Loss of Control – Inflight Research Program (core research funding)

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Overview

- Need for LOC-I Human Factors Research
- LOC-I Research Needs and Sponsors
- LOC-I Research Overview
- Current Research Activities/Findings
- Planned FY14 Research
Loss of Control – Inflight (LOC-I)

• Recent high profile commercial aviation accidents highlighted risks posed by LOC-I and needs for flight crew training
  – Air France 447 (1 JUN 2009)
    • Investigation revealed loss of control subsequent to high altitude stall
    • Extensive flight envelope protection nullified by pitot-static icing and flight control system reversion to degraded mode
    • Training of crew for stall recognition/recovery in degraded modes a factor
  – Colgan 3407 (12 FEB 2009)
    • Investigation revealed loss of control subsequent to approach to landing stall
    • Pilot pulled through “stick shaker” and “stick pusher” warning systems
    • Pilot training confirmed to industry standards
    • Startle/Surprise deemed a factor
LOC-I Leading Cause of Accidents

- World-wide scheduled commercial jet accidents 2002-2011

![Bar Chart]

- Technological mitigations not readily available

Source: Boeing
LOC-I Research Needs and Sponsors

• LOC-I: “Loss of aircraft control while, or deviation from intended flightpath, inflight” (ICAO Common Taxonomy for Occurrences)

• Current research to support FAA review of the report of the Air Carrier Safety and Pilot Training ARC, and the development of a new Advisory Circular providing training and regulatory guidance to airlines/operators to mitigate LOC
  – Project Manager: Michelle Yeh (ANG-C1)

• Sponsors
  – Kathy Abbott
  – Robert Burke
  – Robyn Laporte
  – Doug Farrow

• Key stakeholders
  – Jeffery Schroeder
  – Tom Chidester

• Regulatory and Guidance Material
  – FAA AC 120-109 Stall and Stick Pusher Training (AUG 2012)
  – Public Law 111-216 Mandate for Full Stall Recovery Training
  – New AC on Upset Prevention and Recovery Training
Highlights of Prior Work

• International efforts to study/respond to LOC-I
    • Mandate initial and recurrent upset recovery training including stall
      recognition and recovery training
  – Airplane Upset Recovery Training Aid (URTA) (Rev.2 2008)
    • Extensive background on upset causes, dynamics, and recoveries with
      recommendations for comprehensive training program guidance
    • Report on history, core concepts and mitigation
  – NASA LOC Study Team (2010)
    • Examination of LOC accidents and recommendations for mitigation
  – UK Loss of Control Task Force (2011)
    • LOC causal factors and recommendations for mitigation
  – International Committee for Aviation Training in Extended
    Envelopes (ICATEE)

• FAA/ICAO Loss of Control Aviation Rulemaking Committee
  (2010-2013)
LOC-I Research Overview

- Phase I: Completed comprehensive literature review of existing LOC-I studies including causal and contributing factors (MIT LL, PI: W. Olson in conjunction with FAA CAMI) (JAN 2013)
  - Reviewed and summarized existing LOC-I assessment, findings, and guidance including Airplane Upset Recovery Training Aid (URTA) and ICATEE Upset Prevention and Recovery Training Matrix (Draft)
  - Proposed guidelines and specific training recommendations to mitigate LOC-I in all phases of potential LOC event:
    - Awareness/Avoidance
    - Detection/Recognition
    - Recovery
  - Identified particular issues impacting mitigation through training
- Phase II: Develop priority objectives and measurable outcomes for training to mitigate LOC-I with initial emphasis on air carrier operations (MIT LL, PI: T. Teller) (MAR – OCT 2013)
Framework for LOC-I Priority Training Objectives/Outcomes

- LOC-I Training Objectives/Outcomes organized in framework of five functional areas judged to be of high priority by likelihood of involvement and severity of impact

- Framework applicable to all levels of pilot training/certification
Each Functional Area Further Decomposed to Key High-Level Sub-areas

- For example, for *Flight Guidance and Control*

  ![Diagram showing the decomposition of Flight Guidance and Control into sub-areas]

  - Automation Management; Mode Awareness/Management
  - Flight Envelope Protection
  - Flight Systems/Controls Malfunctions; Operations in Degraded Modes
  - Flight Systems/Controls Capabilities and Limitations

- Not all functional sub-areas applicable to all levels of pilot training/certification, e.g., Flight Envelope Protection is generally applicable only to pilot training/certification for advanced “fly-by-wire” air transport aircraft
High-Level Objectives Specified for each Functional Area/Sub-area

- For example, for *Aerodynamics and Stall: Onset Conditions and Impacts on Propagation*

  - **Aerodynamics and Stall**

  - **Onset Conditions and Impacts on Propagation**

    - List pre-stall onset conditions having substantive impact on stall propagation and post-stall behavior (A/A)
    - Describe how each listed pre-stall onset condition affects stall propagation and stall onset cueing (A/A)
    - Correlate pre-stall onset conditions with observable flight cues or instrument indications (D/R)
    - Demonstrate prompt recovery from each listed onset condition in accordance with stall recovery template (REC)

- Objectives/Outcomes specified for Awareness/Avoidance (A/A), Detection/Recognition (D/R), and Recovery (REC)
  - Measurable outcomes devolve from objectives and vary with level of training/certification (initial emphasis air carrier training/operations)
Cross Correlation of Objectives/Outcomes

- Objectives/Outcomes may cross correlate with multiple functional areas/sub-areas, for example:
  - Objectives/Outcomes associated with contamination of wings and/or control surfaces may cross correlate with
    - Atmospheric Impacts/Dynamics: Airframe Icing
    - Aerodynamics and Stall: Onset Conditions and Impacts on Propagation and Post-Stall Variables and Impacts
    - Flight Dynamics and Energy State Management: Thrust and Drag
    - Flight Guidance and Control: Flight Systems/Controls Capabilities and Limitations
  - Once priority objectives/outcomes fully specified, resulting set will be re-indexed in accordance with instructional/training design hierarchy rather than by functional area/sub-area, eliminating duplications due to cross correlation
Concurrent Activities in Support of Development of Objectives/Outcomes

• Informal consultation with air carriers and other operators regarding current LOC-I training implementation and priorities
  – Interpretation of current LOC-I training and regulatory guidance including implementation of “best practices” identified by ARC
  – Training modalities and best practices
  – Priorities for future LOC-I training guidance and requirements

• Support for other concurrent efforts linked to LOC-I training
  – Technical review of startle/surprise/distraction in the cockpit (FAA ANG-C1, PI: F. Jentch, University of Central Florida Orlando)
  – Evaluation of simulator software models for conducting mandated air carrier full-stall training (FAA, PI: J. Schroeder)

• Collaboration with key stakeholders to address challenges to implementation of LOC-I Training
  – Development of realistic and repeatable training scenarios
  – Methods and metrics to assess LOC-I training effectiveness
Planned FY 14 Research

• Additional work required to fully realize and implement LOC-I training objectives/outcomes
  – Identify set of tasks for implementing upset recovery training and develop specific performance standards for these tasks
  – Provide review of evaluation of computer models for training/simulation of LOC-I
Summary

• Current research supports:
  – FAA review of report and recommendations of the Air Carrier Safety and Pilot Training ARC
  – Development of a new Advisory Circular providing training and regulatory guidance to airlines/operators to mitigate LOC

• Current research focused on developing priority objectives and measurable outcomes for training to mitigate LOC-I with initial emphasis on air carrier operations

• Additional work required to fully realize and implement LOC-I training objectives/outcomes
  – Identify set of tasks for implementing upset recovery training and develop specific performance standards for these tasks
  – Provide review of evaluation of computer models for training/simulation of LOC-I