The unit provides a cross-section of a wing with an AOA probe mounted. The information derived can be displayed on any of the 12 different displays on a simulated panel. Mark showed me the AOA probe, with an innovative mount. "We configured it to replace an ordinary wing inspection panel" he explained. It is quick to install, quick to remove, and it requires no structural changes for mounting it to the wing. That keeps certification and installation costs low." The company also makes an AOA mount for wing struts, and with FAA approval, can mount probes on the fuselage.

I remarked on the unusual number of presentations for AOA information. "We try to accommodate the desires of each owner" he responded. "We have the self-powered panel-mounted gauges for aircraft without an electrical system. We have the "Enhanced Legacy" unit that displays just like the AOA in military and corporate jets. We have the LED units in a variety of configurations—round to fit a 2 ¼ inch instrument panel hole, horizontal and vertical mounts, and minimal sized units for installations with space constraints."

I mentioned that the LED units looked like "TMI"—"*Too Much Information"* as the kids say—and that I preferred the Legacy unit, or perhaps the dial presentation. Mark explained the difference, and in less than 5 minutes, he changed my mind. "I think it is important to put the information in the pilot's peripheral vision, rather than buried in the panel" he said. "When you NEED AOA information, you don't have time to look down—the information and the warning needs to be right there in your face while you are focused outside—like when you are flying a short field approach—or need maximum performance data—or are faced with an inadvertent base-to-final stall. The LED units show where the *stall* is—they show the *margin above a stall*—and they show the *trend* with a decreasing number of lights." If those options were not enough, the units can be configured to activate a chime, a beep, or even a voice that says "*Getting Slow*" or "*Too Slow*." I agree with Mark—I want it as close to the top of the glareshield as possible. Mark did mention that they were working on yet ANOTHER presentation!

We discussed installation. With the inspection-plate mount, the biggest problem for most installations is mounting the indicator. After that, the unit needs to be calibrated. "All you have to do is to make a flight that adds just enough power for a no-climb/no-sink condition" he mentioned. "After that, the unit shouldn't need any recalibration." I asked where the systems could be installed. "We don't install them ourselves" he answered. "We have installers do that." Installation centers in Minnesota include Monaco Air in Duluth, Sierra Hotel and Wipaire at South St. Paul, and Twin Cities Aviation at Anoka County Airport.

I asked what airplanes made up the market for the Alpha System AOA. "ANY General Aviation aircraft" was the response. "Light Sport and legacy aircraft find it useful because while they can fly slowly, they "pay off" (lose speed) rapidly. Obviously, anyone interested in Short Takeoff and Landing operations will appreciate it—as will anyone looking to get maximum utility from their aircraft. Any pilot that is concerned about inadvertent stall/spin operations should have one *(given the number of stall/spin accidents in General Aviation, that should be MOST pilots!)."*

SO, WHY WOULD I WANT ONE?

We often justify purchasing aviation equipment "for safety"—and that's as it should be. Given that stall/spin/loss of control and runway over-runs are some of the leading causes of aircraft accidents, any piece of equipment that would help eliminate the threat ought to be high on our list of "must-haves." The problem is—unless you are an airline, corporate, or military pilot, most General Aviation pilots have never been taught to use an AOA—or experienced what it can do.

- Have you ever been nervous about landing on a short strip or icy runway? Flying an AOA will allow you to fly the approach as slowly as possible for the aircraft weight and conditions, while knowing your margin of safety.
- On takeoff, have you ever needed maximum performance in clearing obstacles? An AOA will give you that information—taking into account aircraft weight, flap configuration, density altitude, and engine performance. Using airspeed to obtain performance is only applicable for the conditions specified in the aircraft operating handbook.
- Most pilots add speed on approach and departure due to gusting conditions. An AOA will tell you just what the wing is actually "seeing" for those conditions.
- Flying AOA eliminates *"The books says approach at 80, but it feels so good at 90, that I think I'll use 100—plus 10 knots for gusts"* approaches. These approaches often end up with the pilot attempting to force the aircraft onto the ground, leading to "wheelbarrowing", "crow-hops", loss of control, or runway over-runs.
- Have you ever needed to get best single-engine performance out of your twin with an engine-out? An AOA can identify best L/D Max for any power loading—the "blue line" on the airspeed indicator was established at only standard temperature—at the certification airport altitude, and at max gross weight. The manufacturers usually give performance at selected weights. As the auto advertisements say "Your performance may differ."
- Have you ever had an engine failure (either full or partial) in a single? If so, you'd better know the best glide speed. SOME aircraft manufacturers give "best glide" at different weights, but most give it at gross weight only. With an AOA, L/D Max is right on the panel.
- Have you ever wondered what the REAL effect wing flaps or G-loads have on stall margin? The AOA is a valuable tool in portraying these conditions on the stall margin. You can learn a LOT about your aircraft by watching the AOA.
- For high-flyers and those interested in cruise control efficiency—an AOA will tell you how close you are to L/D Max—and whether you can step up a flight level for better fuel efficiency—or whether you've out-climbed your best cruise altitude.
- A final reason—"because the pro pilots use them"—military, corporate, and airline pilots use them. Here's a chance to fly like the pro pilots fly.

I've experienced every one of these scenarios personally. You can learn a lot from paying attention to what is actually happening on the wing, instead of airspeed. The AOA also serves as a good backup to the airspeed "bug". On more than one occasion, I've flown an approach in a jet, only to find that if I was on the calculated "bug" speed, the AOA showed "slow". A quick recalculation of landing weight showed that the landing weight had been calculated incorrectly. It's a good cross-check. I've also seen the other side of the airspeed vs. AOA dispute—I was

landing at the Chicago Meigs airport in a Falcon jet—and the field was only 4400' long. We were light—I was right on the calculated "bug" speed for landing, but the moderate (or better) turbulence coming out of the buildings in downtown Chicago caused the AOA-activated stick shakers to activate—even at the correct indicated airspeed. We sped up 10 knots to increase our margin on a possible stall.

Years ago, we had a King Air crew land in the snow, short of the runway at Albert Lea. The crew was perplexed—both swore that they had been flying the recommended speed. I asked them if they had been flying the simplified AOA built into the glareshield of the King Air—they admitted that they had not. Later investigation showed that water had frozen in the tube connecting the left and right static ports, giving an erroneously high airspeed indication, when the aircraft was actually stalled. Paying attention to even a rudimentary AOA would have prevented the accident.

In the Air France crash over the South Atlantic several years ago, the pitot tubes iced up, giving erroneous high airspeed indications. The crew reacted to the overspeed indication by pulling off the power and raising the nose to an extreme attitude, losing control of the aircraft. AOA was available to the crew, but not on the glass cockpit "page" they were using at the time. Some two decades ago, Northwest Airlines had a similar fatal crash involving a 727, when the crew failed to turn on pitot heat. The cockpit voice recorder captured their confusion on what the instruments were telling them. In both instances, flying AOA would have precluded the crash.

In perhaps one of the most noteworthy crashes in Minnesota history, Senator Wellstone and his family were killed in a crash of a King Air. The final radar "hits" showed the aircraft slowing very quickly from approach speed to a ground speed approximating a stall in a matter of seconds. While a definitive cause has not been issued by the NTSB, there is no doubt that the aircraft stalled. My own feeling is that the pilot was not aware of the rapid deceleration of most turboprops when configured for landing and power reduced. The aircraft will stall with the nose well below the horizon—something we are not trained for in primary training. The AOA would tell us otherwise.

An AOA Indicator improves safety and utility perhaps more than anything else you can put on an airplane. I want one!

Jim Hanson is the long-time FBO at Albert Lea, MN. In his 49 years of flying over 300 different types of aircraft, Jim has flown many aircraft with AOAs. The biggest problem for Jim is figuring out which one of his 12 airplanes to put it on. He says "The only one that couldn't use it is the balloons! If you would like to give Jim advice (or any other opinion), contact him at his airport office at 507-373-0608, or jimhanson@deskmedia.com