

# Angle of Attack:



120 Kts



80 Kts

## Who needs it, and What is it?

**T**his is a two-part feature discussing angle of attack. This month, I'll explain what angle of attack is, and who needs it. The second article will describe **Alpha Systems' Angle of Attack System (AOA)** and its installation, calibration and operation in *Bill*, our pampered 182.

### Who needs it?

During my time with Cessna's Citation Marketing Division, I became a staunch believer in angle of attack (AOA) cockpit displays. No matter the aircraft's attitude or airspeed, a Citation business jet's AOA indexer lets you know immediately whether the wing will support the aircraft or not.

### Who uses it?

The United States Navy and Marine Corps Naval Aviators participate in the



65 Kts

by Charles Lloyd

world's largest spot landing contest. The Landing Signal Officer (LSO) and his or her assistants evaluate and document every carrier landing for the aviator and his or her squadron. In addition, an aft-facing camera broadcasts to many areas of the ship so everyone on board the carrier can observe the landing.

A Naval Aviator lands on an angled carrier deck with four arresting wires 40 feet apart. The object is to safely land the jet with a 130-knot approach speed chasing a carrier going 25-30 knots into

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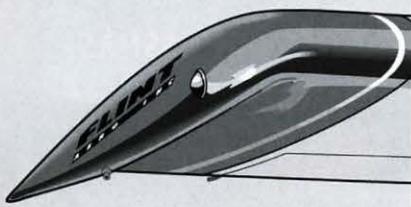
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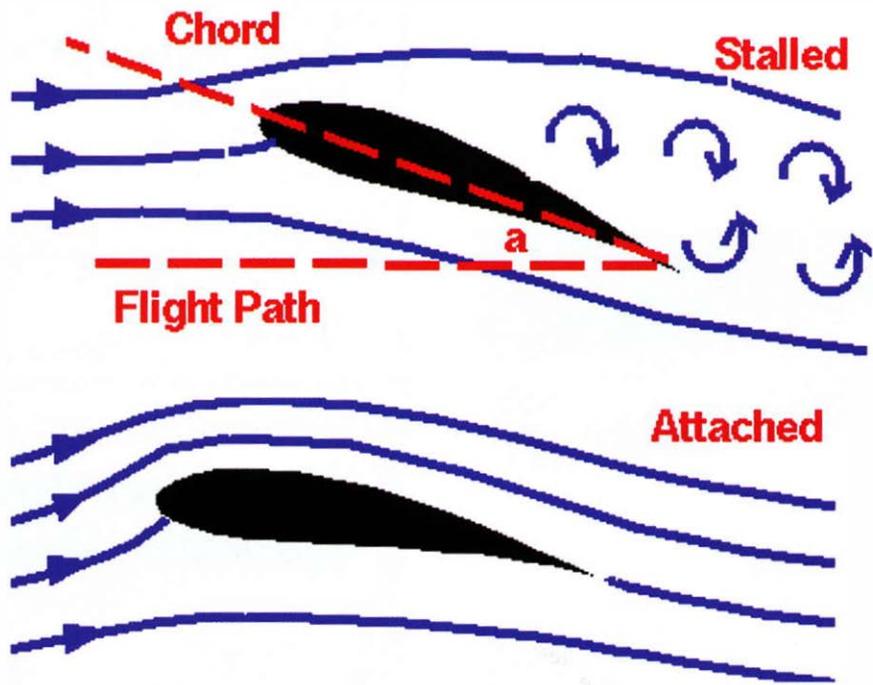
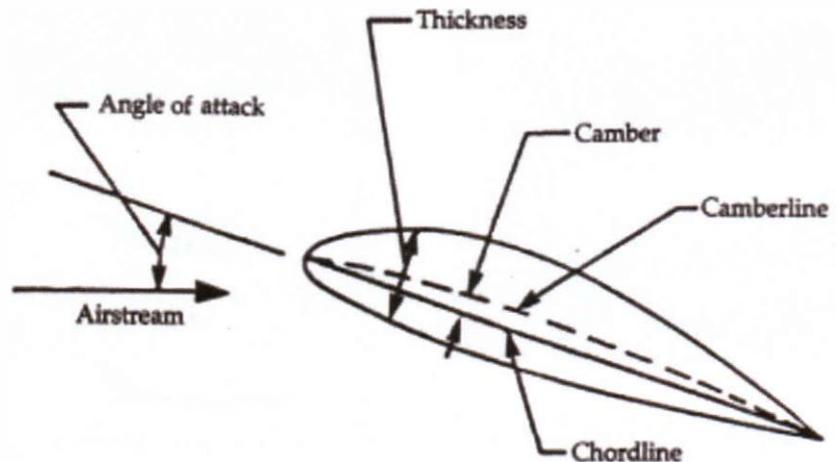


Figure 2. At normal angles of attack, the air flows smoothly over the upper wing surface and rejoins the air flowing underneath the wing.



This diagram illustrates the angle of attack and the critical components of the wing structure.

the wind for an across-the-deck speed of 90-100 knots, catch the number-three wire, and stop in 300 feet.

Yes, the aviator has a visual approach slope indicator—called the “ball”—to help with a glide path angle (typically 3.75 to 4.0 degrees). The aviator has an AOA system indexer in the cockpit, and external indexer lights so the LSO may observe aircraft pitch attitude and angle of attack.

To land consistently in a 40-foot-long flight deck touchdown zone is phe-

nomenal and requires skill and practice. Angle of attack information is vital to safely landing a high performance jet precisely on speed at the same spot on the carrier deck every time. An AOA system provides the information necessary to land an aircraft at any landing weight consistently and precisely every time.

### Pop Quiz

Before you say “Well, that’s OK for jets, but my airplane is different,” you

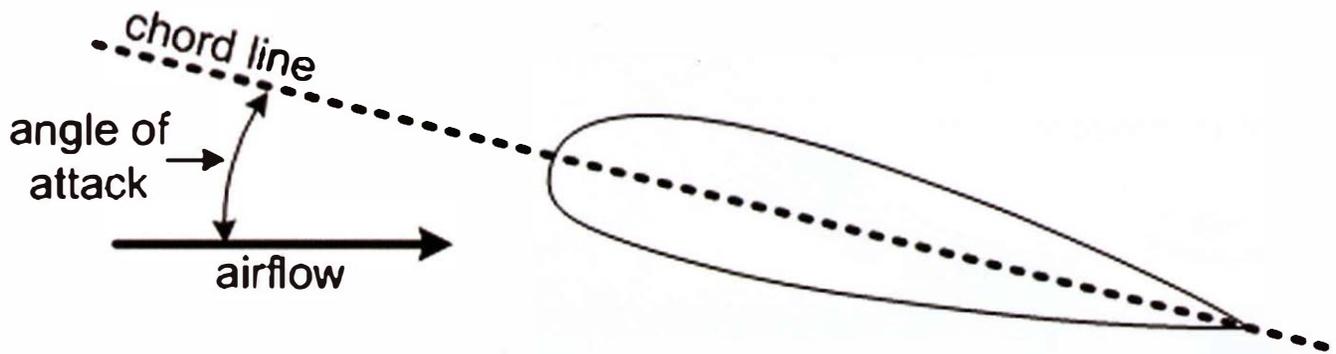


Figure 1. A chord is an imaginary line between the drawn between the wings leading and trailing edges.

should know this: having AOA information—versus relying completely on Indicated Airspeed and control feel—may be more important than you realize. Take the quiz below:

1. What is the stall speed difference between flaps-up and full-flap configuration? Some heavy singles have a 20-knot variation in stall speed depending on flap configuration and landing weight. The difference may be even greater for light and medium twins.
2. Do you ever forget to set flaps for takeoff or landing?
3. Do you ever bank more than 20 degrees?
4. Have you ever overbanked turning base to final to prevent overshooting the approach path?
5. Do you want to make more consistent landings?

If you answered “maybe” to questions two through five, then I urge you to keep on reading.

Question one compares the stall speed variation for a heavy single for maximum landing weight (flaps up) to minimum landing weight with full flaps. In a 1976 Cherokee Lance the difference is 18 knots. Late model Cessna manuals

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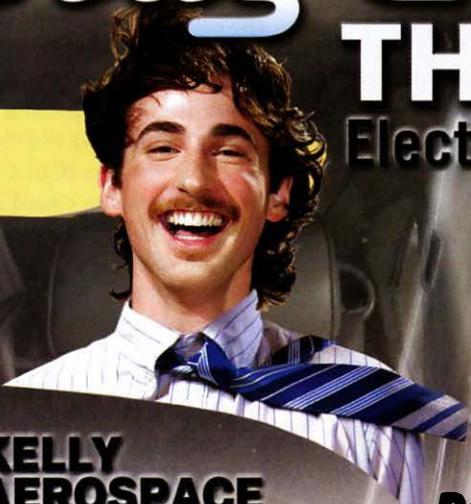
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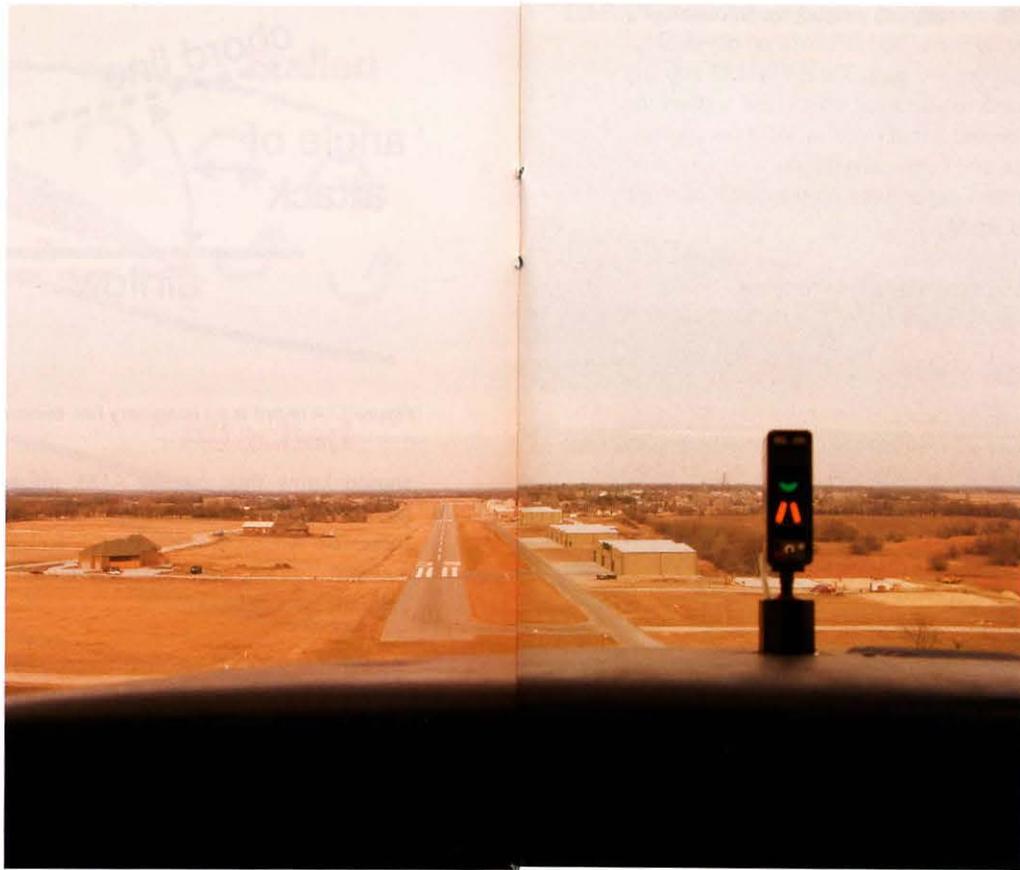
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**Alpha Systems Angle of Attack Indexer** in our 172 "Bill" on short final.

give one stall speed (for the maximum gross weight only), but a Cessna 210, for example, has a wide variation for these landing weight and flap conditions also.

The answer to question two relates to question one. If you forget to configure the flaps for landing and then overbank to final, you have now progressed into the situation for questions three and four.

On to question five. I know you are probably saying: "Good grief, most of us GA pilots don't need to consistently land in a 40-foot spot;" I will agree with you on that point. However, to land within 150 feet of your intended touchdown point with consistent rollouts at any landing weight gives added safety, and causes less wear on your brakes.

### AOA: What is it?

There will be no mathematics involved in this explanation, primarily pictures backed up with words. Whenever we fly an aircraft, angle of attack is present whether we realize it or not. The angle that our aircraft's wing impinges

the airstream creates lift. Increase this angle and lift increases.

Angle of attack is the bite your airplane's wing takes as it moves through the air. Technically, it is the angle between the wind flowing by the wing and wing's chord. For those of you who might need a review, a "chord" in aeronautical terms is an imaginary line drawn between the wing's leading and trailing edges (as shown in fig. 1, page 29).

At normal angles of attack, the air flows smoothly over the upper wing surface and rejoins the air flowing underneath the wing (fig. 2, page 28). Increase this angle of attack to the critical angle, and the airflow over the top of the wing separates from the wing, and lift is lost. Now the wing is a board plowing through the air, creating only drag and no lift.

### AOA Practical Application

As a youngster I used to enjoy rolling down the car window and sticking my hand out in the wind. With my palm

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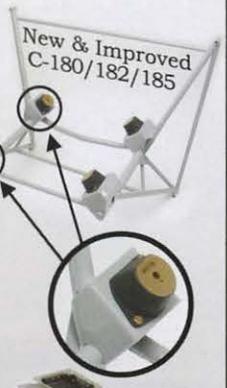
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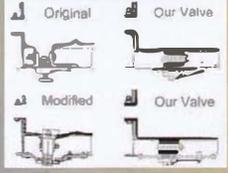
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# ALASKAN B

Landing Systems that



flat, rotating my wrist up and down made my arm rise and fall with no physical effort on my part. Then I would cup my hand to see what effect this had on the rise and fall of my arm. I did not appreciate that I was carrying out a simple wind tunnel experiment on the effect of angle of attack.

### Angle of Attack in Pictures

A picture series (fig. 3, pages 26-27) will help you to visualize angle of attack. Flying my 182 across the Kansas landscape at three different airspeeds for the same configuration and weight graphically shows different angles of attack. AOA varies with airspeed or wing loading (gross weight or bank angle).

The wing's angle with the horizon is minimal for cruise and increases progressively for pattern and slow flight conditions. As airspeed decreases for a given weight, the wing needs to take a bigger bite to support the aircraft weight. Slow down too much and you are going to fall out of the sky (stall) unless you do something different.

Examiners will interject scenario-based distractions into checkrides that pilots may see in everyday flying. Flight instructors use the same techniques on biannual flight reviews and instrument competency checks. These distractions happen at times when an angle of attack visual clue would be helpful.

One way pilots can get a visual clue is to use an angle of attack system, similar to the indexers the Naval Aviators use. Alpha Systems offers a variety of models that include a probe, transducer computer and display to give you these visual clues in any attitude or airspeed. See you next month with more on installing and using an AOA system) in a Cessna 182.

Charles Lloyd has logged 10,000 hours since his first flying lesson in 1954. He worked for Cessna Aircraft for 16 years. Lloyd retired as captain of a Citation Encore Plus for a major fractional aircraft ownership company. He flies a tricked-out 1966 Cessna 182—also known as Bill—that is a great business tool for his real estate investment company. Send questions or comments to editor@cessnafter.org.

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