TOWARDS A NEXT-GENERATION AIRLINE FLIGHT OPERATIONS SYSTEM (AFOS)

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AFOS

- What is it?
- Who’s responsible for it?
- Why change it?
- When things go wrong
- Classic vs Contemporary HF view of Human Error
- A killer application

AFOS

- Theory vs. Practice
- The Brain's to Blame
- Examples of bad procedural design
- Cues, Anchors, and Checks
- Mitigations
- Stakeholders
- A way forward

AFOS –WHAT IS IT?

- **An Airline Flight Operating System (AFOS) includes every action, reaction and interaction involving the pilots from the moment they begin flight preparation until they leave the aircraft**
- **It includes an airline's checklists, procedures, manoeuvers, automation interface, crew interactions, CRM, policies, manuals, training, checking, and character**
- **Cockpit procedures design is at the heart of an AFOS**

AFOS –WHO IS RESPONSIBLE FOR IT?

- **The AFOS is designed, applied, and modified by an individual airline's flight ops management**
- **Airline industry is in constant flux so the AFOS is typically a work in progress**
- **AFOS can range from highly capable and sophisticated to deficient**
- **Most flight ops managers feel all is well with their respective AFOS.**

AFOS –WHY CHANGE IT?

- **We’re unlikely to get to the next level of safety if we don’t change direction**
- **We will introduce evidence to support that assertion.**

AFOS –WHEN THINGS GO WRONG

- **The following accidents are all related……**

LH 540, B747, NAIROBI, NOVEMBER 1974, 59 FATALITIES, 55 INJURIES

NW 255, MD82,
DETROIT, AUGUST 1987,
156 FATALITIES,
1 INJURY

DL 1141, B727, DALLAS-FT WORTH, AUGUST 1988, 14 FATALITIES, 76 INJURIES

LAPA 3142, B737, BUENOS AIRES, AUGUST 1999, 65 FATALITIES, 40+ INJURIES

MANDALA 091, B737, MEDAN, SEPTEMBER 2005, 149 FATALITIES, 41 INJURIES

SPANAIR 5022, MD82, MADRID, AUGUST 2008, 154 FATALITIES, 18 INJURIES

AFOS –WHEN THINGS GO WRONG

- About 600 fatalities
- A common thread
- Flaps and slats not properly set prior to take-off
- Final reports all cited **pilots' failure to follow established procedures.**

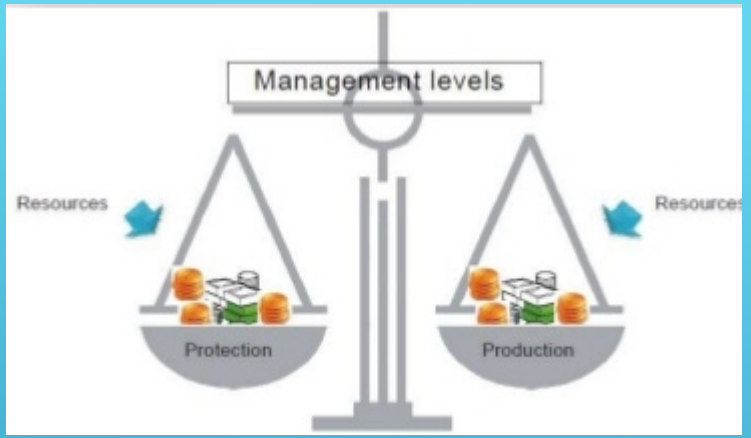
HUMAN ERROR – CLASSIC VIEW

- **Were these pilots all “bad apples?”**
- **Classic view: system assumed to be basically safe if not for a few unreliable people in it (the bad apples)**
- **Dekker and many others believe this traditional view of human error is increasingly outdated**
- **“Bad apple” theory is pretty much a dead end.**

HUMAN ERROR – CONTEMPORARY VIEW

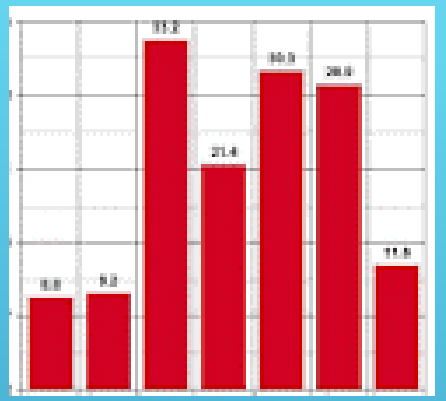
- **Human error is a symptom of trouble deeper inside the system**
- **Safety is not inherent in systems; systems themselves are contradictions between multiple goals that people must pursue simultaneously**
- **Human error is systematically connected to features of people's tools, tasks and operating environment. Progress on safety comes from understanding and influencing these connections.**

HUMAN ERROR – CONTEMPORARY VIEW



- **A series of human errors of a similar type suggests an organizational problem**
- **When an organization manages the trade-offs between protection and production it must account properly for human strengths and frailties.**

LET THE DATA GUIDE US



- One airline's data on flap extension
- Is your airline better? Can you prove it?
- Contemporary HF view offers the only practical solution
- Necessary research has already been performed
- **"…carelessness and lack of professionalism or discipline is not an adequate explanation."**

THEORY VS. PRACTICE
IN THEORY:

- **In theory, and in most training, task sequence is linear; task A then B then C, etc.**
- **Task management is predictable, information is available**
- **The operation is under moment-to-moment control of the crew**

THEORY VS. PRACTICE
IN PRACTICE:

- **Normal line operations much more dynamic**
- **Pilots must juggle several tasks concurrently; interruptions frequent, external demands arrive unpredictably, tasks performed out of normal sequence**
- **Pilots sometimes struggle to control timing and sequence of their workload**
- **Little guidance or training on coping effectively with dynamic world of line operations.**

THEORY VS. PRACTICE
IN PRACTICE:

- **Line training helps (somewhat)**
- **Pilots develop coping techniques and workarounds**
- **Most of the time things work out OK**
- **BUT these situations substantially increase vulnerability to error, especially the omission of critical procedural steps.**

WHY SUCH VULNERABILITY?

- Blame it on the brain
- Controlled processing - slow, deliberate
- Automatic processing - fast, low effort, minimal conscious supervision, but VULNERABLE
- Mitigating the vulnerabilities in automatic processing
- Myth of multi-tasking

EXAMPLES OF DEFICIENT PROCEDURES/CHECKS

- **Inadequate use of cues, anchors, and checks for critical items**
- **Excessively long checklists**
- **Low value checklist items**
- **Required Interaction with the cabin at critical times**
- **Silent checklists**
- **Broken or paused checklists**

EXAMPLES OF DEFICIENT PROCEDURES/CHECKS

- **Silent unchecked/unverified flap position changes**
- **Redundant checklist items**
- **Single item checklists**
- **Rote reading of checklists**
- **Alternating of pre-flight responsibilities**
- **Repeated use of ambiguous or generic responses**

EXAMPLES OF DEFICIENT PROCEDURES/CHECKS

- **Overtasking First Officers when they are Pilot Flying**
- **Requiring running of checklists while taxiing onto the active runway, rather than completing entire checklist prior to approaching the runway**
- **Inadequate connections between flow patterns and checklists**
- **Not scheduling critical tasks early in the window of opportunity**

CUES, ANCHORS AND CHECKS

- **A CUE is a stimulus that triggers an action (e.g. a wave-off is a cue for the Captain to do something)**
- **ANCHORING is a form of behavioral conditioning and caters to the way the brain works - it connects a stimulus (cue/trigger) with a predictable response**
- **This association is reflexive and not a matter of choice**
- **The stimulus/response behavior becomes more strongly established through repetition**

CUES, ANCHORS AND CHECKS - EXAMPLE

- **A useful anchor is Captain calling for the “Before Taxi Checklist”**
- **By tying the killer item (set the flaps) to this call we can take advantage of the way humans naturally develop and reinforce habit patterns**
- **The anchored command is thus: “Flaps One, Before Taxi Checklist”**
- **Net result is a very high likelihood of a stable state**

CUES, ANCHORS AND CHECKS

- **Much has been written about checklist design and implementation**
- **Publications by HF experts such as Reason, Degani and Wiener are amongst the most often cited**
- **Industry has not adequately integrated their observations and recommendations into cockpit SOPs**
- **Many still cling to the ‘bad apple’ theory of human error.**

MITIGATING HUMAN VULNERABILITIES

- **Some things airlines can do (training, education, etc.)**
- **Some things line pilots can do (be methodical, don't rush, etc..), but**
- **The big payoff will be achieved through industry collaboration to develop best practice procedures that are strongly informed by HF expertise, then integrating them with the operation**
- **These best practice procedures will enable a robust AFOS to be scaffolded around them**

INDUSTRY COLLABORATION –THE STAKEHOLDERS

- **Airlines**
- **Pilot associations**
- **Aircraft manufacturers**
- **HF Experts (NASA and Academia)**
- **Regulators**
- **Government agencies**
- **Existing collaborative groups (CAST, JIMDAT, ASIAS, etc.)**

THE STAKEHOLDERS - AIRLINES

- **May be reluctant participants in this endeavor**
- **Many carriers employ HF experts; influence rarely extends beyond CRM programs**
- **Procedures development typically left to fleet captains or instructors**
- **Commercial pressures often dominate; production-protection balance is easily skewed**
- **Most airlines feel their existing operational procedures are adequate, and they rarely collaborate.**

THE STAKEHOLDERS – PILOT ASSOCIATIONS

- **Likely to favor initiatives which attempt to better match operational demands with human capabilities**
- **Line pilots are weary of trying to resolve problems that have been "designed into" their operating environment.**

THE STAKEHOLDERS – MANUFACTURERS

- **Produce recommended procedures and checklists**
- **Typically generic but, if followed, will usually keep airplanes out of trouble**
- **Can often claim that had the crew followed approved procedures a particular accident would not have occurred**
- **But still don’t like to see their products wrecked.**

THE STAKEHOLDERS – HF EXPERTS (NASA AND ACADEMIA)

- **Participation pivotal; much research already completed**
- ***"If the error rate is to be reduced, it is important to identify the causal or contributing factors that led to the commission of the error. ……The objective ….would be to re-evaluate the procedural requirement to determine if it contributed to the error."*** ***(Degani/Wiener 1990)***

THE STAKEHOLDERS – HF EXPERTS (NASA AND ACADEMIA)

- ***"Checklists conducted during periods of heavy workload are more subject to error. A company required procedure, though needed, may be ill placed, ill timed, or be so cumbersome that when interjected into a heavy workload environment, e.g., during ground taxi operation, it may potentially become a distraction."*** *(Degani/Wiener 1990)*
- **Many findings yet to be adopted**
- **Should be eager participants in any collaborative effort to improve flight operating systems.**

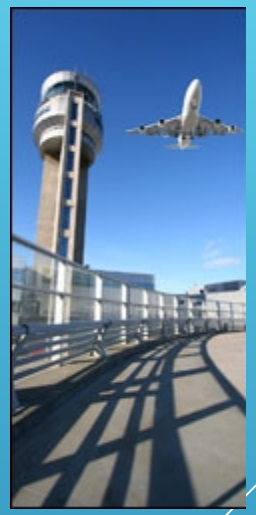
THE STAKEHOLDERS – GOVERNMENT AGENCIES (FAA)

- **Has funded research and produced ample guidance on SOP and checklist design (eg AC120-71a)**
- **Often endorse the need for increased HF focus, but**
- **Give much latitude to POI**
- **Recent SAFO on criticality of flap configuration reflects ‘bad apple’ failure-to-comply mentality**

THE STAKEHOLDERS – GOVERNMENT AGENCIES (NTSB)

- **NTSB identified deficiencies in standard operating procedures as contributing causal factors in numerous accidents**
- **Pilot noncompliance with procedures is commonly cited**
- **Many recommendations to FAA concerning development of SOPs and the requirement for flight crew adherence**
- **Had the NTSB dug deeper into noncompliance and been more specific in their recommendations then more progress could have been made.**

THE STAKEHOLDERS – COLLABORATIVE INDUSTRY GROUPS –COMMERCIAL AVIATION SAFETY TEAM



- **CAST founded1998 with goal to reduce US commercial aviation fatality risk by 80 % by 2007**
- **Broad membership**
- **2007 report: US commercial fatality risk reduced 83 %**
- **Transitioning to prognostic safety analysis**
- **Aim of reducing the U.S. commercial fatality risk by another 50 % from 2010 to 2025**
- **Many CAST Safety Enhancements globally applicable.**

THE STAKEHOLDERS – COLLABORATIVE INDUSTRY GROUPS –ASIAS

- **Aviation Safety Information Analysis and Sharing program**
- **Connects multiple safety data and information sources**
- **Works with CAST to monitor known risks, evaluate deployed mitigations, and detect emerging risks**
- **Can leverage voluntarily provided safety data representing 99 percent of U.S. air carrier commercial operations**
- **From ASIAS analysis Safety Enhancements are developed by CAST and voluntarily implemented by its community.**

THE STAKEHOLDERS – COLLABORATIVE INDUSTRY GROUPS – JIMDAT

- **Joint Implementation Measurement Data Analysis Team (JIMDAT)**
- **Oversees CAST master safety plan**
- **Monitors the implementation and effectiveness of the safety enhancements, and recommends modifications and changes to CAST's safety portfolio**
- **With ASIAS, JIMDAT identifies gaps and emerging risks and additional areas of study**
- **JIMDAT is preferred forum to progress HF-centered procedures development and next-generation AFOS.**

TOWARDS A NEXT GENERATION AFOS - SUMMARY

- **Data reveals industry problem with adherence to procedures: bad apples or bad procedures?**
- **Pilots sometimes inexplicably get it wrong**
- **Performing concurrent tasks frequently leads to errors**
- **Until now, HF knowledge has not been well integrated**
- **Procedures and checklists developed by manufacturers tend to assume a ‘perfect world’**

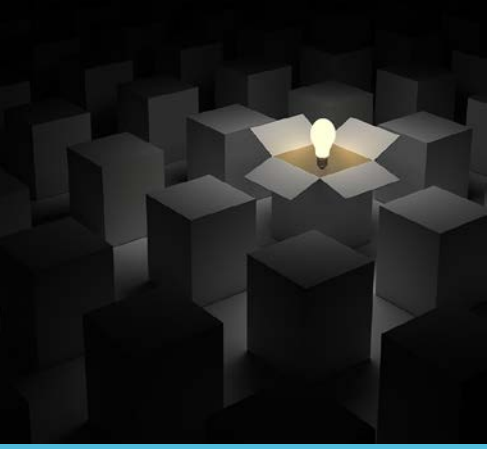
TOWARDS A NEXT GENERATION AFOS - SUMMARY

- **Most airline training assumes predictability unachievable in dynamic line operations**
- **Few airlines have the in-house knowledge to develop robust flight ops procedures. HF expertise is essential**
- **Most airlines have not allocated the resources to intelligently develop procedures that account for known human capabilities**
- **Commercial and other pressures often trump common-sense/HF-centered cockpit operating procedures, creating distractions and interruptions.**

TOWARDS A NEXT GENERATION AFOS - SUMMARY

- **Most airlines believe their own flight operations procedures are superior**
- **Collaborative industry approach needed to develop and implement best practice procedures**
- **Mechanisms to address this issue already exist**
- **In US the CAST/JIMDAT arena offers the most logical forum to develop best practice procedures**

TOWARDS A NEXT GENERATION AFOS



- ***"There is no quick safety fix…..for systems that pursue multiple competing goals in a resource-constrained, uncertain world. There is, however, percentage in opening the black box of human performance – understanding how people make the systems they operate so successful, and capturing the patterns by which their successes are defeated."*** ***Sidney Dekker***

QUESTIONS?