Federal Aviation Administration

The National FAA Safety Team Presents

Topic of the Month – April

Angle of Attack

Presented to: WAFC and Friends

By: Stephen Bateman, CFI

Date: April 12th 2021

Produced by AFS-850
The National FAA Safety Team (FAASTeam)

Welcome

- **Steve Bateman, AOPA Director of Flying Clubs**
  - Treasurer, maintenance and safety officer – Westminster Aerobats Flying Club
- **Sponsor Acknowledgment – WAFC, AOPA, FAASTeam, Baltimore FSDO**
- **Please - MUTE your microphone. "Raise your hand" if you need something!**
- **WINGS Credit: Yes…but give me a day or two…**
- **In-and-out…no time for questions, but send email:**
  - **steve.bateman@aopa.org**

Important!

- Wilmington Delaware TFRs
- Extended P-40 TFRs
- Will be popping up like daisies…
- Check NOTAMs
- Subscribe to NOTAM notifications
- Call flight service when in flight

VIP TFR OVER WILIMINGTON, DE BEGINNING
TODAY SATURDAY, MARCH 6, 2021

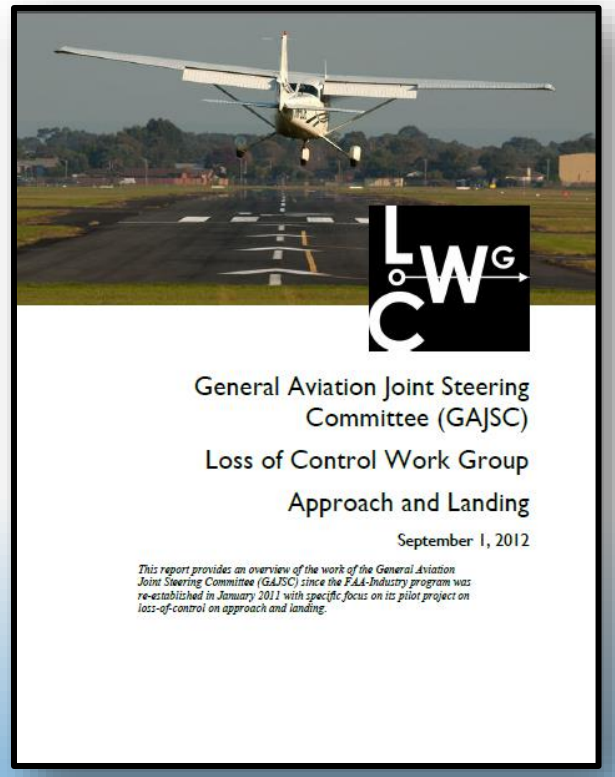
VIP TFR OVER HAGERSTOWN/THURMONT, MD
BEGINNING FRIDAY, APRIL 2, 2021
(((CHANGE IN DEPARTURE TIME)))

Important!

KILG New Castle Airport
N57 New Garden Airport
7N7 Spitfire Aerodrome
KEVY Summit Airport
58M Claremont Airport
KOQN Brandywine Regional Airport
KMQS Chester County
9N2 Philadelphia Seaplane Base
KPHL Philadelphia International Airport
M06 Havre De Grace Seaplane Base
38N Smyrna Airport
MD1 Massey Aerodrome
0W3 Harford County Airport
P72 Penn's Landing Heliport
O03 Morgantown Airport
00N Bucks Airport

Overview

- **General Aviation Joint Steering Committee (GAJSC) & FAA Accident Study Findings**
- **Angle of Attack Systems**
  - Yer training
  - Yer eyes
  - Yer butt
  - Instrumentation
- **Angle of Attack Management**



What the GAJSC's LOC Working Group discovered:

… pilot awareness of the overall energy state in flight was just not where it needed to be. AOA seemed a logical place to start with how to mitigate this risk….

…Awareness

…Indicators

Awareness & Indicators

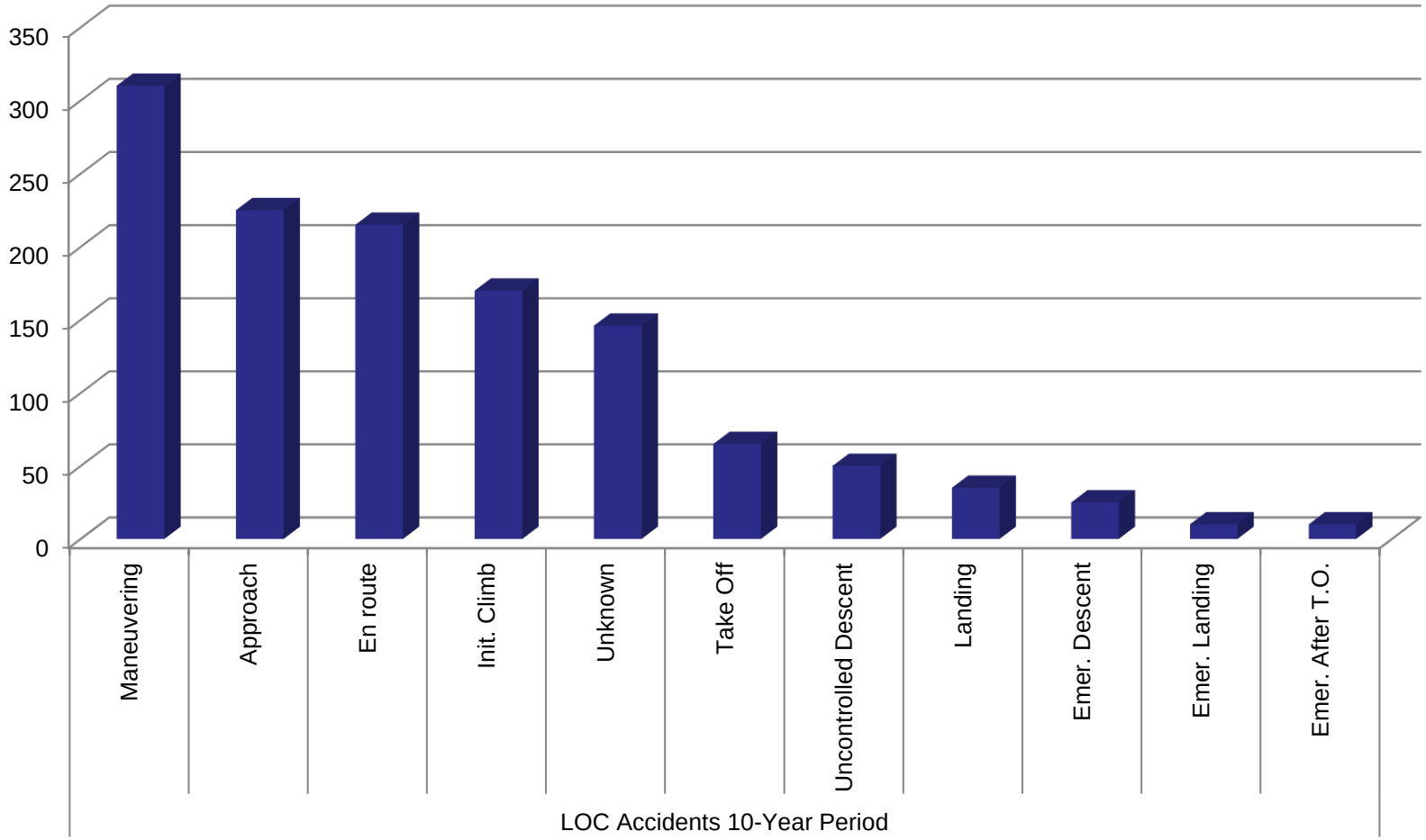
- What Does the Accident Data Tell Us
- Define Angle of Attack
- Illusions and Perceptions
- Stall Awareness Training
- Angle of Attack – Look and Feel
- AOA Indicators and Use
- Best Practice Thoughts

Loss of Control – The result, not the cause…

- **The most lethal GA accident precursor**
  - Disorientation (Continued VFR into IMC)
    - >90% fatality rate. “178 Seconds to Live”
  - Distraction
  - ***Inappropriate response to emergent event***
  - ***Lack of aircraft handling skill***
  - ***Not understanding the situation/sensation***
  - Inadequate risk management/mitigation

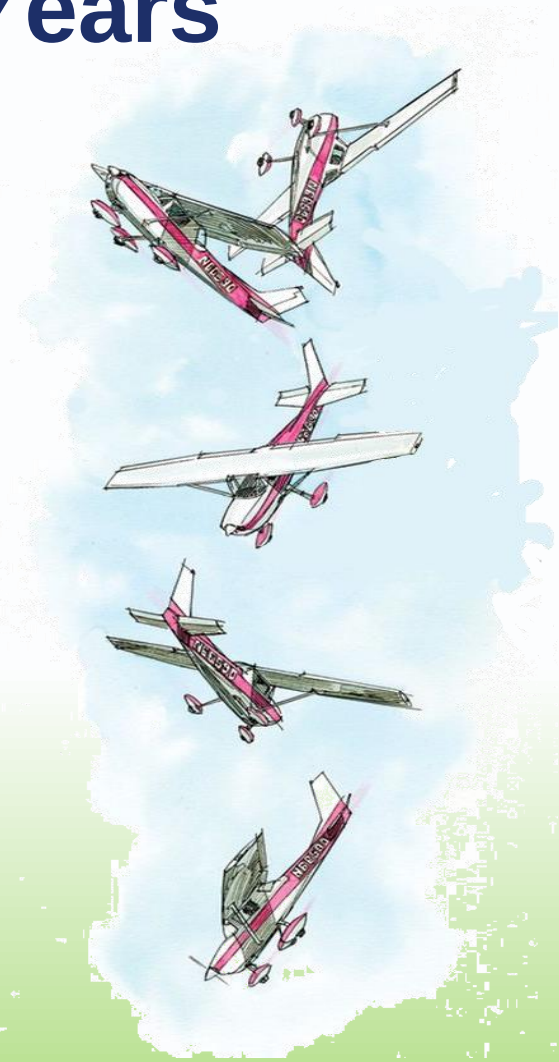
- **Proficiency Training addresses all of these**

Looking at Fatal LOC Accidents

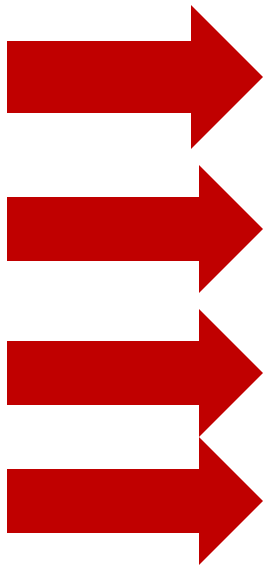


Total LOC Accidents: Last 8 Years

- 789 – Airspeed
- 572 – Altitude
- 368 – Descent/Approach/Glide Path
- 265 – Pitch Control
- 160 – Lateral Bank Control
- 134 – Climb Rate



Which of these statements are true with respect to stalls?



A. Can occur in any phase of flight

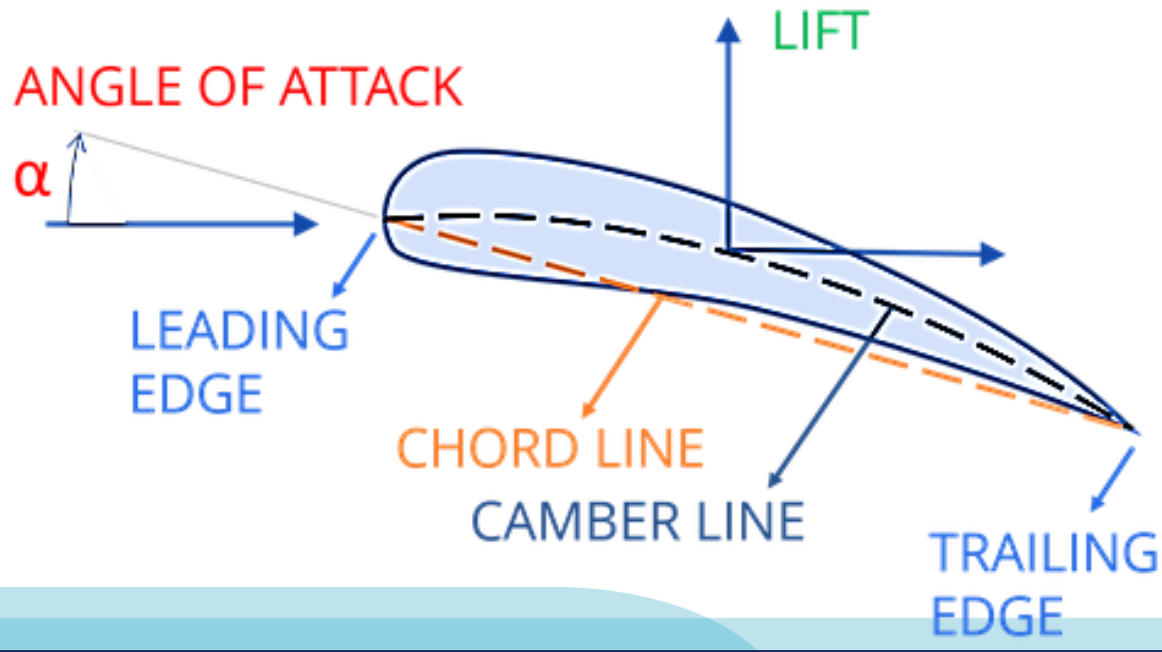
B. Are a factor in many fatal accidents

C. Usually involve low time pilots

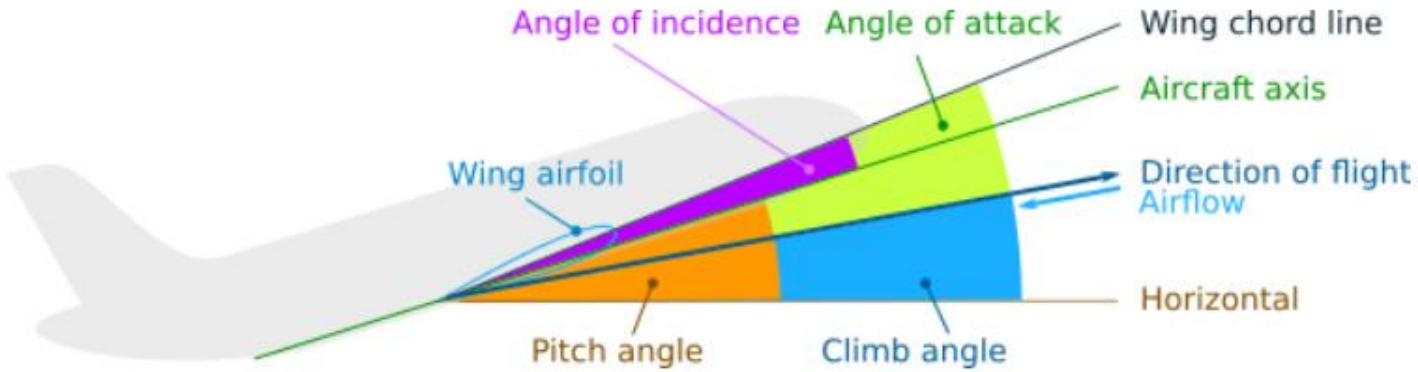
D. Can occur at any airspeed

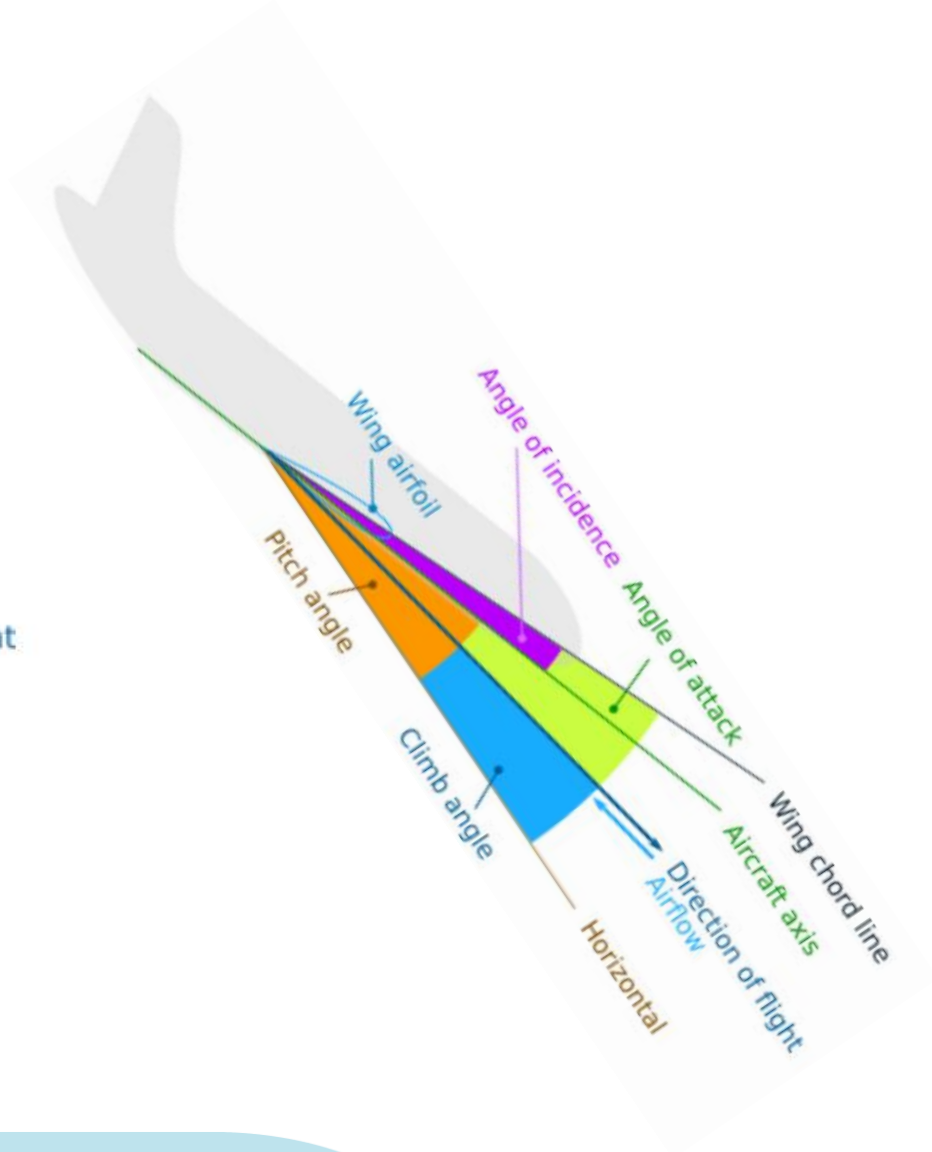
Angle of Attack (AOA)

- **The angle at which the chord of an aircraft's wing meets the relative wind.**
  - The chord is a straight line from the leading edge to the trailing edge
  - Relative wind is exactly opposite the direction of travel



What's Your Angle?





Angle of Attack: Visual

Visual perception of attitude

Airspeed

Pitch

Bank Angle Pitch

Altitude

Power Setting

Angle of Attack: Visual + Performance

Visual perception of attitude

>90%

- Airspeed
- Pitch
- Bank Angle Pitch
- Altitude
- Power Setting

Power-Pitch-Performance Tables

Level Flight		
RPM	Pitch Angle	IAS

Slow Flight. Level Full Flaps, Carb Heat On		
RPM	Pitch Angle	IAS
		70
		65
		60
		55
		50
		45

500FPM Descent First Flap, Carb Heat On		
RPM	Pitch Angle	IAS
		80
		70
		65

500FPM Descent Full Flaps, Carb Heat On		
RPM	Pitch Angle	IAS
		70
		65
		60

Altiude Lost in Impossible Turn		
Turn to:	Altitude	Alt Lost

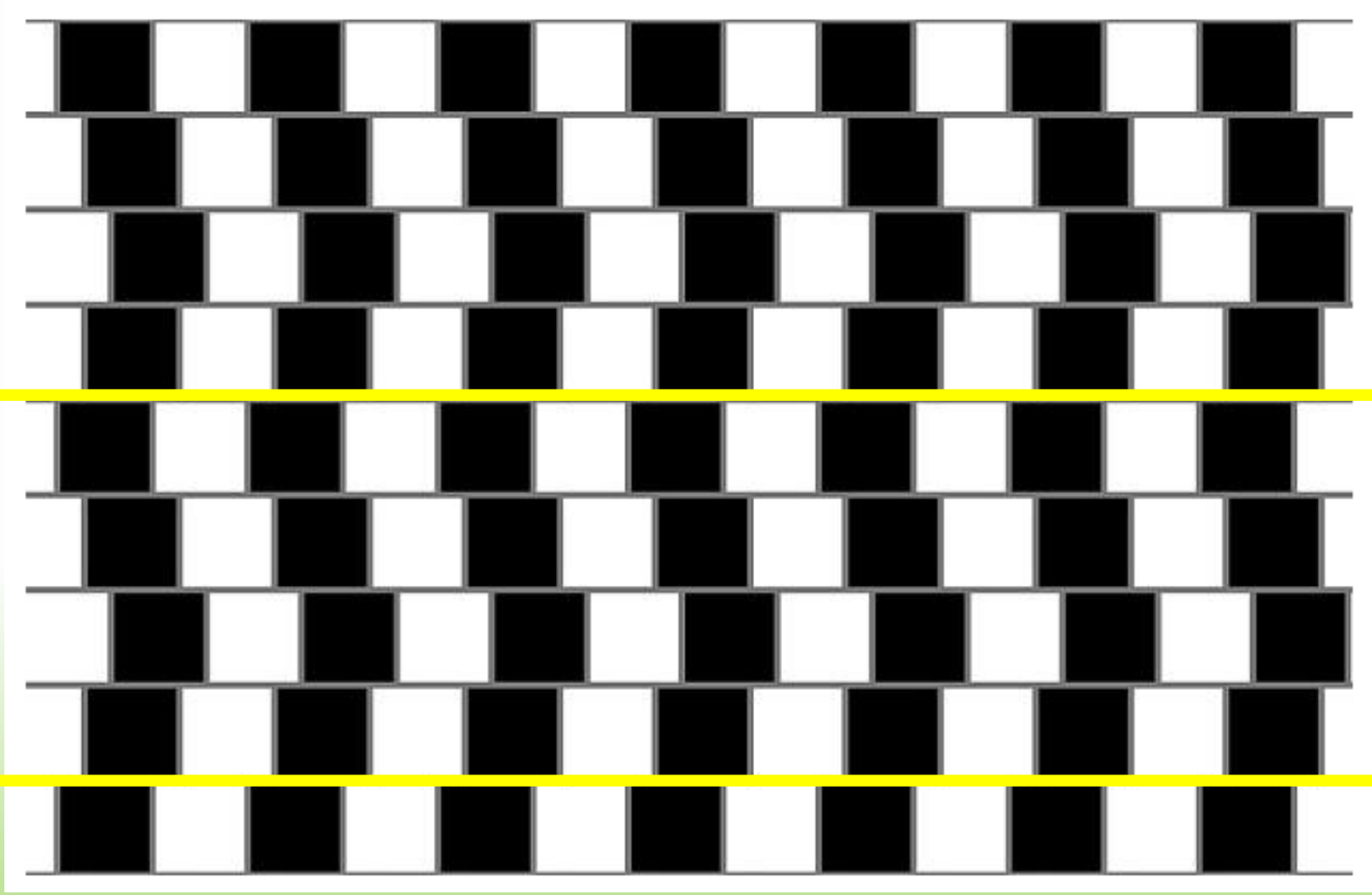
Altiude Loss Per Turn at Best Glide		
Turn #	Altitude	Alt Lost

Add pitch-power-performance data

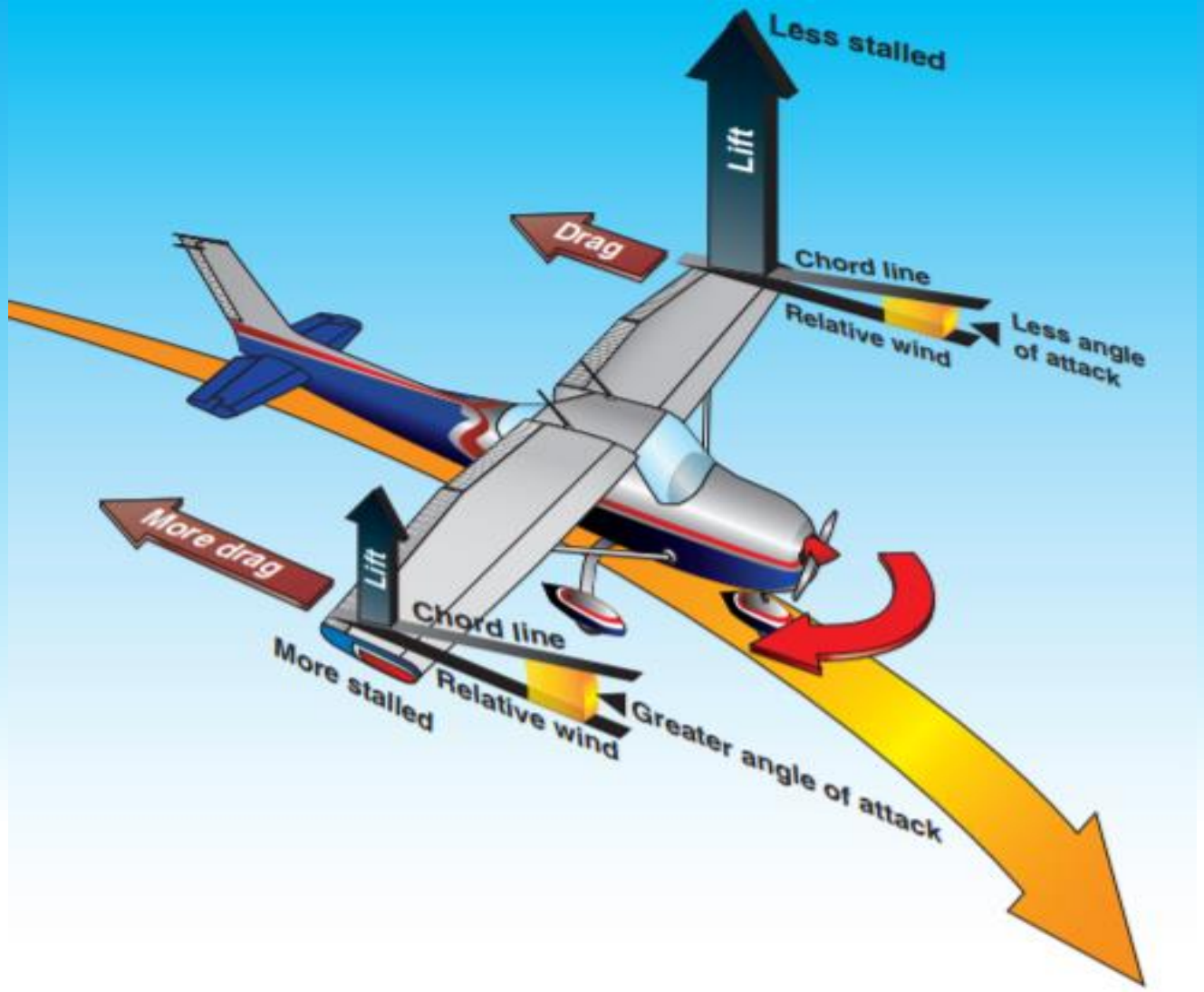
"World ain't what it seems is it, Gunny? You keep that in mind. The moment you think you got it figured, you're wrong"

Shooter

Illusions



Stall Awareness



It’s all about AOA…

Spin Awareness

- **What does it mean…?**
- **Aerodynamics:**
  - Can’t spin if not stalled
  - Yaw + Stall = Yawll = Spin
  - Is stall related to speed?

Spin Awareness

- **Prime situations for stall/spin:**
  - Slow, level flight (high AoA), uncoordinated
  - Any uncoordinated stall
  - Inducing yaw – e.g., “ruddering” the nose around into a skidding turn when trying the recover from runway overshoot. Base to final turn…
  - Uncoordinated while stretching the glide
  - Dragging it in on long windy final and getting distracted

Spin Awareness

- **Recovery:**
  - Counter the yaw
  - Reduce angle of attack
  - PARE
- **Get some awareness training:**
  - Feel the sloppy controls as a stall is approached
  - Witness aileron-rudder coupling in slow flight
  - Feel the “kick” when the “yawll” (yaw/stall) happens
  - Feel the ease and joy of a spin recovery!

Spin Awareness

- **Reactions:**
  - Recognize the difference of yawing from banking from turning
  - Counter yaw with rudder, not aileron
  - Elevator to lower AoA (and pleasingly increases airspeed at the same time)
  - Don’t believe the AI – it may have likely tumbled…
  - Do believe the TC
- **PARE:**
  - Power: IDLE
  - Ailerons: NEUTRAL
  - Rudder: OPPOSITE
  - Elevator: FORWARD

ACS Version

- **Take-off, Landings and Go-Arounds:**
  - Stall/Spin called-out on Risk Areas:
    - Maneuvering during slow flight
    - Power on and off stalls

VII. Slow Flight and Stalls

Task	*A. Maneuvering During Slow Flight*
References	FAA-H-8083-2, FAA-H-8083-3, FAA-H-8083-25; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with maneuvering during slow flight. ***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.*
Knowledge	The applicant demonstrates understanding of:
PA.VII.A.K1	Aerodynamics associated with slow flight in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:

VII. Slow Flight and Stalls

Task	*B. Power-Off Stalls*
References	FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power-off stalls. ***Note:*** *See Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.*
Knowledge	The applicant demonstrates understanding of:
PA.VII.B.K1	Aerodynamics associated with stalls in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
PA.VII.B.K2	Stall characteristics (i.e., airplane design) and impending stall and full stall indications (i.e., how to recognize by sight, sound, or feel).
PA.VII.B.K3	Factors and situations that can lead to a power-off stall and actions that can be taken to prevent it.
PA.VII.B.K4	Fundamentals of stall recovery.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:

VII. Slow Flight and Stalls

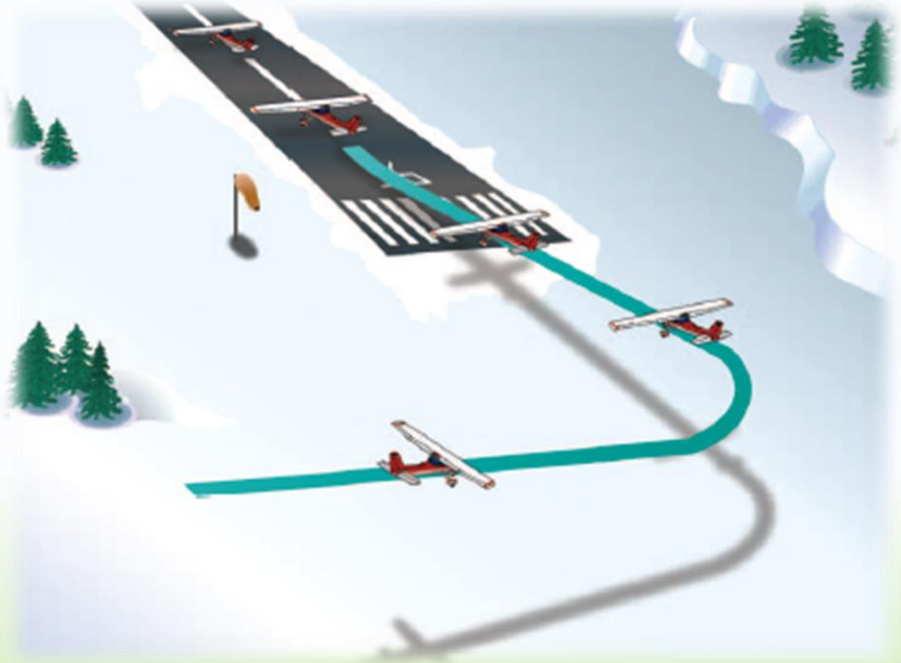
Task	*C. Power-On Stalls*
References	FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with power-on stalls. ***Note:*** *See Appendix 6: Safety of Flight and Appendix 7: Aircraft, Equipment, and Operational Requirements & Limitations.*
Knowledge	The applicant demonstrates understanding of:
PA.VII.C.K1	Aerodynamics associated with stalls in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
PA.VII.C.K2	Stall characteristics (i.e., airplane design) and impending stall and full stall indications (i.e., how to recognize by sight, sound, or feel).
PA.VII.C.K3	Factors and situations that can lead to a power-on stall and actions that can be taken to prevent it.
PA.VII.C.K4	Fundamentals of stall recovery.
Risk	

VII. Slow Flight and Stalls

Task	*D. Spin Awareness*
References	FAA-H-8083-2, FAA-H-8083-3; AC 61-67; POH/AFM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with spins, flight situations where unintentional spins may occur and procedures for recovery from unintentional spins.
Knowledge	The applicant demonstrates understanding of:
PA.VII.D.K1	Aerodynamics associated with spins in various airplane configurations, to include the relationship between angle of attack, airspeed, load factor, power setting, airplane weight and center of gravity, airplane attitude, and yaw effects.
PA.VII.D.K2	What causes a spin and how to identify the entry, incipient, and developed phases of a spin.
PA.VII.D.K3	Spin recovery procedure.

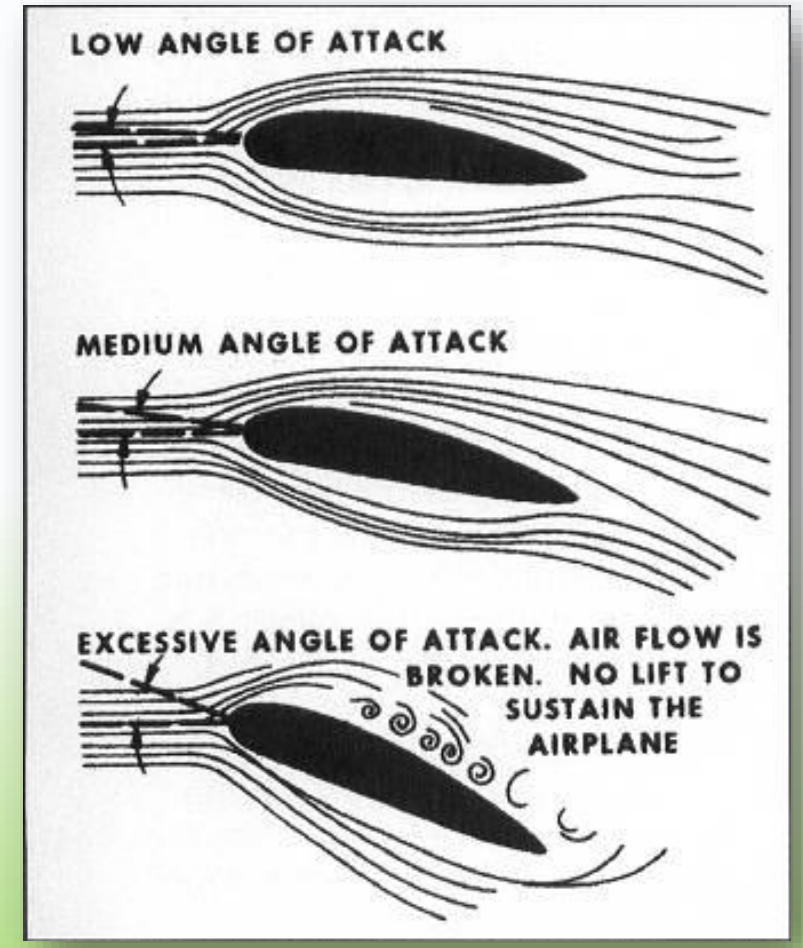
Stall/Spin Accidents

- **In the traffic pattern**
  - Takeoff 28 %
  - Approach 18 %
  - Go Around 6 %
    - Crosswind
- **Maneuvering** 41%



One Fatal Accident / 3 days

Airspeed is a (Bad) Surrogate for Stall Awareness

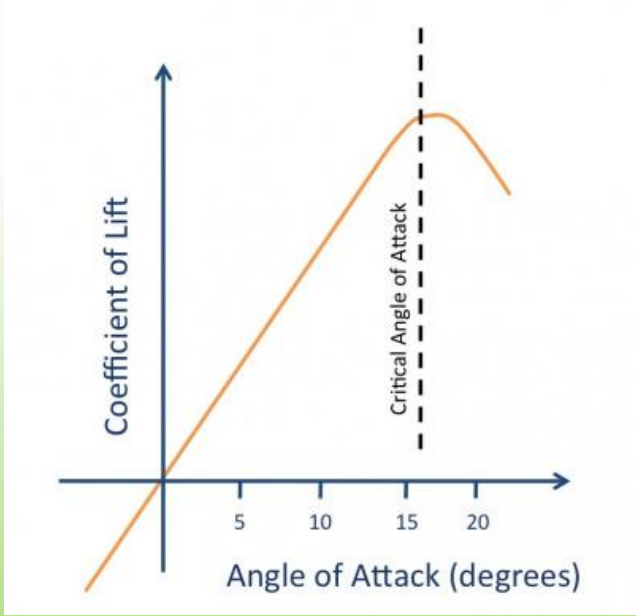


The Airspeed Problem

- **Lift equation:**

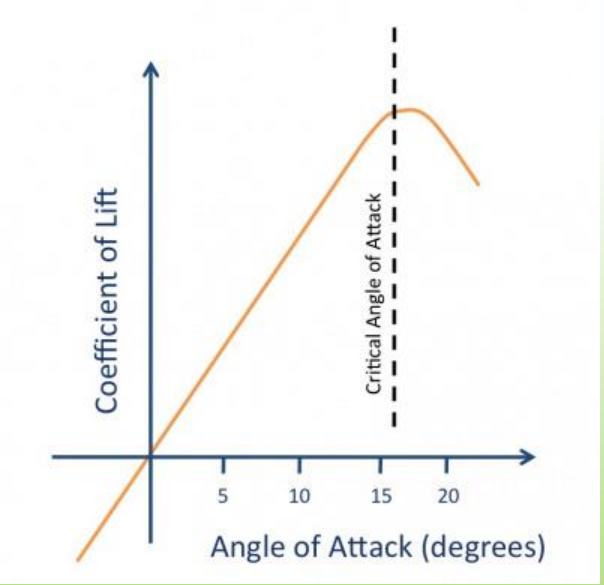
  $$\text{Lift} = C_L * \tfrac{1}{2} V^2 * \rho * A$$

- **In level flight, L = W (1g)**
- **If slow down (to the "stall speed")**
- **To stay level, C_L must be increased**
- **This requires increasing AOA = pulling**
- **Get to AOA_{Crit} and off you go…**



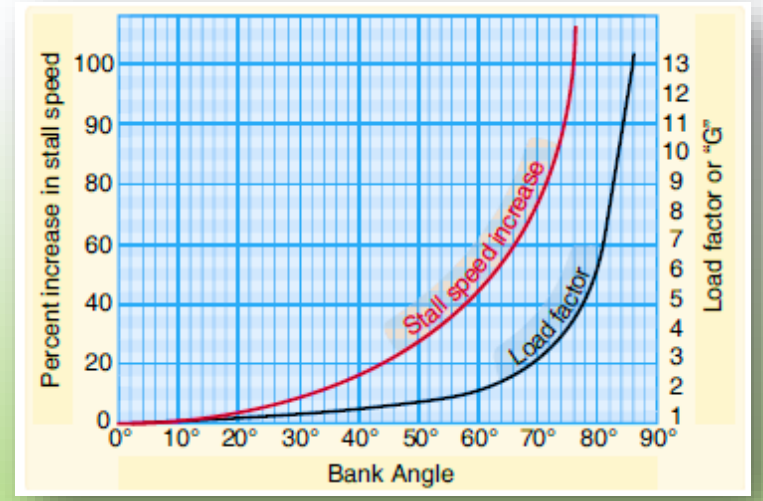
The Airspeed Problem

- **What does “stall speed mean?**
- **The speed at which the critical angle of attack is reached….IN LEVEL FLIGHT (pulling back…).**
- **Resolution?**
- **PUSH to reduce AOA!**



The Airspeed Problem

- **Aircraft configuration**
  - V_S Cruise configuration
  - V_{SO} Landing configuration
- **Load**
  - If the wings is loaded up…
  - Higher effective weight…so…
  - Need more lift to stay level
  - Means greater C_L = more AOA
  - Get to AOA_{CRIT} sooner!
  - “Stall speed is higher”



Be honest, now…

- **How many of you have gone out and practiced stalls in the last year?**
  - Last 2 Years?
  - Haven't since I got my Private Certificate?
  - My instructor didn't like stalls.
  - Are you insane?

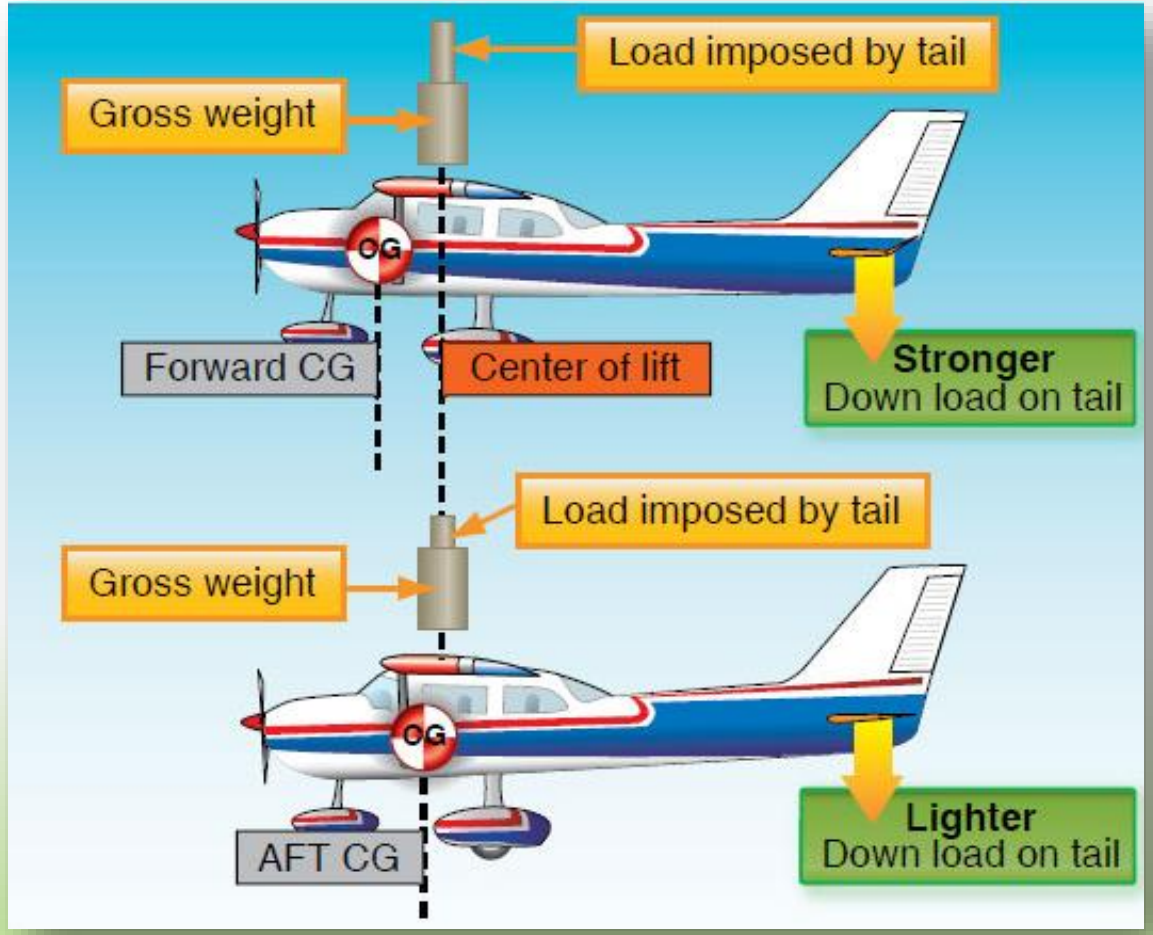
How will this change things?

More W requires more L from V and/or C_L

At given V, AOA will have to be higher = Closer to Critical

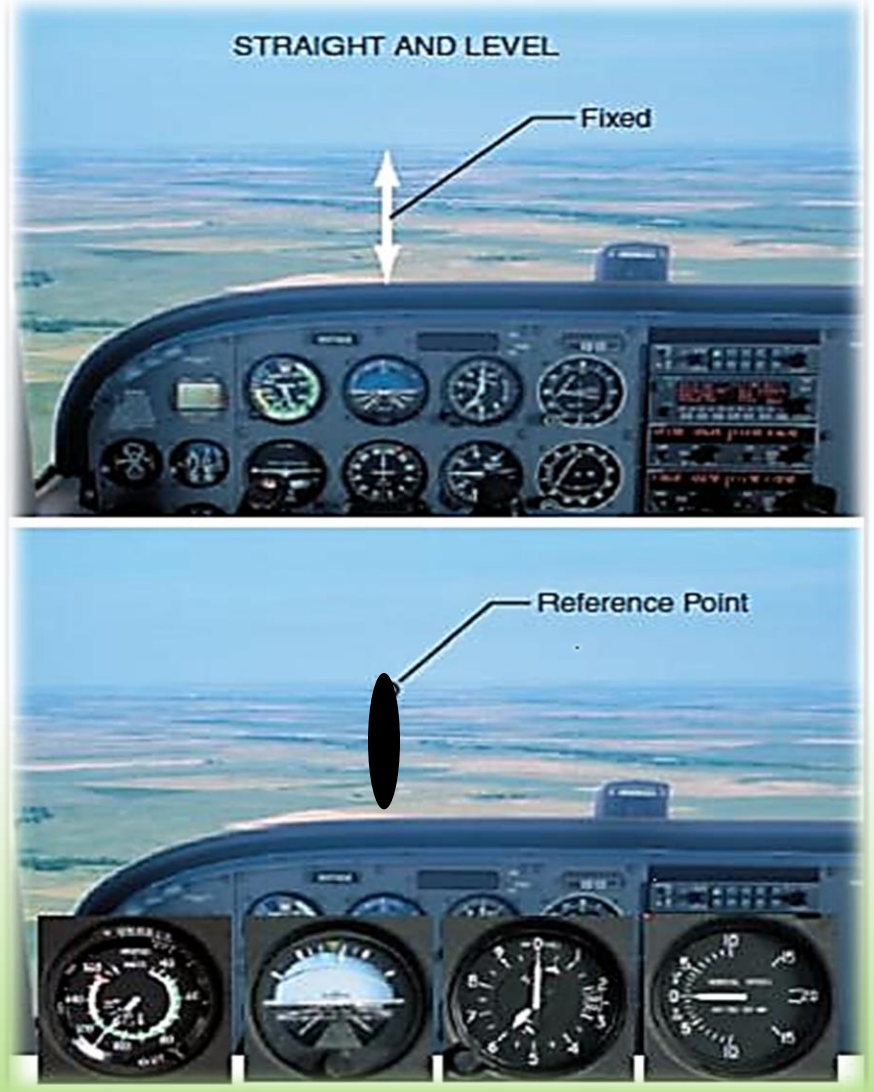
Planning for the maneuver…

- Weight and Balance
- Aircraft Configuration
  - Flaps Up/Approach/Landing
  - Gear Up or Down
  - Cowl Flaps Open or Closed
- Speed
  - Cruise
  - Take-off
  - Landing



Angle of Attack: Setting up your Visual view

Or this

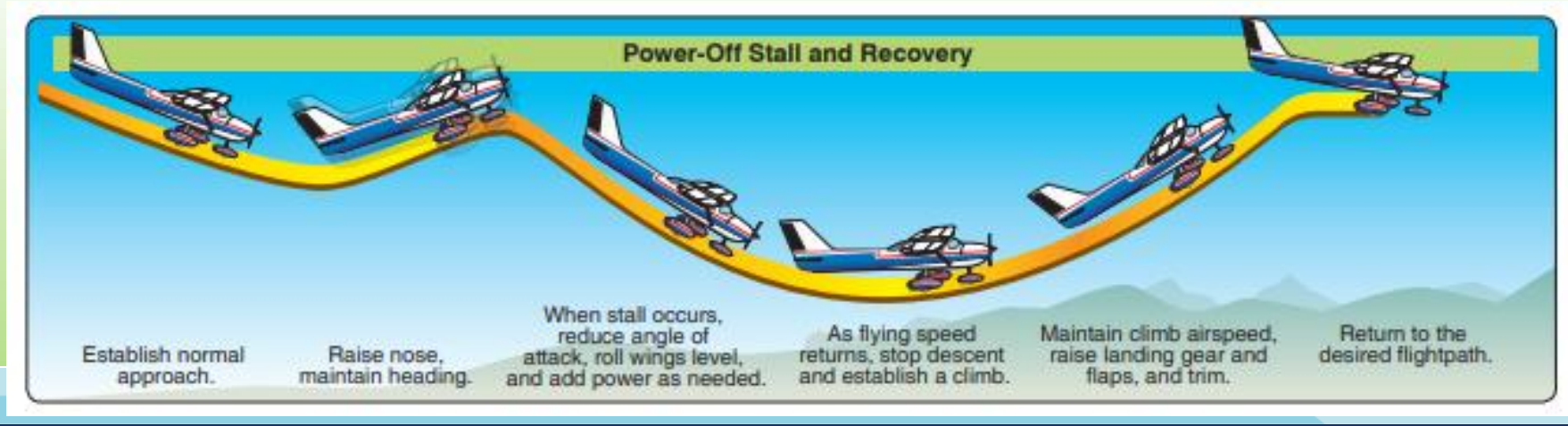


Mark It!

Power Off Stall and Recovery

- **CLEAR THE AREA!**
- **Altitude – Maintain**
- **Trim - Set**
- **Artificial Horizon – Set**
- **Altimeter – Set**
- **VSI – Zero**

- **Power - off**
  - Going into the maneuver
  - Stall indication
  - Recover
- **Clean Up and Recovery Procedure**

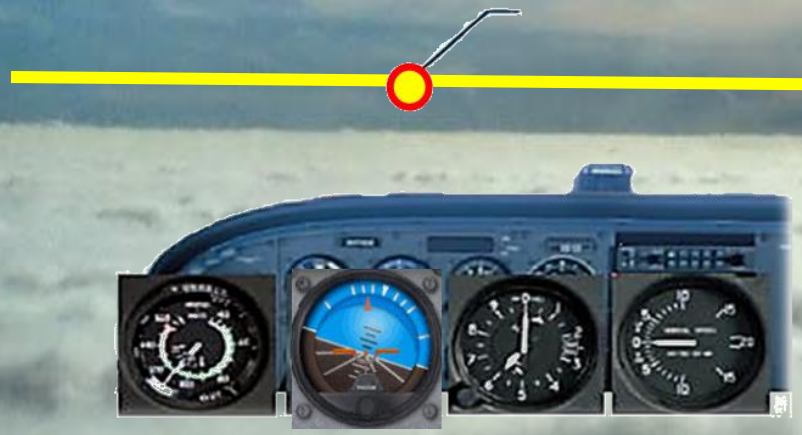


The Look and feel of the stall:

- **Note control effectiveness as the aircraft slows towards stall speed**
- **Note the view out the windscreen**
  - Forward
  - To the sides – angle of wings to horizon

These angle of attack indicators will assist you further understanding what the aircraft is doing

Other Indications you need to see and feel:

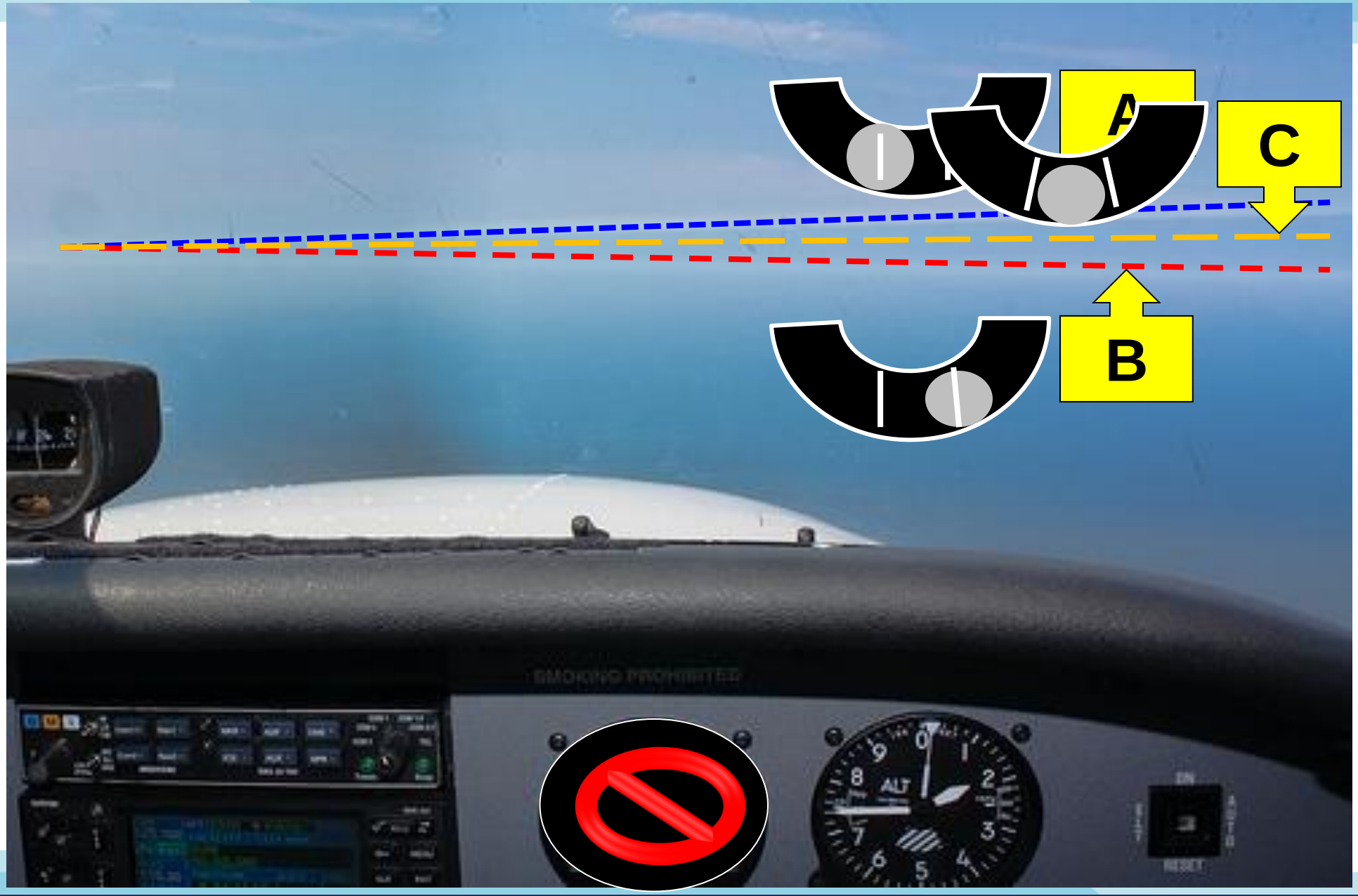


Left Turn

Right Turn

Federal Aviation Administration

AOA Indicators…


A
C
B
ALT

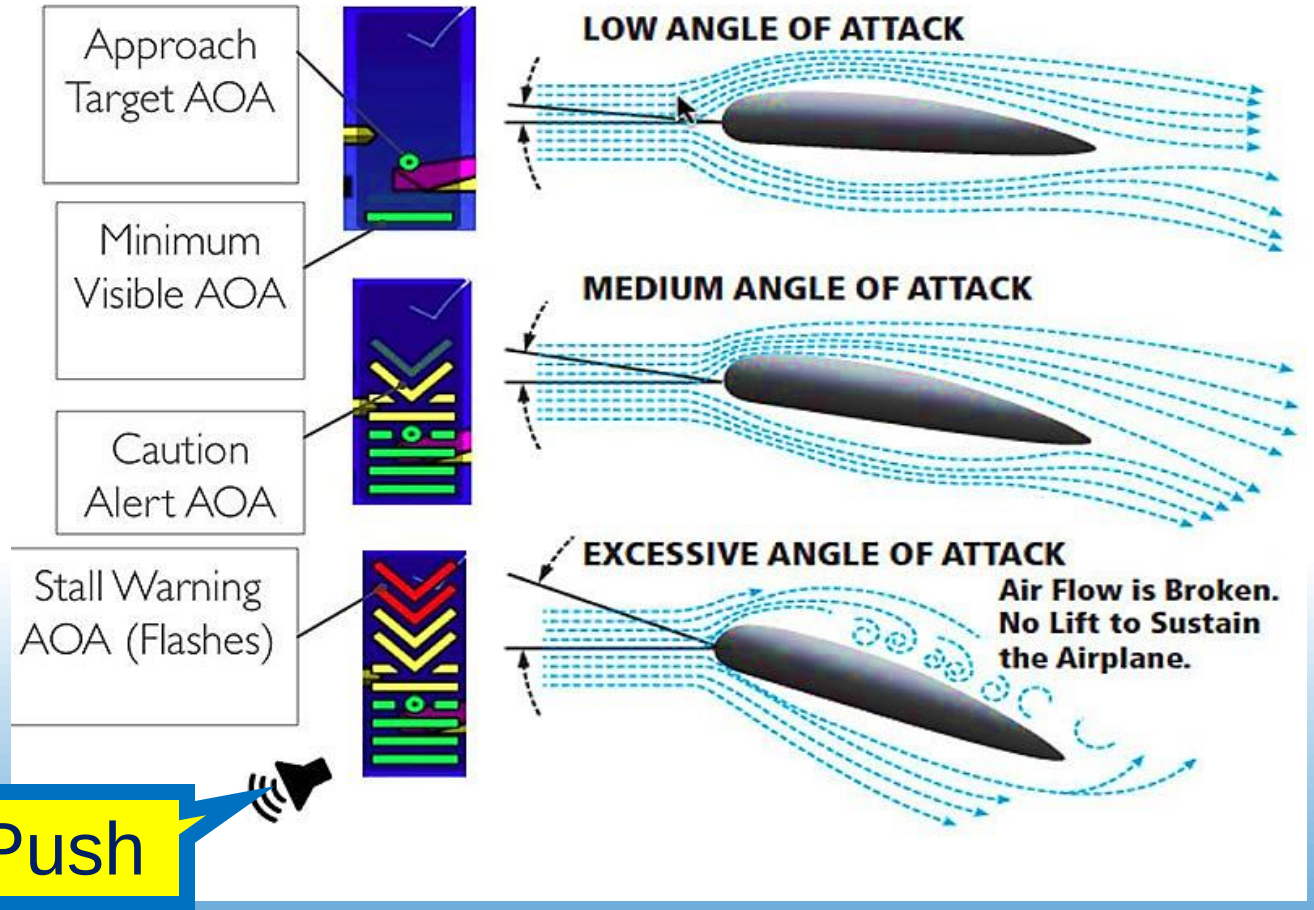
AOA For GA


ALPHA SYSTEMS

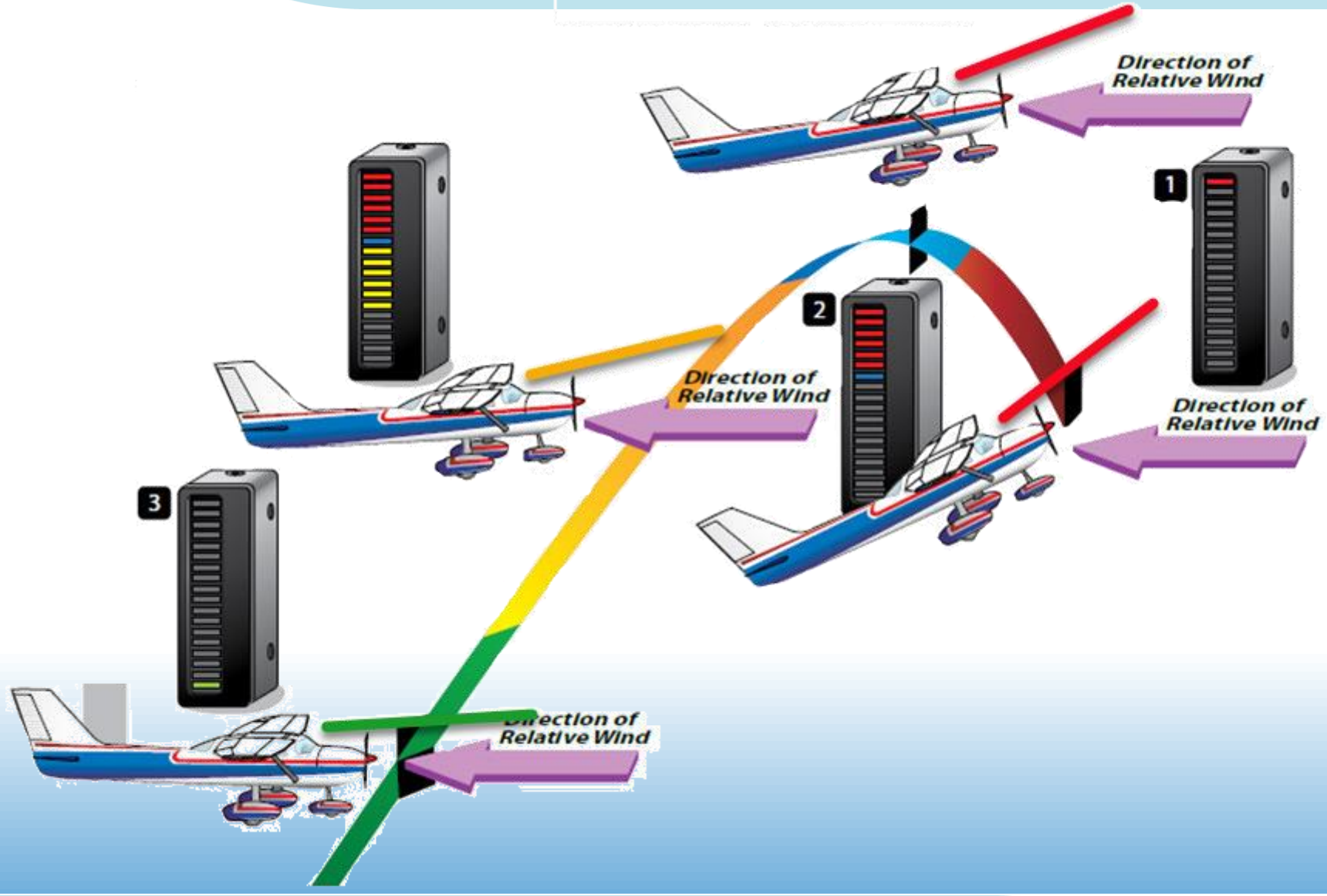

ANGLE OF ATTACK
α
ALPHA SYSTEMS


KLR 10
BendixKing

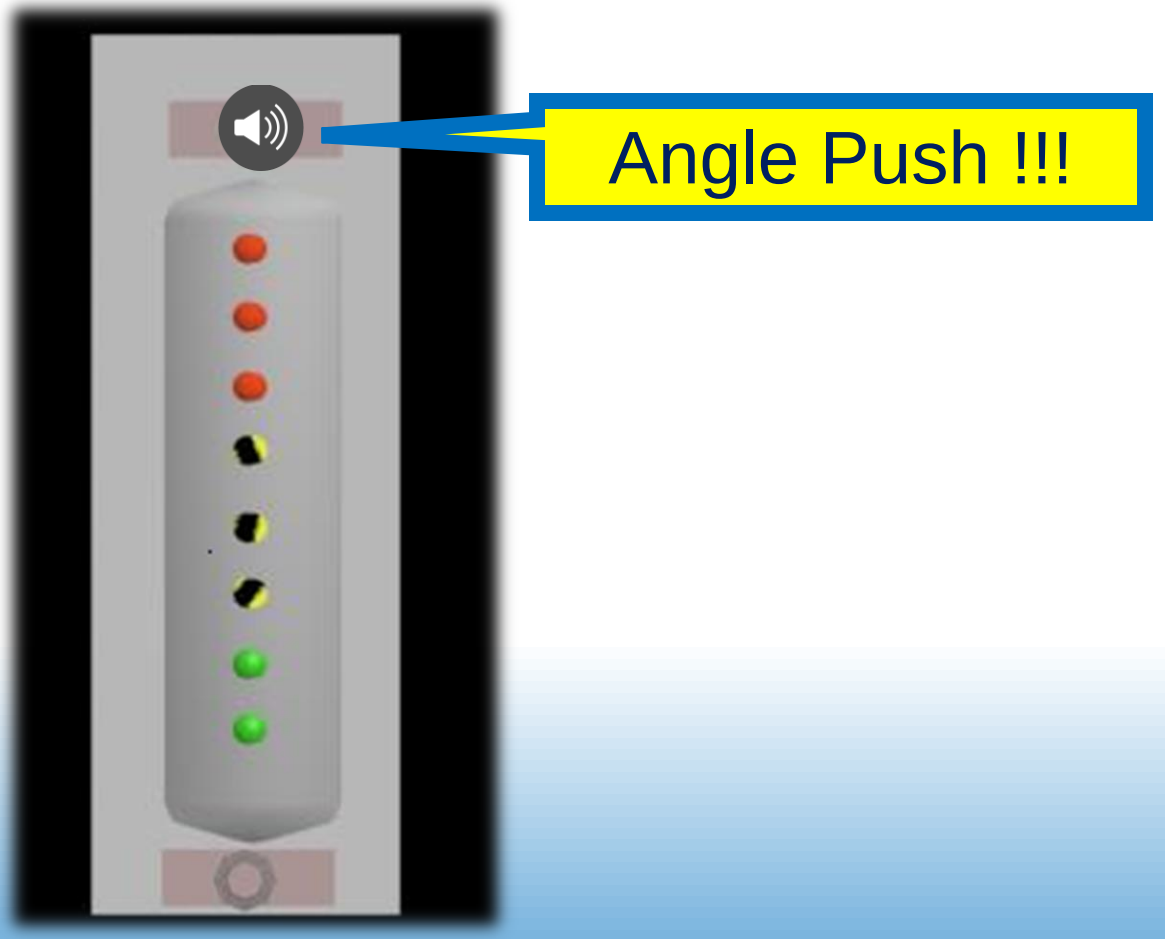
What's this thing trying to tell me?



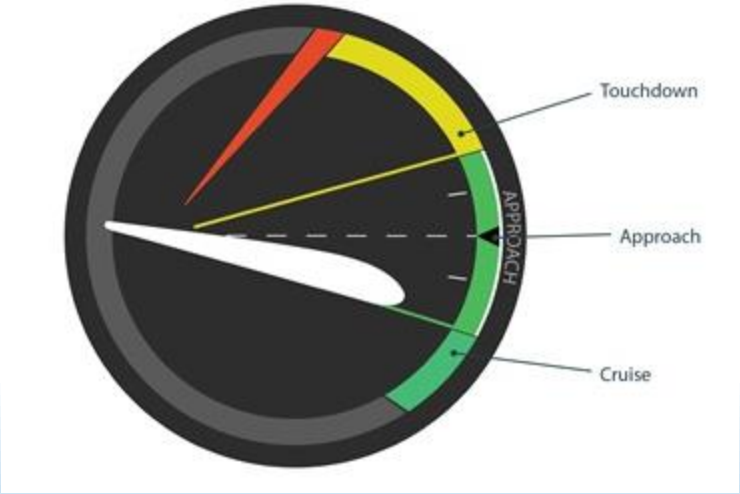
Angle Push


Direction of
Relative Wind
1
Direction of
Relative Wind
2
Direction of
Relative Wind
3
Direction of
Relative Wind

Even Light Sport aircraft can…



Even Light Sport aircraft can…

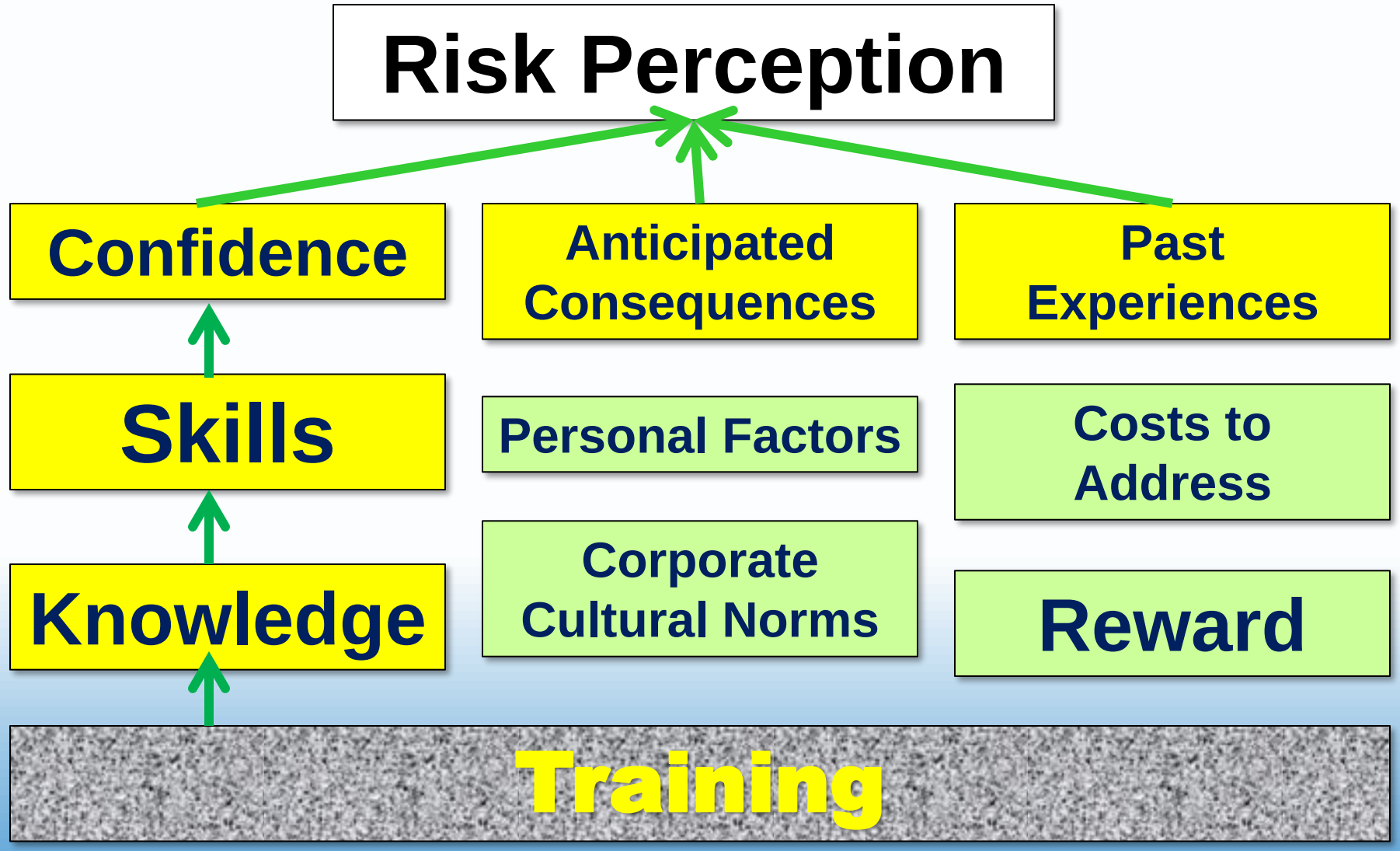


Every aircraft is different!

Here are some examples:

- **Swept wing aircraft vs. straight wing aircraft**
- **Conventional Tail vs T-tail**
- **Small rudder vs. Big rudder**
- **Aircraft with or without Vortex Generators**
- ***Clean Wing vs. a Dirty wing!***

Important: Always follow the manufacturers and/or the operators recommended procedures


Risk Perception
Confidence
Anticipated Consequences
Past Experiences
Skills
Personal Factors
Costs to Address
Knowledge
Corporate Cultural Norms
Reward
Training

Can’t control it if you can’t measure it…

Resources:

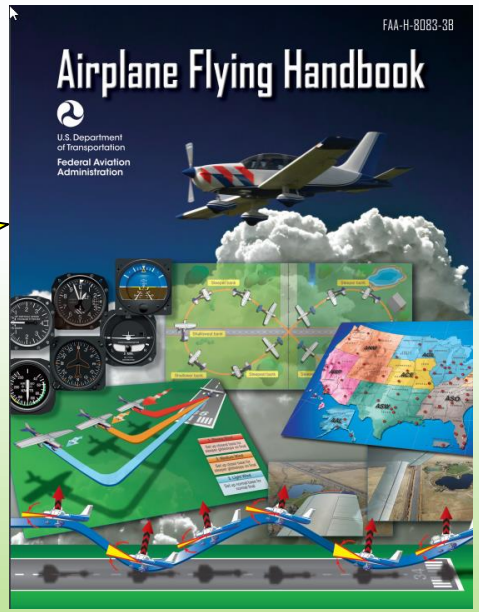
- **AOA Press Release**
  - http://www.faa.gov/news/press_releases/news_story.cfm?newsid=15714

- **FAA Safety Briefing Magazine**
  - https://www.faa.gov/news/safety_briefing/2018/media/MayJun2018.pdf

Resources

- **Airplane Flying Handbook**
  - http://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/airplane_handbook/

Remember this book?? It's where it all began…



Proficiency and Peace of Mind

- Fly regularly with your CFI
- Perfect Practice
- Document in ***WINGS***

www.faasafety.gov

Thank you for attending!

You are vital members of our GA safety community!