## Human Factors Challenges in the Flight Deck

Kathy Abbott Brief to Future Sky Safety on Final Approach

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Federal Aviation Administration

# Challenges – not a complete list

- Complexity
- Dealing with change
- Information management
- Data too much or not enough?
- Effectiveness of risk mitigations
- Dealing with the unexpected
- Automated systems/autonomy



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# Complexity

- Increase in numbers and diversity of operations
- Pilot-controller interaction

### Tradeoff between complexity and flexibility



### A Lot to Manage



#### Air Agency Certificates: 6,219

811 Pilot Training Schools 4,907 Repair Stations 177 Maintenance Training Schools 324 Pilot Training Centers

#### Air Operator Certificates: 5.068

70 Major Air Carriers -- (e.g. United Airlines) 1,936 Commuter Air Carriers/On Demand Air Taxis 85 Commercial Operators (e.g. Baltimore Orioles) 486 Foreign Air Carriers (e.g. Lufthansa) 354 External Load (Logging/Oil Platform) 1,807 Agricultural Operators 330 Public Use Authorities (State/City/Police)



Mechanics with Inspection Authority: 22,460 Approved Manufacturers: 1,539



Designees: 9,089

•2.844 Aircraft Certification 3,627 Flight Standards 2,618 Aerospace Medicine

#### Non-Pilot Air Personnel: 696,676

 321,308 Mechanics & repairmen 25,454 Control Tower Operator 222,037 Flight Attendant 66,423 Ground instructors 61,454 other (dispatchers/flight navigators/parachute riggers/flight engineers)



#### National Transportation Safety Board: 621

39 Safety Recommendations (avg/yr based on last 5 yrs) 337 Formal NTSB requested for FAA research & info 245 Open NTSB Safety Recommendations

#### ATCS Medical Clearance Exams: 13.895

•13.802 Air Traffic Controller Workforce 93 Flight Service Station Workforce

#### Airmen Medical Examinations: 384,798

•32,776 Special Issuances 341,470 Standard Issuances

Aviation Industry Entities Covered by Anti-Drug & Alcohol Programs: 6,829

#### Aircraft: 309,423

7.631 Air Carrier Aircraft 710 Commuter Air Carrier Aircraft 8,621 On Demand Air Taxi Aircraft 213,905 General Aviation Aircraft

#### Aviation Authorities - other countries: 427

- - 48 Countries covered by Bilateral
    - **Agreements**
  - **192 Foreign Carrier Aviation Authorities** 187 Accident Investigation Authorities



#### Check Airmen: 9,071

•5.573 Part 121 117 Parts 121/135 3,381 Part 135

#### Active Pilots: 736,461

- 167,556 ATP
- 115,816 Commercial
- 175,762 Private
- 147 Recreational
- •6,245 Sport
- •167.636 Student
- •40,699 Foreign Pilot
- 106.026 UAS Remote Pilots

#### AOV Credentials: 17,257

- 12.649 ATCS Credentials
- •4,415 ATSS Credentials
- 193 AIS Credentials

#### Flight Instructors: 108,273



UAS Registrations: 1,223,073 •958,505 Hobby 257,970 Commercial •6,598 Paper Registration

# Pilot-Controller Interaction – Selected Examples

- Half-degree waypoint issue in North Atlantic Tracks
- Late runway changes
- Go-around from visual approach
- Defining stabilized approaches
- Airspace procedure complexity
- Complex clearances
- Conditional clearances



### **Operational Factors – Complexity of Instrument Flight Procedures (IFPs)**

- ATC Intervention (such as)
  - (Late) route amendments
  - Unpublished restrictions
  - Vectors
  - etc...

#### Aircraft Factors

- Lack or unreliability of automated systems
- Performance characteristics

#### Crew Factors

- (Standard) expectations
- Fatigue
- Communication style
- Distractions
- Local area familiarity
- Familiarity with different types of IFPs

#### **Operator Factors**

- Independence vs. dependence on Dispatch
- Clarity and consistency of PF/PM roles in reviewing IFPs

#### Environment Factors

- Terrain
- Traffic
- Weather (Wind or IMC)
- Prohibited airspace



## **Complex clearances**

Example format: "Cleared direct (fix), (crossing altitude if necessary), change to runway (runway number), descend via (STAR), expect (instrument approach)"

Legal, but complex



# **Conditional Clearances**

### On the ground

 "Line up and Wait after landing aircraft (or behind departing aircraft)" or "After landing aircraft, line up and wait, after landing aircraft"

Note: Conditional clearances involving runway operations are not used in the US

### • In the air

- AT [time/position] CLIMB/DESCEND TO [level] or AT [time/position] CLIMB/DESCEND TO AND MAINTAIN [altitude] (Note: Text displayed depends on implementation)
- Debated in international circles for years: Pilots hate them, controllers say that their airspace can't function well without them



# **Our Brains are Set Up to:**

### Process information in the most efficient way

- Seeing what we expect to see
- More likely to process information that conforms to our expectations
- Focus on the most salient information



ical. Situations where k silot will self-separate and/o perform duties station-keeping maneuvers are anticipated. But there will likely also be situations where the ground nsed automation will perfor rration functions, signals, or



Courtesy K. Cardosi, Volpe



Federal Aviation Administration

### **Drivers of Change in the System**

A more globally connected system Aviation is an **increasingly global** enterprise under increasingly complex and decentralized business models

### **Projected growth in demand and diversity**

from conventional customers as well as new entrants in non-traditional areas

Growing aviation demand & diversity



The public has internalized the **unprecedented levels of aviation safety** 



# How Are Flight Operations Changing?

 New ways to do Communications, Navigation and Surveillance







### **New Technologies and Operators**





# **Change in Aviation**

- Change management
- Change fatigue
- Change can bring risk



#### **Accident Rates by Years Following Introduction**

Hull Loss and/or Fatal accidents - Worldwide Commercial Jet Fleet - 1959 through 2003



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# How are things changing for pilots?

- Sometime simpler, sometimes more complex
- More tasks
- Different errors
- More use of automated systems
- More information





# **Flight Deck Information**





# Outside the Flight Deck: Operational Data – Too Much or Not Enough?

- More data
- Better data? Sometimes yes, sometimes no
- Every data source has strengths and weakness
- Still major gaps
- Remember absence of evidence is not evidence of absence
- Data still mainly from the "front line"



# **Scary Stuff**





### **Risk Mitigations**

### (in decreasing order of effectiveness)

- Eliminate hazard
- Alter design
- Incorporate engineered features or safety devices
- Provide warning devices
- Incorporate signage, procedures, training

Decreasing effectiveness

#### Source: MIL-STD-882E System Safety Handbook



# **Concluding remarks**

- Managing complexity and change are key parts of moving forward
- Multiple, dissimilar sources of data will help us make better decisions
- Information management needs attention
- Mitigate risk in the most effective way possible

