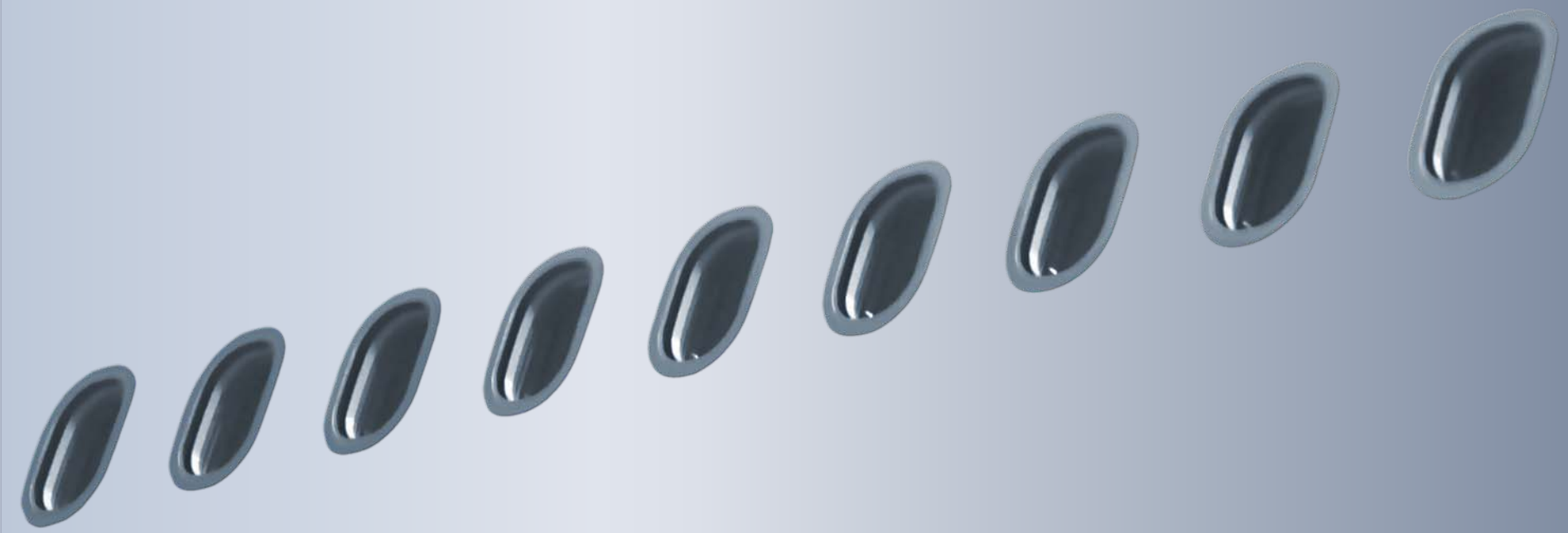

17th Performance and Operations Conference in Dubai

Update on stall procedure

Presented by
Xavier LESCEU – Test Pilot & Operational Expert Pilot

AIRBUS

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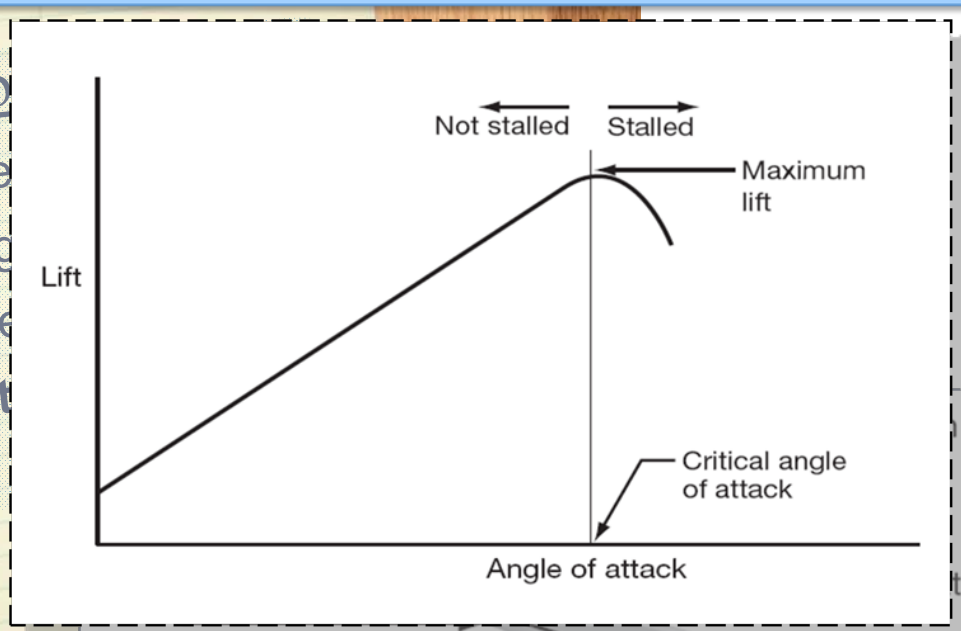
Aerodynamic Review

For a given configuration, a given speed and a given altitude,

Lift is only linked to AoA



For a given aircraft configuration and speed

An aircraft stalls for a given AoA

Stall

- A loss of speed can result in an aircraft reaching the stall AoA
- BUT it remains an AoA issue

Stall is only an AoA problem

Low speed is a common contributing factor

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AoA Control – Pitch control effect

The pitch control is a direct AoA command

- The elevators control DIRECTLY the AoA.
- A nose down command has an IMMEDIATE effect :

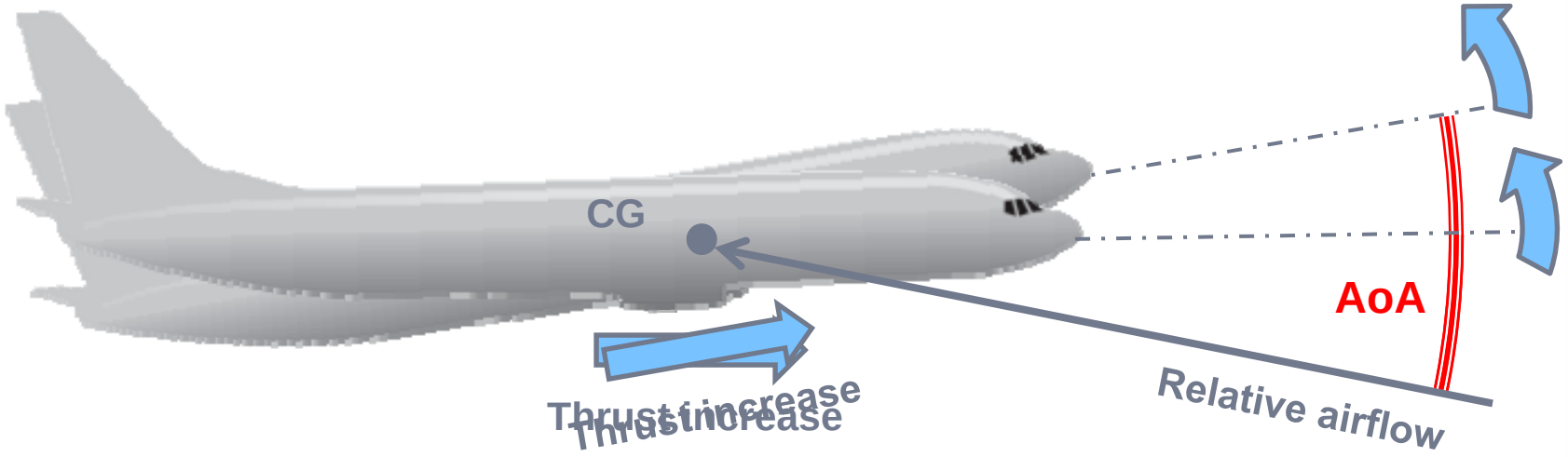
Nose down command ⇒ AoA decrease

AoA Control – Thrust effect

- **Aircraft with engines below the aircraft Center of Gravity**

  ⇒Thrust has a significant pitch effect

Thrust increase ⇒ AoA increase



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Stall Recovery

When Aircraft is stalled

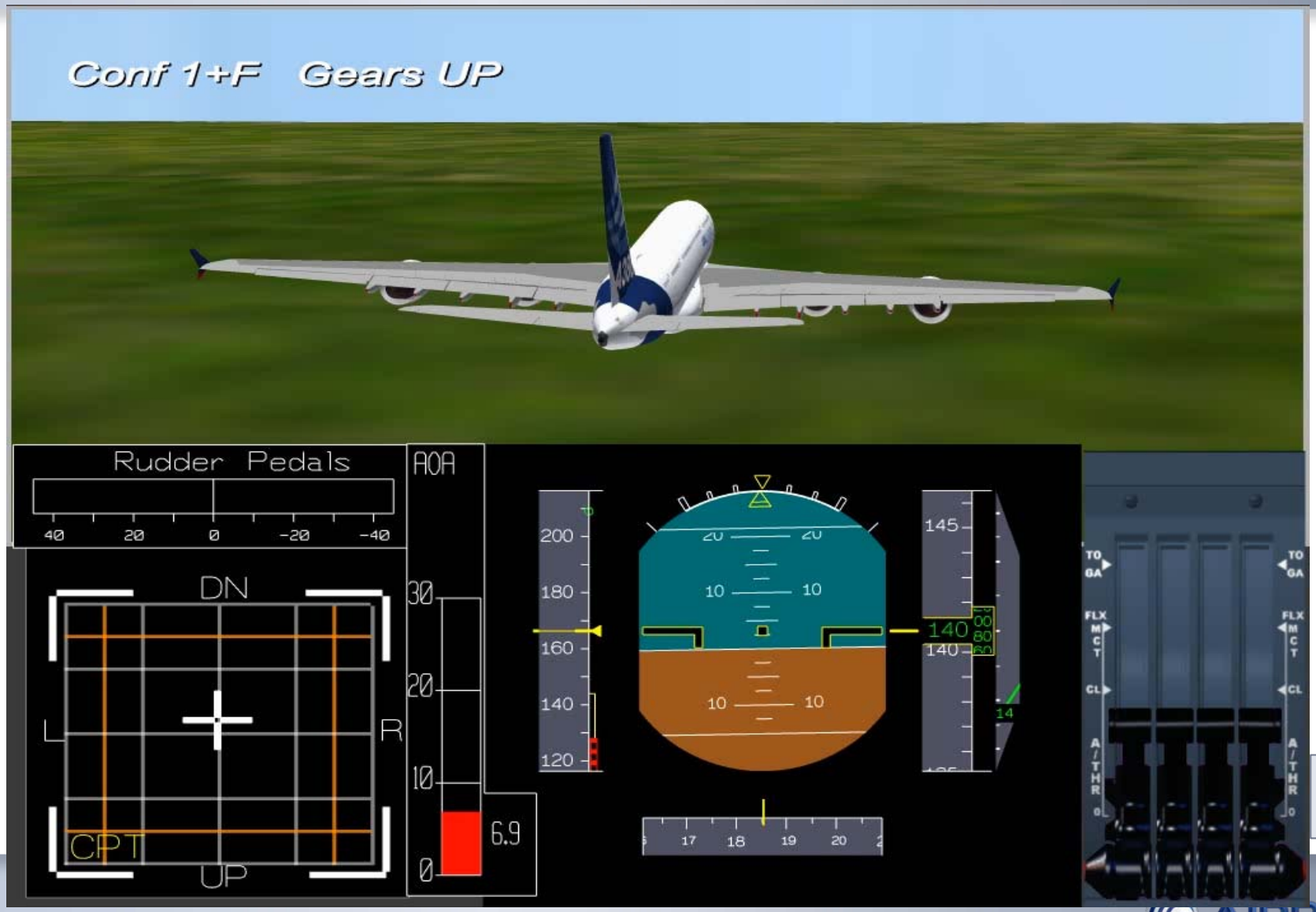
- FIRST: **AoA MUST BE REDUCED**
  - Release back pressure on stick or column
  - Nose down pitch input may be needed

  Note : Increasing thrust has an adverse effect on AoA reduction for Aircraft with engines below aircraft CG

- SECOND: If speed needs to be recovered
  - When stall indications cease, increase thrust with care due to possible pitch up effect

AoA comes first, speed second

A380 Stall in flight test



Approach to Stall v/s Stall

Approach to Stall

- Stall indications already present
  - ✓ Artificial stall warnings
  - ✓ Some natural stall warning indications may be present
- Progressive airflow separation
- Trajectory controllable with decreasing margin for manoeuvring

Stall

- Stall indications
  - ✓Artificial stall warnings
  - ✓Natural stall warnings
    - ➢Buffeting
    - ➢Lack of pitch authority
    - ➢Lack of Roll control
    - ➢Inability to arrest descent
- Airflow separated from wing
- Trajectory no longer controllable

The change from approach to stall v/s actual stall is not easy to determine, even for a specialist.

Approach to Stall v/s Stall recovery procedure

- The classic recovery procedure associated with "*Approach to stall"* was characterized by a recovery focusing on:
  - ✓ Maximum thrust application
  - ✓ Minimum loss of altitude
- Whereas the recovery procedure from an "*Actual stall*" has always focused on:
  - ✓ AoA reduction as first action, followed by a speed recovery if needed

Need for procedure change

- Drawbacks associated with this dual recovery approach are:
  - ✓ TOGA application may lead to an **increase** of the AoA
  - ✓ Reluctance to apply nose down input
  - ✓ Challenge to identify the change from "*Approach to stall*" to "*Actual stall*"

- Numerous accidents where the "*Approach to Stall*" recovery procedure
  - ✓ was applied whereas the aircraft was actually stalled
  - ✓ or generated a stall through thrust effect

A single procedure focusing on AoA reduction,
as a first action, required to cover both
the "*Approach to Stall*" and the "*Actual Stall*" recovery:

It is called the "*Stall Recovery*" procedure

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New Procedure

- The FAA Stall Recovery Working Group issued a generic ***"Stall Recovery"*** procedure
  - A generic procedure for ALL types of aircraft
  - One single procedure to cover ALL stall conditions
  - Prevent full thrust/TOGA from being first action
  - Focus on **AoA reduction**

Generic Stall Recovery Procedure

STALL WARNING OR AERODYNAMIC STALL RECOVERY PROCEDURE

Immediately do the following at the first indication of stall (buffet, stick shaker, stick pusher, or aural or visual indication) during any flight phases *except at lift off.*

1. Autopilot and autothrottle…… Disconnect

Rationale: While maintaining the attitude of the aircraft, disconnect the autopilot and autothrottle. Ensure the pitch attitude does not change adversely when disconnecting the autopilot. This may be very important in mis-trim situations. Manual control is essential to recovery in all situations. Leaving one or the other connected may result in in-advertent changes or adjustments that may not be easily recognized or appropriate, especially during high workload situations.

Generic Stall Recovery Procedure

2. a) Nose down pitch control… Apply until out of stall (no longer have stall indications)

b) Nose down pitch trim……..As needed

Rationale: a) The priority is reducing the angle of attack. There have been numerous situations where flight crews did not prioritize this and instead prioritized power and maintaining altitude. This will also address autopilot induced full back trim.

b) If the control column does not provide the needed response, stabilizer trim may be necessary. However, excessive use of trim can aggravate the condition, or may result in loss of control or in high structural loads.

3. Bank……Wings Level

Rationale: This orientates the lift vector for recovery.

Generic Stall Recovery Procedure

4. Thrust …….. As Needed

Rationale: During a stall recovery, many times maximum power is not needed. When stalling, the thrust can be at idle or at high thrust, typically at high altitude. Therefore, the thrust is to be adjusted accordingly during the recovery. For engines installed below the wing, applying maximum thrust can create a strong nose up pitching moment, if speed is low. For aircraft with engines mounted above the wings, thrust application creates a helpful pitch down tendency. For propeller driven aircraft, thrust application energizes the air flow around the wing, assisting in stall recovery.

5. Speed Brakes…….. Retract

Rationale: This will improve lift and stall margin.

6. Return to the desired flight path.

Rationale: Apply gentle action for recovery to avoid secondary stalls then return to desired flight path.

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Conclusion

- Working together with other aircraft manufacturers, we have:
  - ✓Agreed the principle with the FAA Stall Recovery Working Group
  - ✓Issued a harmonized procedure focusing on AoA reduction as a first action
- The procedure was published mid-May 2010 and the corresponding FCTM end of May 2010.