DAVE SIZOO

AOA: More than Just a Display

Real World Uses for Angle of Attack

AOA probe used on a Cessna 182 in FAA research program

Two Super Cubs departed the Anchorage, Alaska airport in formation just as the sun was coming over the horizon. It was a perfect day for flying and fishing. The 52-degree springtime air was crisp and the winds were calm as the airplanes headed toward their favorite secret fishing spot. Both pilots were looking forward to fishing after landing on the riverbank. Although they had flown to this spot many times before, this was their first trip this year.

As they approached the landing zone at about 350' above ground level, the first airplane spotted an extremely large moose crossing the river. The giant moose lumbered straight toward the middle of the landing zone. Instinctively, the pilot banked to the left for a better view of this amazing creature while simultaneously telling the trailing airplane of his find. As the two Cubs maneuvered across the circle from each other, the moose stopped in his tracks and lazily looked up.

The lead PA-18 pilot radioed, "This is the largest . . . " Suddenly, his airplane rolled to the right and ended up inverted. There was no time to recover.

Meanwhile, the pilot in the trailing Super Cub almost succumbed to the same trap. However, his airplane had some additional safety enhancements. He had an angle of attack (AOA) probe, an AOA indicator with audio, and an AOA-activated stick shaker. When he felt a rumble in the control stick and heard the stall warning audio, he knew something was not right. Glancing at the AOA indicator, he noticed he was in the red arc. He immediately relaxed backpressure and added full power while rolling wings level, but he was low and heading for the ground.

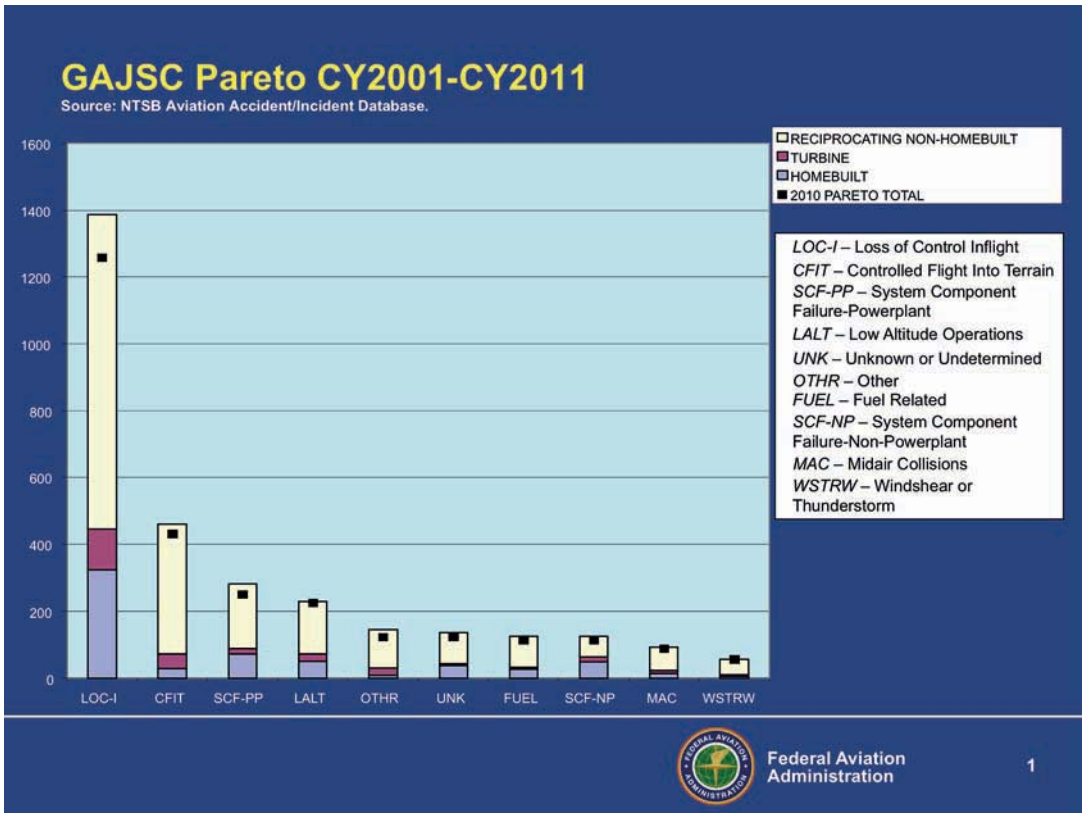
Looking forward, the pilot could see nothing but riverbank filling his windscreen. If he instinctively pulled back to avoid crashing, he would no doubt stall again. How hard could he pull without stalling? This was a max performance situation. His attention was now focused on where it needed to be — avoiding a secondary stall while minimizing altitude loss.

He loosened his clenched, reactive grip on the stick. Clearing the river by a few feet, he realized how close a call this was. As he climbed out, his heart was pounding. He gently banked to the left and craned his neck around to check on the lead airplane. His heart sank when he saw the pile of twisted metal and torn fabric burning on the riverbank. How could this happen to a mature 52-year old pilot with over 5,400 hours total time?

Although fictitious, this story illustrates an accident pattern that occurs all too frequently. In Alaska alone, over the last six years, there have been 97 accidents categorized as fatal or having caused serious injury. The most common of these was stall spin accidents, with 39 people killed and 26 people seriously injured. That's almost one person a month! This problem is not unique to Alaska. Loss of control is the leading cause for general aviation (GA) mishaps in the lower 48 as well, having caused 1,190 fatal accidents in the last 10 years. That works out to one fatal accident every three days on average. Clearly, this is a big problem, so let's have a look at how AOA indicators can assist pilots in preventing a loss of control situation and in recovering from a stall.

As pilots, we all should understand the theory of AOA and how important it is to safely maneuver

GAJSC/SAT Identifies Loss of Control In-Flight (LOC-I) as Leading Cause of Fatal GA Accidents (2001-2011)



our airplanes around the sky. We learned in ground school that an airplane will stall if you exceed the critical AOA. If aggravated, a stall can progress to a spin and/or loss of control. During flight training, we rely on airspeed to avoid a stall. However, it is important to keep in mind an airplane can stall at *any airspeed*, any pitch attitude, and any power setting.

If the pilot is expected to manage AOA to stay in control, why is this angle not displayed or utilized in the aircraft? AOA is displayed in most military fighters, many transport airplanes, and even in some small aircraft. However, AOA devices are not commonplace in GA. Thanks to a new FAA policy change, that may change.

In an effort to reduce both the GA accident rate and the cost of installing safety devices in airplanes, the Small Airplane Directorate started a campaign about three years ago. Collaborating with other FAA offices, the Directorate worked to streamline the time and money required to get AOA devices in the field.

The hardware itself for an AOA device is relatively inexpensive. New devices on the market accurately measure and display AOA. They also provide audio warnings as the critical angle is approached.

Speaking of affordability, how about a low cost aftermarket stick shaker activated from an AOA device? In recent flight tests conducted under an FAA Research and Development Project, this concept has proven very effective at getting the pilot's attention.

Now let's discuss the human factors of AOA devices. It is no wonder that pilots cannot manage AOA when it is not displayed to them. Displaying AOA is certainly a good start, but may not be enough. The pilot may not be looking at the display when he/she needs it the most. This is where getting his/her attention in another way is paramount.

Invoking three of the five senses progressively with an AOA-based stick shaker, aural tone, and visual display should enhance the pilot's focus on what is important at the time. This approach may help address the root cause of many loss of control accidents — pilot error resulting from distraction.

To combat the Loss of Control issue, the FAA collaborated with industry and academia to form a Loss of Control Working Group. This group was under the General Aviation Joint Steering Committee Safety Analysis Team (GAJSC/SAT). The working group reviewed over 275 loss of control accidents and developed 98 specific interventions that would address the root cause of these accidents. Not surprisingly, AOA systems ranked first among these interventions in terms of feasibility and effectiveness.

When used properly, AOA can help pilots in many other ways. For example, AOA information can provide for a more consistent, stabilized approach and landing.

The Small Airplane Directorate is actively sponsoring multiple research programs with NASA, academia, and industry to explore additional benefits of AOA. This small but important angle is finally getting the attention it deserves in the general aviation world.

Dave Sizoo is a flight test pilot from the FAA's Small Airplane Directorate.
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TOM HOFFMANN

The Alpha (and Omega)

How a Small Angle Can Make a Huge Difference

Unlike some of my classmates at the time, I actually have some fairly fond memories of high school geometry. In particular, I enjoyed breaking out the compass and protractor to measure, draw, and dissect angles. Long ago familiar terms like transversal, supplementary, complementary, and alternate-exterior are fun to rehash in my mind. Lucky for me geometry followed me into my flying career and become an important element to understanding aerodynamics and unlocking some of the mysteries of flight. Wing dihedral, angle of incidence, and the effect of aerodynamic forces are all examples of how geometric principles govern the way we fly. Then there's the "alpha" angle — the all-important angle of attack which every student pilot learns early on is an aerodynamic threshold that deserves the utmost respect.

Simply put, the angle of attack is the angle between an aircraft's wing and the oncoming air. If this angle becomes too great in flight, the wing will be unable to produce lift and the aircraft will stall. Not good. Most general aviation pilots rely on airspeed and the piercing whine of the stall warning horn to avoid getting themselves into a stall situation. However, another stall warning device that has long been available — but not without a sizeable effort and cost to install — is the angle of attack (AOA) indicator.

These supplementary devices are designed to alert pilots of a high angle-of-attack condition before a stall occurs, either with a visual or aural warning, or both. AOA systems provide an added layer of safety due to a more reliable indication of airflow towards the wing than an airspeed indicator can provide, regardless of gross weight, G-loading, or turbulence. And now, thanks to a revised FAA policy for producing and installing these devices, there's good news for those who were previously put off by the prohibitive cost and red tape.

So what's changed for AOA installations? Under the new policy announced February 5, 2014, manufacturers can now build the AOA indicator system according to standards from the American Society for Testing and Materials (ASTM). They then apply for FAA approval for the design via a letter certifying that the equipment meets ASTM standards and was produced under required quality systems. That means manufacturers no longer have to go through the full Technical Standard Order certification process to have an AOA device approved. The FAA's Chicago Aircraft Certification Office will process all applications to ensure consistent interpretation of the policy.

"This represents a drastic change for the FAA," says Craig Holmes, Aviation Safety Inspector with FAA's Aircraft Certification Service, referring to the manner in which this new streamlined policy was implemented. "The new guidance will allow us to significantly speed up the application and approval process and should help encourage owners to equip their aircraft with this important safety device."

There are a few important items to keep in mind with this new policy, however. First, it applies only to supplemental AOA systems — not those required for type certification of the aircraft. Second, it is limited to those systems installed in U.S.-registered aircraft, excluding commuter and transport category airplanes. The guidance also stipulates that no operational credit can be taken for such items as reduced approach speeds and shorter landing distances.

While the use of AOA systems is an effective means of reducing loss of control accidents, their effectiveness can be limited by how much proficiency an operator has gained with a particular device.

"Given the lack of available training on certain AOA systems, I recommend going up with a qualified instructor and testing it out thoroughly," says Holmes. "With an instructor by your side, you'll be able to monitor precisely how your AOA device reacts during stalls and other maneuvers."

Regardless of your take on geometry, I'm sure you'll appreciate the FAA's new "angle" on improving safety for GA.

Tom Hoffmann is the managing editor of FAA Safety Briefing. *He is a commercial pilot and holds an A&P certificate.*

Learn More

Approval of Non-Required Angle of Attack (AOA) Indicator Systems
http://1.usa.gov/1kNTZiT

FAA Press Release - Installation of Angle of Attack Indicators in Small Aircraft
http://1.usa.gov/1sGpW21