National Training Aircraft Symposium (NTAS)

2017 - Training Pilots of the Future: Techniques & Technology

Aug 15th, 11:45 AM - 1:00 PM

Lunch Keynote Speaker — Challenges of Increasing Automation

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Challenges of Increasing Automation

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Member, NTSB

Outline

- NTSB Basics
- Automation Benefits
- Automation Downsides
  - When it does not work as intended
  - When it does work as intended

NTSB 101

- Independent federal agency, investigate transportation mishaps, all modes
- Determine probable cause(s) and make recommendations to prevent recurrences
- Primary product: Safety recommendations
  - Favorable response > 80%
- *SINGLE FOCUS IS SAFETY*
- Independence
  - Political: Findings and recommendations based upon evidence rather than politics
  - Functional: No “dog in the fight”

The Theory

Automation can eliminate human error by eliminating the human from the loop

The Reality

Automation can significantly increase productivity, efficiency, reliability, throughput, and safety

but the downside . . .

"In their efforts to compensate for the unreliability of human performance, the designers of automated control systems have unwittingly created opportunities for new error types that can be even more serious than those they were seeking to avoid."

Prof. James Reason, University of Manchester (UK)

The Ramifications

- When it does *not* work as intended:
  - Increasing complexity increases the likelihood that operators will not completely understand the system
  - Increasing reliability increases the likelihood that operators have never seen a given problem before, even in training, and may not know how to respond
- When it *does* work as intended:
  - Loss of skills
  - Complacency
  - Reduced professionalism?

Why the Downside

- Automation may not work as intended

- Even if it does work as intended, there are additional opportunities for human error in
  - Design
  - Manufacturing
  - Maintenance
  - Infrastructure design, manufacture, maintenance
  - Other human operators

Might Not Work as Intended Because

- Human factors were not adequately considered in designing automation
- Automation encountered unanticipated circumstances
- Automation failed

Human Factors Inadequately Considered

Strasbourg, France (1992)

Cali, Colombia (1995)

San Francisco (2013)

Strasbourg, France

– Risk Factors
  - Night, mountainous terrain
  - No ground radar
  - No ground-based glideslope guidance
  - No airborne terrain alerting equipment

– Very Sophisticated Autopilot
  - Autopilot Mode Ambiguity

Human Factors Challenge

- "3.2" in the window, *with a decimal*, means:
  - Descend at a *3.2 degree angle (about 700 fpm at 140 knots)*
- "32" in the window, *without a decimal*, means:
  - Descend at *3200 fpm*

Clue: Quick Changes in Autopilot Mode

Frequently Signal a Problem

Flight data recorder readout program could have helped safety experts identify this problem

Cali, Colombia

– Risk Factors
  - Night
  - Airport in deep valley
  - No ground radar
  - Airborne terrain alerting limited to "look down"
  - Last-minute change in approach
    - ➢ More rapid descent (throttles idle, spoilers)
    - ➢ Hurried reprogramming

– Navigation Radio Ambiguity

– Spoilers Do Not Retract With Power

Recommended Remedies

- Operational
  - *Caution re last minute changes to the approach!!*
- Aircraft/Avionics
  - Enhanced ground proximity warning system
  - Spoilers that retract with max power
  - Require confirmation of non-obvious changes
  - Unused or passed waypoints remain in view
- Infrastructure
  - Three-letter navigational radio identifiers
  - Ground-based radar
  - Improved reporting of, and acting upon, safety issues

Note: All but the first of these remedies address system issues

San Francisco

- Clear day, negligible wind
- Adequate runway (more than 11,000’)
- Electronic glideslope inoperative, but visual glideslope available
- Pilot rarely did manual approach
- Pilot unaware that autothrottle on standby, not controlling speed
- Poor altitude and speed control (34 knots under Vref)
- Crashed short of runway, into seawall

Unanticipated Circumstances

Amsterdam, Holland (2009)

Rio to Paris (2009)

Landing on the Hudson (2009)

Amsterdam, Holland

- The Conditions
  - Malfunctioning left radar altimeter
  - Pilots selected right side autopilot
  - Aircraft vectored above glideslope
  - Autothrust commanded throttles to idle
  - Unknown to pilots, right autopilot using left radar altimeter
  - Pillot unsuccessfully attempted go-around

- Queries:
  - Should autopilot default to same side altimeter?
  - More clarity re source of information? Ability to select?

Rio to Paris

- The Conditions
  - Cruise, autopilot engaged
  - Night, in clouds, turbulence, coffin corner
  - Ice blocked pitot tubes
  - Autopilot and autothrust inoperative without airspeed information
  - Alpha protections disabled
  - Pilots' responses inappropriate

- Queries:
  - Pilot training re loss of airspeed information in cruise?
  - Importance of CRM – pilot knowing other pilot's actions?
  - Pilot training re manual flight at cruise altitude?

Landing on the Hudson

- Both engines were disabled by ingesting birds shortly after takeoff
- Decided to land in the river due to inability to glide to an airport
- While flaring for touchdown on water, effort to minimize vertical impact speed was limited by phugoid damper
- Pilots had no knowledge of or training re phugoid damper

Failure

- Fort Totten Metro Crash, Washington, DC (2009)
  - Train became electronically invisible, no warning to following train
  - Following train accelerated when it sensed (due to electronic invisibility of preceding train) that the track ahead was unoccupied
  - Operator of following train saw stopped train ahead after coming around curve (which limited her sight distance)
  - Applied emergency brake, too late to avoid impact

When It Works As Intended

- Many transit systems: Automation
  - Starts the train out of the station
  - Observes speed limits, avoids collisions
  - Stops the train in the next station
  - Opens the doors
- Operator
  - *Closes the doors*
- Issues
  - Loss of skills
  - Complacency
  - Adverse impact on professionalism?
    - Job satisfaction?
    - Work for pay, rather than for job well done?

Moral of the Story

The human is both extremes --

the most *unreliable and unpredictable* part of the system

and also

the most *flexible and adaptable* part of the system

Recent Challenge

Introducing automation onto our streets and highways:

Significant potential benefit – *Save 40,000 lives per year!*

but . . .

Much more difficult than many people think!

- More variable and less structured environment
- Less stringent operator qualification requirements
- Complete absence of human operators is unlikely

Conclusion

Automation presents significant opportunities to improve safety (in addition to productivity, efficiency, reliability, and throughput)

but . . .

Increasing automation complexity increases the challenges of continuing to improve safety

Thank You

Questions?