Emergency and Abnormal Situations Project

Barbara Burian, Ph.D.
SJSUF / NASA Ames Research Center

Immanuel Barshi, Ph.D. and Key Dismukes, Ph.D.
NASA Ames Research Center
The Challenge

Emergency and abnormal situations:
- are often time critical, complex, and/or ambiguous
- are high stress, high workload, and a great deal is at stake
- require exceptionally high levels of coordination inside and outside of the airplane

Emergency and abnormal procedures:
- are generally focused on aircraft systems rather than on the situation as a whole
- are practiced seldom (twice a year or less) and used rarely
- are often highly dependent on fragile cognitive processes
- when needed, are crucial and must be performed correctly
# Industry Contacts and Consultants

<table>
<thead>
<tr>
<th>Manufacturers:</th>
<th>Boeing, Airbus Industries, BAE Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory Agencies:</td>
<td>FAA, CAA (UK), ICAO</td>
</tr>
<tr>
<td>Unions and Trade Groups:</td>
<td>ALPA, APA, SWAPA, ATA</td>
</tr>
<tr>
<td>Accident Investigation Bodies:</td>
<td>NTSB, TSB of Canada</td>
</tr>
<tr>
<td>Airlines:</td>
<td>Southwest Airlines, United Airlines,</td>
</tr>
<tr>
<td></td>
<td>Continental Airlines, American Airlines,</td>
</tr>
<tr>
<td></td>
<td>Fed Ex, Aloha Airlines, Hawaiian</td>
</tr>
<tr>
<td></td>
<td>Airlines, Air Canada, Cathay Pacific,</td>
</tr>
<tr>
<td></td>
<td>Airborne Express, UPS, US Airways,</td>
</tr>
<tr>
<td></td>
<td>TWA (prior to merger)</td>
</tr>
</tbody>
</table>
Themes from Industry Interviews

- Industry lacks substantive human performance guidelines for the creation, validation, certification, and training of procedures for emergency and abnormal situations.

- Challenging to design procedures that reflect real-world ambiguities, workload demands, time constraints, and cognitive limitations.

- Training provides limited opportunity to practice procedures in the context of full real-world demands
  - LOFT/LOE: one scenario/year
  - Recurrent training focuses on practicing procedures not on concurrent demands (e.g., coordination with ATC, dispatch, and maintenance)
Emergency and Abnormal Situations Project
Taxonomy of the Domain

15 Different Categories of Issues:

- Broad, Over-arching Issues
- Issues Related to Checklists and Procedures
- Issues Related to Humans
- Issues Related to the Aircraft
- Issues Related to Training
- Selected Emergency Equipment and Evacuation Issues
Philosophies and Policies of Dealing with Emergencies and Abnormal Situations

Aircraft System Focused ----------- Situation Focused
Engineering Function------------ Human Performance
Ideal--------------------------- Context Dependent

Manufacturers
Regulatory Agencies
Company (Management, Dispatch, Maintenance)
Flight and Cabin Crews
ATC
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Philosophies

Economic and Regulatory Pressures

Economic and Regulatory Pressures Pertaining to Dealing with and Training for Emergencies
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Philosophies

Economic and Regulatory Pressures
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Definitions and Perspectives

Philosophies

Economic and Regulatory Pressures

Issues in Definition and Perspective

- Normal vs. Abnormal / Emergency Procedures
- Emergency vs. Abnormal Procedures and Situations
- Proceduralization vs. Creative Problem Solving
- Procedures vs. Checklists
- Objectives and Goals of Emergency and Abnormal Checklists
- Issues That Might Exist in the Future (e.g., due to new technologies, etc.)
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Definitions and Perspectives

Philosophies

Economic and Regulatory Pressures
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Development of Checklists and Procedures
Who develops them?
When and how are changes made and recorded?
How do they get regulatory approval?
Degree to which they reflect the operational environment
Degree to which they can be standardized across fleets

Definitions and Perspectives
Philosophies
Economic and Regulatory Pressures
Emergency and Abnormal Situations Project
Taxonomy of the Domain

- Definitions and Perspectives
- Development of Checklists and Procedures
- Philosophies
- Economic and Regulatory Pressures
Checklist Structure and Design

- Items that are included and their order
- Incorrect Items, missing items
- Length of checklist and timing issues
- Inclusion of recall (memory) items
- Nomenclature and language issues
- Navigating within a checklist
- Organization and indexing issues
- Integration with normal checklists
- Consistency with Cabin Crew checklists, MELs and other materials
- Checklists that do not exist for certain situations or phases of flight where needed
- Flexibility for responding to “non-standard” situations
- Style guide, formatting and layout considerations
Checklist Type and Availability

Type: Paper
  - Mechanical
  - Electronic – connected and not connected to the aircraft through sensors
  - Computerized Prioritization Schemes

Availability
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Definitions and Perspectives

Development of Checklists and Procedures

Philosophies

Economic and Regulatory Pressures

Checklist Structure and Design

Checklist Type and Availability
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Definitions and Perspectives

Development of Checklists and Procedures

Checklist Structure and Design

Checklist Use

Checklist Type and Availability

Coordination and Response

Training

Relevant Training Technologies and Approaches

Initial vs. Recurrent Training in Dealing with these Situations

Skill Acquisition and Retention – Especially of Procedures that are Unpracticed or Seldom Touched Upon

Training for “Textbook” vs. “Nonstandard” Situations

Training for Single vs. Multiple Problems

Negative Training

Use of Contract Instructors or Non-Line Pilots

Joint Training of Flight and Cabin Crews

Economic and Regulatory Pressures
Roles and Behavior of Others in Dealing with an Emergency or Abnormal Situation

Communication and Coordination with:
- Cabin Crew
- ATC
- Dispatch
- Maintenance
- Airport Rescue and Fire Fighting Personnel
- MedLink
- Passengers

And the Degree to Which Their Various Procedures and Checklists are Consistent With and Compliment Each Other
Emergency and Abnormal Situations Project
Taxonomy of the Domain

- Definitions and Perspectives
- Development of Checklists and Procedures
- Critical Aircraft Systems
- Critical Aircraft Systems
  - Protected (i.e., flight protection envelope)
  - Automated Systems
  - Legacy
  - MEL’d Equipment that Effect the Completion of Checklist Items
- Human Performance
- Roles and Behavior of Others
- Crew Coordination and Response
- Personnel Issues
- Training
- Checklist Structure and Design
- Checklist Use
- Checklist Type and Availability
- Economic and Regulatory Pressures
Emergency and Abnormal Situations Project
Taxonomy of the Domain

- Definitions and Perspectives
- Economic and Regulatory Pressures
- Development of Checklists and Procedures
- Critical Aircraft Systems
- Checklist Structure and Design
- Checklist Use
- Checklist Type and Availability
- Philosophies
- Checklists and Procedures Use
- Roles and Behavior of Others
- Training
- Personnel Issues
- Human Performance
- Crew Coordination and Response
- Taxonomy of the Domain
- Critical Aircraft Systems

Diagram showing the relationships between these topics.
Emergency and Abnormal Situations Project
Taxonomy of the Domain

- Definitions and Perspectives
- Economic and Regulatory Pressures
- Development of Checklists and Procedures
- Critical Aircraft Systems
- Philosophies
- Checklist Structure and Design
- Checklist Use
- Checklist Type and Availability
- Impact of Automation
  - Degree to Which Uncritical Acceptance of Automation Leads to Misdiagnosing and / or Responding to the Situation
  - Procedures Developed for Automated vs. Less Automated Aircraft
  - Degradation in Hand-Flying Skills
  - Issues in Reverting to Manual
- Personnel Issues
- Training
- Human Performance
- Roles and Behavior of Others

Critical Aircraft Systems

Checklist Use
Emergency and Abnormal Situations Project
Taxonomy of the Domain

- Definitions and Perspectives
- Development of Checklists and Procedures
- Critical Aircraft Systems
- Impact of Automation
- Economic and Regulatory Pressures
- Checklist Structure and Design
- Checklist Type and Availability
- Checklist Use
- Crew Coordination and Response
- Human Performance
- Roles and Behavior of Others
- Personnel Issues
- Training
Emergency and Abnormal Situations Project
Taxonomy of the Domain

- Definitions and Perspectives
- Economic and Regulatory Pressures
- Development of Checklists and Procedures
- Critical Aircraft Systems
- Impact of Automation
- Equipment and Evacuation Issues
- Checklist Structure and Design
- Checklist Use
- Checklist Type and Availability

Emergency Equipment and Evacuation Issues:
- Equipment that is Problematic to Use in an Emergency (e.g., smoke goggles that do not fit over eyeglasses)
- Inadequate Training in the Use of Emergency Equipment
- Negative Transfer (Interference) of Equipment Usage Across Different Aircraft Types
- Confusion or Problems Regarding the Initiation of Evacuations

- Human Performance Issues
- Personnel Issues
- Training
- Roles and Behavior of Others
Emergency and Abnormal Situations Project
Taxonomy of the Domain

Definitions and Perspectives
Development of Checklists and Procedures
Philosophies
Critical Aircraft Systems
Impact of Automation
Equipment and Evacuation Issues
Human Performance
Roles and Behavior of Others
Crew Coordination and Response
Personnel Issues
Training
Checklist Structure and Design
Checklist Use
Checklist Type and Availability
Emergency and Abnormal Situations Project
Taxonomy of the Domain

- Definitions and Perspectives
- Economic and Regulatory Pressures
- Development of Checklists and Procedures
- Critical Aircraft Systems
- Impact of Automation
- Equipment and Evacuation Issues
- Checklist Structure and Design
- Checklist Use
- Checklist Type and Availability
- Human Performance
- Personnel Issues
- Roles and Behavior of Others
- Training
- Crew Coordination and Response
Scope of the Project

- Part 121 and Part 135 operations
- United States domestic operations
- Flight deck centric
- Temporal window: from the beginning of the situation through the initiation of an evacuation (if any)
Approach

Review: all existing guidelines, handbooks, bulletins, reports, recommendations, documents, and pertinent literature

Analyze: ASRS reports, NTSB and FAA accident reports

Study: philosophies, policies, practices, and procedures currently in use by manufacturers and air carriers

Observe: normal air carrier operations, initial and recurrent emergency and abnormal training for flight crews

Interview: manufacturer procedure developers, procedure certifiers, POIs, air carrier management, instructors, pilots, cabin crew, dispatchers, maintenance personnel, air traffic controllers, etc.

Conduct: surveys, field studies, simulator studies, experimental lab studies
A Few Current and Recently Completed Studies

- Current Practices in Emergency and Abnormal Training for Flight Crews
- Boeing Checklist Development Process, Design, and Philosophy: B777 ECL and QRH, B737 QRH
- Non-normal Checklists: Issues in Philosophy, Design, and Use
- B737 QRH Comparison
- Stress and Cognition – A Review of the Scientific Literature
- Declaring Emergencies: Fact and Fiction
- Pilot Critical Incident Interviews
- Emergency and Abnormal Situations: ASRS Incident and NTSB Accident Reviews
Develop guidance for procedure development and certification, training, crew coordination, and situation management based on knowledge of the operational environment, human performance limitations, and cognitive vulnerabilities in real-world situations.
Products and Deliverables

Intermediate Products:
Reports, Articles, Papers, Presentations

End Products:

Field Guides for
• Training Entities and Instructors
• Operators
• Manufacturers
• Regulatory Agencies
  (Certification, POIs)
EAS Project Team

Immanuel Barshi, Ph.D., ATP, CFI
Sean Belcher, M.A., ATP, CFI
Ben Berman, A.B., ATP, CFI
Barbara Burian, Ph.D., PPL
Key Dismukes, Ph.D., ATP, CFI
Captain Richard Fariello (Ret.), B.S., ATP
Colleen Geven, A.A., ATP, CFI
Richard Geven, M.A., ATP, CFI
Todd Kowalski, B.S., CPL, CFI
Chris Reed, B.S., ATP, CFI
http://human-factors.arc.nasa.gov/eas