



Air Line Pilots Association

What Really Can Be Done in Simulation to Improve Upset Training?

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Outline

- The problem
- Today's requirements
- Training needs
- Technology gaps and possible improvements
- Pros and cons of possible training solutions
- Conclusions

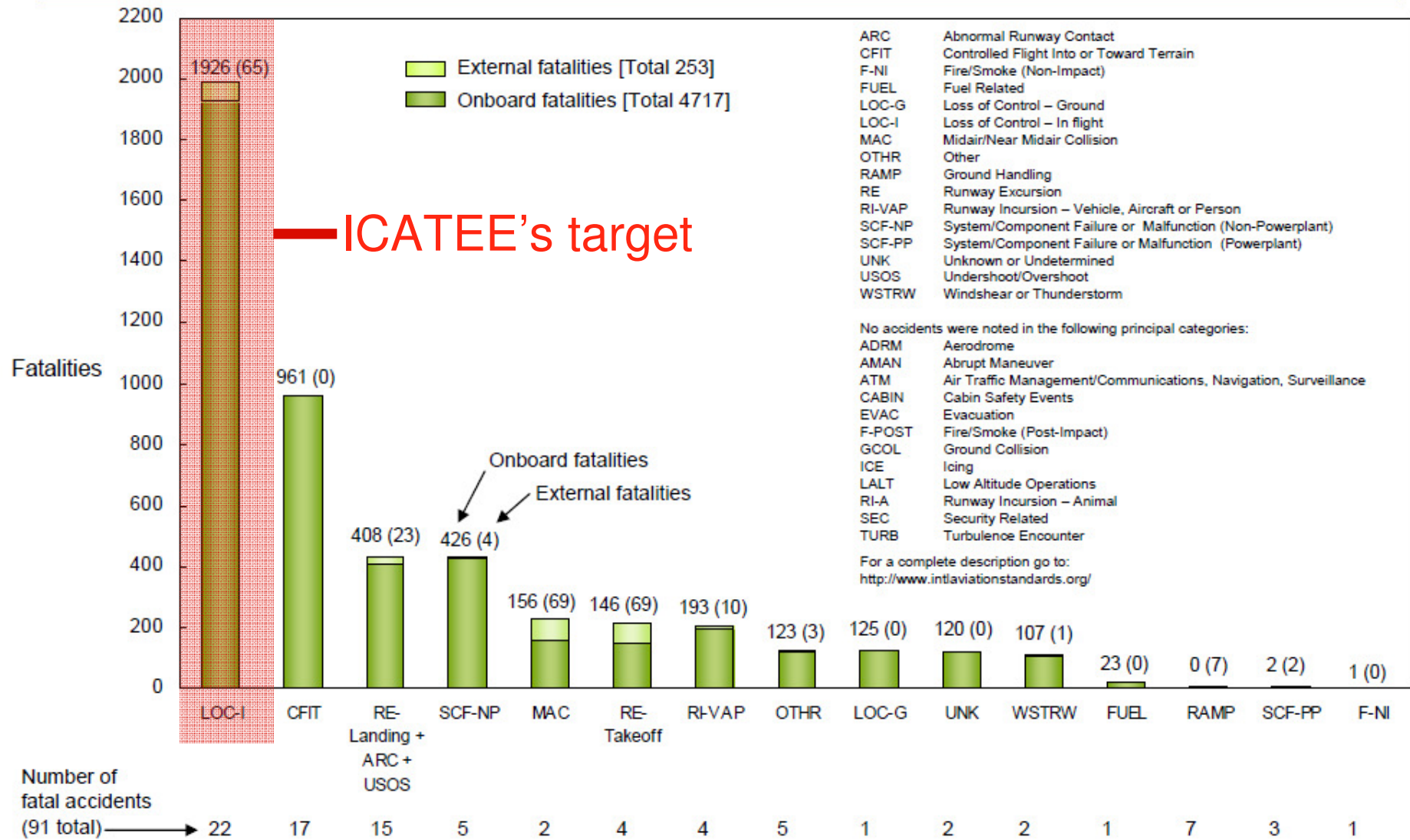
Take-away

- Today's simulators are inadequate to meet NTSB recommendations for upset training
- Improvements in awareness, recognition & avoidance, recovery warranted
- Simulator improvements needed in the following areas:
 - startle factor
 - lateral/directional characteristics in the stall regime
 - motion cueing

The background of the slide is a bright, overexposed landscape. The sky is a deep, vibrant blue, filled with soft, white clouds. The horizon line is visible, showing a bright, washed-out area that could be a body of water or a flat plain. The overall lighting is very bright, creating a high-contrast, almost ethereal atmosphere.

The Problem

Fatalities by CAST/ICAO Common Taxonomy Team (CICTT) Aviation Occurrence Categories Fatal Accidents – Worldwide Commercial Jet Fleet – 1999 Through 2008



Note: Principal categories as assigned by CAST.



What is the Problem?

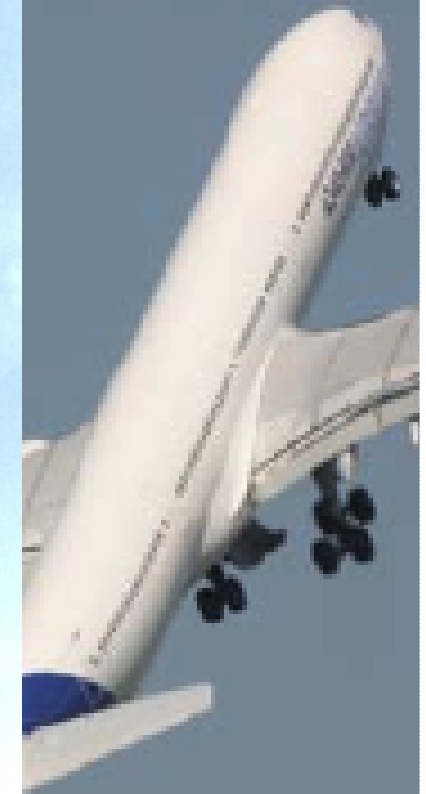
- Loss of control is the leading cause of fatalities in the worldwide commercial jet fleet
- In early 2010, the NTSB recommended:
 - training centers develop and conduct training that incorporates stalls that are fully developed and unexpected
 - simulation model fidelity requirements to support an expanded set of stall recovery training requirements be defined and codified

Today's Upset Training Requirements

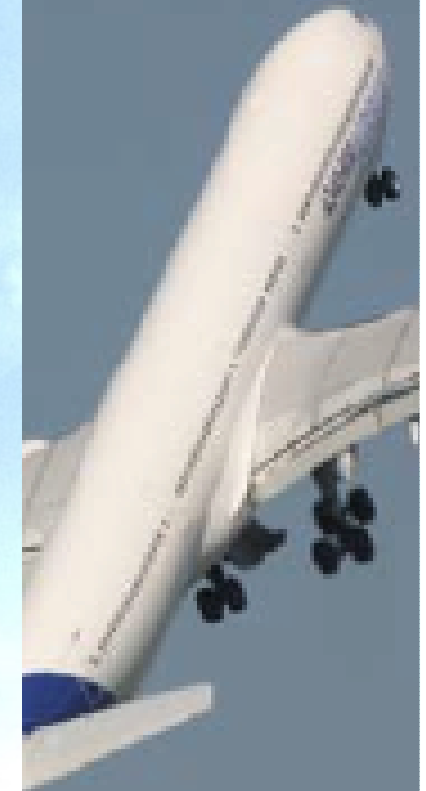
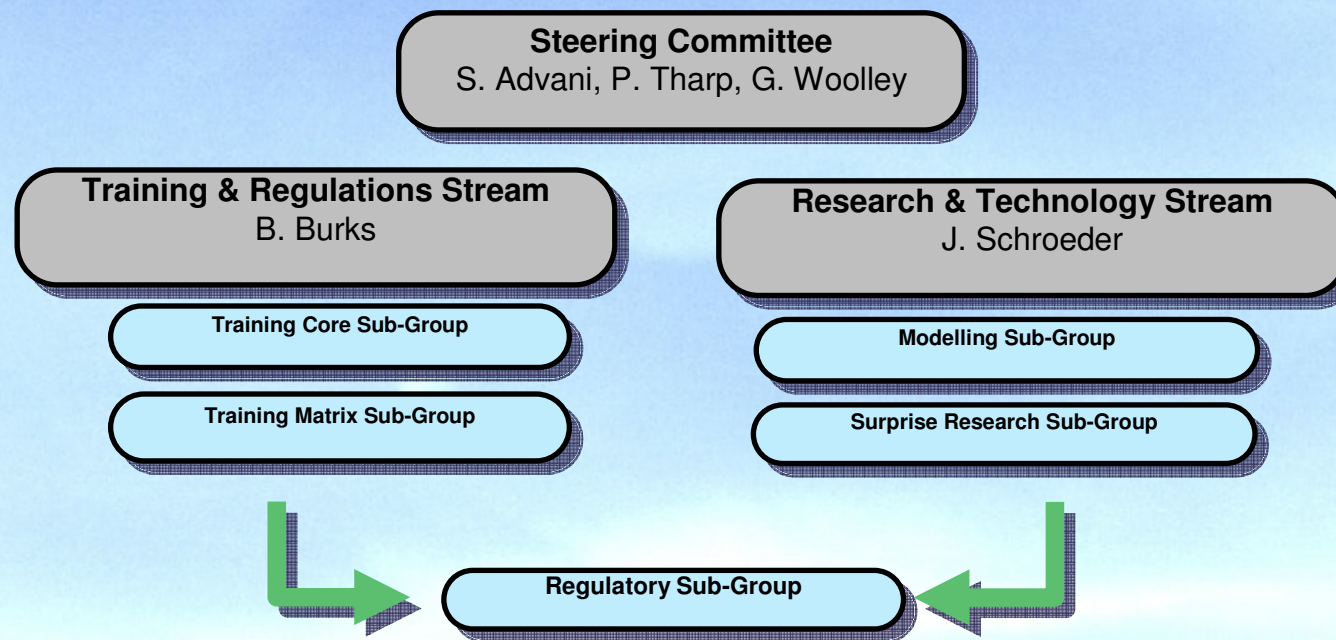
- FAA:
 - Requires recoveries in the simulator from approach-to-stalls in the clean, takeoff, and landing configurations
- European Aviation Safety Agency
 - Used to demonstrate ability to recover from full stall, although now it is typically a briefing
- Transport Canada
 - Upset training is required for airline operations

iCATEE

- International Committee for Aviation Training in Extended Envelopes
- Formed in 2009 by Flight Simulation Group of the Royal Aeronautical Society
- AIM: Upset Prevention and Recovery
- MISSION: To deliver a complete and comprehensive long-term strategy to eliminate or reduce the rate of Loss of Control In-Flight accidents and incidents through enhanced Upset Prevention and Recovery Training (UPRT)



Deliverables (internal)



Participants

Transport Canada
Embry-Riddle
FAA
Airbus
NASA
Boeing
ALPA
KLM
IDT
Boeing Flight Training
AIAA MSTC
DLR
Bihrl
ATA
FlightSafety
SOS
Opinicus
ETC
CALSPAN
APS Emergency
Maneuver Training
UTIAS
CAA
IFALPA
BBGA
CAE
NLR
FedEx
TNO
Volpe
NTSB

ICATEE
International Committee for
Aviation Training in Extended
Envelopes



Flight Simulation Group -
Royal Aeronautical Society
London, UK

Deliverables (external)*

Master Document

Recommended training practices:

- What to train
- How to train
- Whom to train
- How often to train

Training & Regulations

Upset Prevention (Awareness, Avoidance/Recognition, Recovery) Manuals:

- Operator
- Instructor

Regulatory recommendations:

- Approved Training Program
- Professional Pilot Licensing & Certification
- Qualification at appropriate licensing levels
- Instructor qualification

Research & Technology

Adaptations to FSTD standards (e.g. ICAO 9625) to enhance qualification for UPRT in FSTD's

Guideline for the use of alternative training devices

***subject to advice from ICAO**

Training Needs

- Levels of mitigation
 - Awareness
 - Recognition and avoidance
 - Recovery
- Hazards
- Training criteria
- Training media
- Frequency of training
- Training matrix and challenges

Simulator vs aircraft as training medium

| Training medium | Advantage available | Disadvantage or currently missing | |
|-----------------|---|--|--|
| | | surmountable | insurmountable |
| Aircraft | <ul style="list-style-type: none"> •continuous increased and decreased g-loads for awareness •realistic startle factors, fear/threat, aerodynamics •α-management | <ul style="list-style-type: none"> •knowledge transferability - trainer aircraft to target environment •risk exposure from aircraft-based training | <ul style="list-style-type: none"> •dissimilarity with target environment •cost to train several thousand pilots (initial & recurrent) |
| FFS | <ul style="list-style-type: none"> •type-specific environment •repeatable, measurable, safe •procedures | <ul style="list-style-type: none"> •model limitations •less startle than aircraft •motion cueing (improvement) •lack of feedback on airplane envelope limits | <ul style="list-style-type: none"> •identical g-cueing •identical stress, fear, startle •expectations of trainee |

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Technology gaps

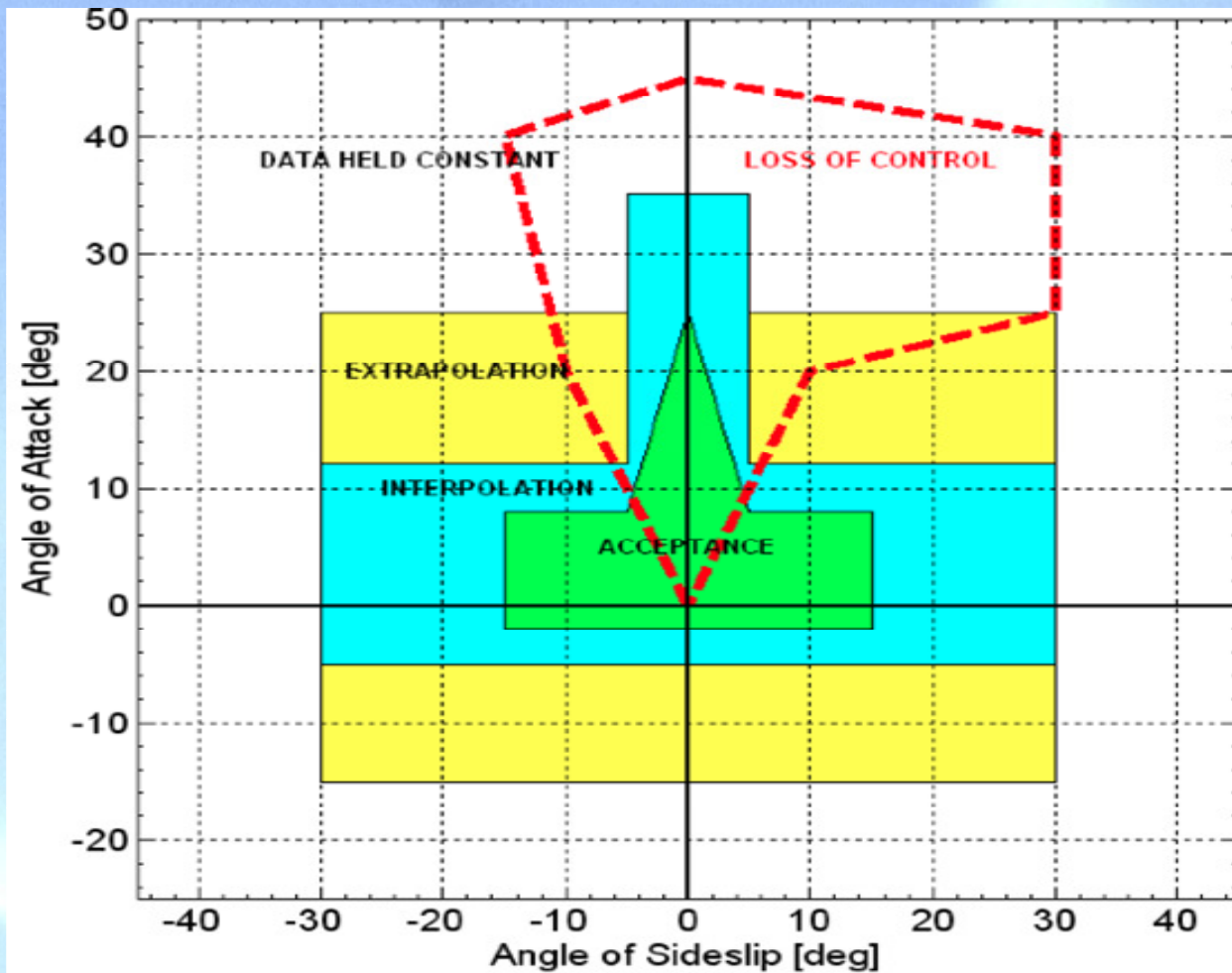
Gaps and Improvements

- Need to do better to achieve startle in simulation
 - Some operators achieving this in clever ways
 - Create immersion by making simulator training environment more like airplane (e.g., wear uniforms, more realistic air traffic communication)
 - Increase workload by having instructor add distractions
 - Invoke a startling situation (e.g., wake upset) at the will of the instructor after distraction accomplished

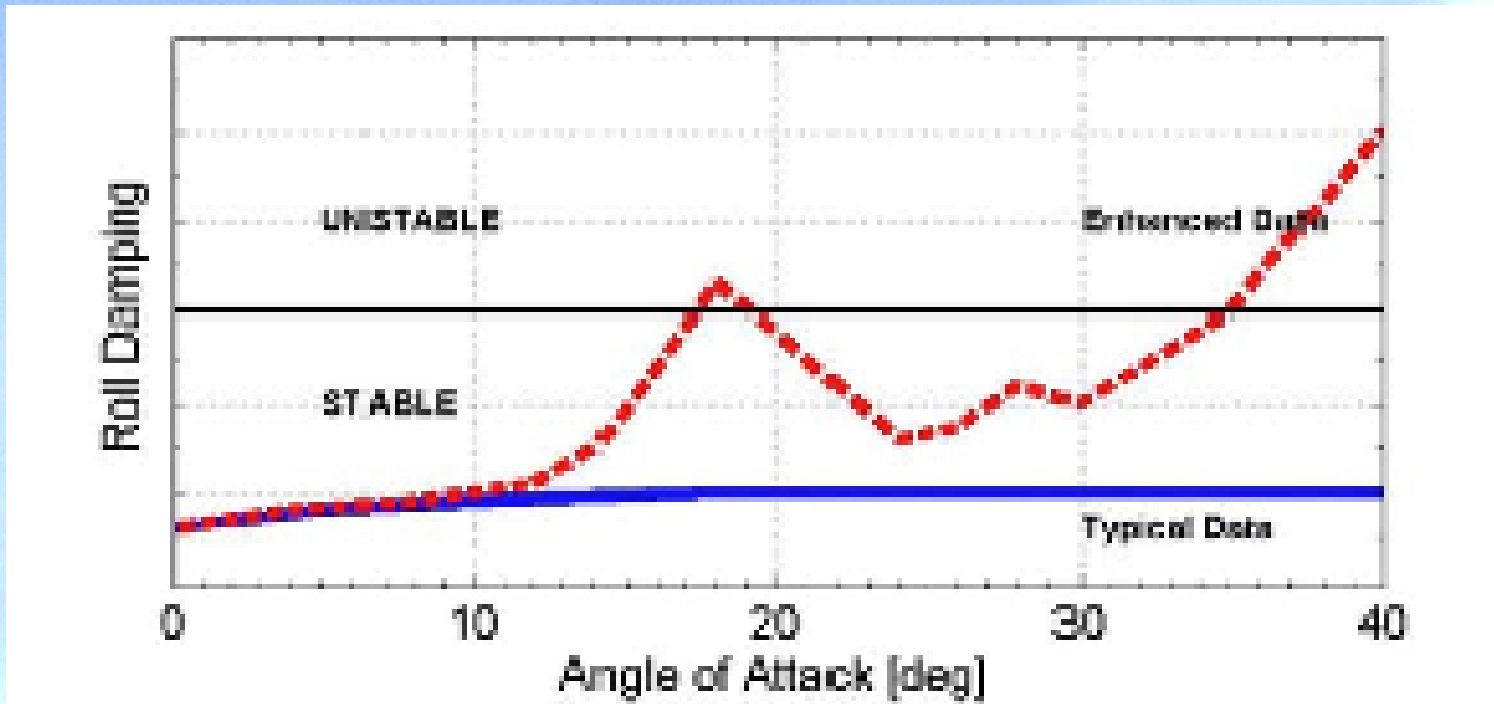
Gaps and Improvements

- Reduction in lateral stability and control effectiveness typically not modeled adequately
 - Although some simulations account for these effects
 - Flight data past approach-to-stall often not part of the data package used to build simulator model
 - Sometimes data in this region exists, but is not comprehensive
 - Instead, extrapolated values used, which too often give pilots a false sense of security in recoveries (i.e., simulated aircraft is more stable and is more easily controlled than the aircraft)
 - Neither pilots nor instructors are informed when they are operating in the extrapolated region
 - To train confidently in the post approach-to-stall region, the above deficiencies need improvement

Modelling Gaps



Modelling Gaps



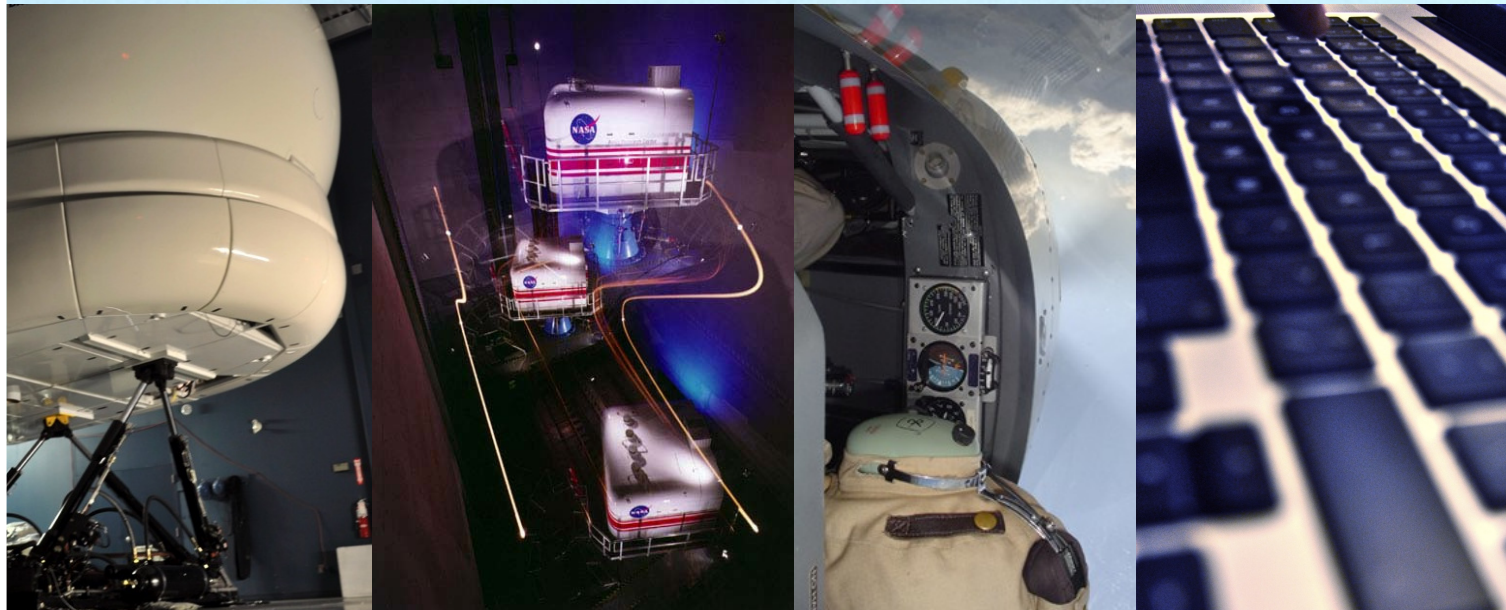
courtesy Bihrl Applied Research

Gaps and Improvements

- Need: Vibration indicative of stall buffet, degradations in pitch/roll control, show difficulty in arresting descent
- Motion cues need improvement, primarily vertical axis
- Important: Define and avoid negative cueing
 - Vertical accelerations in simulator are often on the order of 10% that experienced in the aircraft
 - Usually no feedback to the pilot or instructor as to how many g's were pulled in the last maneuver
 - Instances of when excessive control might have compromised aircraft structural integrity not fed back to the pilot or instructor

Possible Tools for Upset Prevention & Recovery Training

- Maximum use of existing infrastructure
- Specialized devices to support our internal research goals
- Aerobatic-capable aircraft for basic-level training
- Modern tools for academics training:
 - content is the key, not necessarily the tools themselves



Pros and Cons of Possible Training Solutions

- Status quo
 - Pros: changes may result in unknown and unintended consequences
 - Cons: If we know we can do better, we should endeavor to do so
- Mandate use of Upset Recovery Training Aid
 - Pros: Tests show simulators can be used to improve recovery from upsets
 - Cons: May go outside simulator envelope. Also, lack of consensus on proper technique for envelope-protected aircraft

Pros and Cons of Possible Training Solutions

- Extend envelope in today's simulators
 - Pros: Know how to make representative improvements, and in some cases flight data exist to check
 - Cons: The benefit/cost ratio may not support this approach, especially if near foolproof recognition and avoidance can be achieved
- Mandate upset recovery training in aircraft
 - Pros: There's nothing like the real thing, and studies support this fact
 - Cons: Infrastructure does not exist to allow it now, and benefit/cost ratio may not support this approach

Pros and Cons of Possible Training Solutions

- Embrace scenario-based training for upset recovery
 - Pros: Invokes some surprise instead of using today's scripted approach
 - Cons: Concerns about evaluating pilots on these events, as simulator may not be representative and probability of seeing such an in-flight scenario may be remote
- Cost-effective combination of previous solutions
 - Pros: Graduated approach is more comprehensive and allows strengths to be emphasized and weaknesses to be de-emphasized
 - Cons: Would prefer one way to skin a cat for simplicity instead of multiple ways

UPRT is not only a simulator problem

- Regulatory:
 - When in a career should UPRT occur?
- Instructional:
 - How do we enhance the instructor's role?
- CRM:
 - Encourage teamwork in upset prevention and recovery

FAA Deliverables

- ICATEE has delivered to the FAA/Industry Stall/Stick-Pusher Working Group:
 - Recommendations on how to implement startle in simulation during UPRT
 - Recommendations on how to provide feedback via Instructor Operator Station on effective UPRT

Summary

- Today's simulators are inadequate to meet NTSB recommendations for upset training
- Improvements in awareness, recognition & avoidance, recovery warranted
- Simulator improvements needed in the following areas:
 - startle factor
 - lateral/directional characteristics in the stall regime
 - motion cueing
- ICATEE is prioritizing recommendations from a mix of possible solutions
- Will propose recommendations through RAeS to FAA and ICAO