HUMAN FACTORS
BEYOND THE SLOGAN

4º Simpósio de Segurança de Voo (SSV)
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O VALOR DE PROJETO
CONSIDERAÇÕES HF DE PROJETO

Guiding Principles

- Minimize human error
- Increase error tolerance
- Avoid excess complexity
- Evaluate new technology or operational changes for effect on human performance

PRINCÍPIOS DE PROJETO

SYSTEM SAFETY ORDER OF PRECEDENCE

1. Design for Minimum Risk
2. Incorporate Safety Devices (Protect)
3. Provide Warning Devices (Notify)
4. Develop Procedures and Training

(FAA Handbook of System Safety, 2000)
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PROJETO PARA RISCO MÍNIMO

- **Status** of configuration or parameters
  - **Patterns** of color or switch position
  - Absence of indication is difficult to notice (absence of green)

- **Consistent** flight deck
  - Philosophy “Dark, Quiet”
  - Control knobs – direction of movement
  - Flow of checklist matches panel design

- **Prevent** Ability for Operator to Committ Error
  - E.g., Flight Envelope Limiting
August 19, 2005
NWA 74, B747-200
Gear-up landing at Agana, GUAM (GUM)
Panel Design

Multiple Indications of Status of all 5 Gear
- Front Panel: Presence of gear warning illuminated & absence of confirmation
- Landing Gear Aural Tone
- FE Panel: Absence of nose gear down
**PROJETO PARA RISCO MÍNIMO**

- Crew Conducted Checklist 3 Times:
  - "Four Green – Good to go."
  - "All down and locked."

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**Training Fix for Design Limitation**

The Bureau of Air Safety Investigation suggests that operators of Australian registered B747-200 and B747-300 series aircraft consider placing a fine border line around the five landing gear annunciators located on the flight engineer panel to better define the annunciators as a group.
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DISPOSITIVOS DE SEGURANÇA

- **Protect** the Operator from Poor / Inadvertent Actions
- **Extra step** required
- Physical **barrier**
  - E.g., Flight Control Protection
- **Confirmation** required
  - Increase cognizance
  - Purposeful action
DISPOSITIVOS DE SEGURANÇA

- **Incident:** United Air Lines
  - March 31, 1986
  - San Francisco, CA
  - B767-200

- **Incident:** Delta Air Lines
  - June 30, 1987
  - Los Angeles to Cincinnati
  - B767-200

Inadvertent shutoff/deactivation of engines during climb
Engine re-start at low altitude

**Issue:** Inadvertent Activation of Controls
- Electronic Engine Control (EEC) Caution
- Inadvertently activated Engine Start Controls
- Located Side by Side on Pedestal
- How? Controls push-button vs. toggle/lever

**Manufacturer Response:**
- Larger **“Fence”** around engine start buttons
- **Re-design** – Moved EEC to overhead panel

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**DISPOSITIVOS DE AVISO**

- February 12, 2009
- Colgan Air, Inc. Flight 3407
- DHC-8-400 (Bombardier)
- Buffalo, NY
- 50 Fatalities
- Low Airspeed and Stall on Approach
- Unable to Recover
HOT-2: gear’s down.
HOT-1: flaps fifteen before landing checklist.
HOT-2: uhhh.

**Low Speed Awareness Tape**

- Indicates proximity to stall speed (not to exceed low airspeed)
- **Amber/Yellow**: Caution Range
  - Margin above Stick-Shaker
- **Red**: Warning Range
  - V-Shaker and below
  - Top of range is small margin above stall speed
NTSB Conclusions:

- “The Q400 airspeed indicator lacked low-speed awareness features, such as an amber band above the low-speed cue … that would have facilitated the flight crew’s detection of the developing low-speed situation.”

- “An aural warning in advance of the stick shaker would have provided a redundant cue of the visual indication of the rising low-speed cue and might have elicited a timely response from the pilots before the onset of the stick shaker.”
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O Que Nós Podemos Fazer?

AUTOMAÇÃO E CONSIDERAÇÕES DE PROJETO
Flight Deck Automation Problems or Concerns
- Automation-Centered (39.7%)
  - Human-centered design
  - Automation failures
  - Automation authority and levels
- Pilot/Crew and Organization-Centered (57.7%)
  - Role Change and Crew Coordination
  - Training and Use
  - Confidence in use (over/under)
  - Situation and automation awareness
  - Manual skill
  - Workload and focus of attention

Pattern of Automation Accidents and Incidents
- Pilots *do not understand* what the automation is doing (*Automation “Mode” Confusion*)
  - OR
- Pilots *do not receive adequate feedback* from automation

- Dr. Charlie Billings, NASA “Human-Centered Aircraft Automation: A Concept and Guidelines”

Human Factors in Aviation System Engineering
Prof. Katherine Andrea Lemos, Ph.D.
Agosto 2011

Human Factors: Beyond the Slogan
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AUTOMAÇÃO: NTSB GA PILOTOS

“Glass cockpit displays can present more information in the space required for conventional instrument panels, but the increase in information places greater demands on pilot attention and creates a risk of overloading pilots with more information than they can effectively monitor and process.

The complexity of the integrated computerized systems that drive glass cockpit displays may also limit pilots' understanding of the functionality of the underlying systems.”

AUTOMAÇÃO: PILOTOS COMERCIAL

CAST REPORT (2008)

- Fundamental Problems:
  - What is automation doing?
  - How to manipulate to eliminate error?

- Two Root Causes:
  - Training and System Knowledge
  - Incompatibility between:
    - Automation System
    - Flight Regime

- CAST, 2008
AUTOMAÇÃO: EXEMPLOS DE ACIDENTES

Pilot vs. Autopilot

- **China Air Lines A300-600 Flt 140**
  - April 26, 1994
  - Nagoya, Japan
  - 264 fatalities (of 271)

- **Interflug A310**
  - February 11, 1991
  - Moscow, Russia
  - Aircraft recovered (Incident)

AUTOMAÇÃO

- **CAST Recommendations: Guidance and Training**
  - Philosophy and Approach to Use of Automation
  - Maintaining Awareness:
    - Verification
    - Monitoring
    - Communication

- **Most Important Take-Away**
  - “Fly the Airplane”
  - Revert to a more “direct level of automation”
Autoflight Philosophy Statement
ATA Industry Automation Task Force

“Pilots must be thoroughly knowledgeable and proficient in the selection and use of all levels of automation and manual flight.”

“The appropriate use of autoflight systems offers enhanced levels of safety, efficiency, and situation awareness, allowing for optimal time and task management.”

Understanding the FULL FLIGHT REGIME and the skills to address all off the autoflight levels means INCREASED PILOT PROFICIENCY – NOT LESS.
ATENÇÃO

Definitions of Attention and Vigilance:

- **Attention**: The process whereby a person concentrates on some features of the environment to the (relative) exclusion of others.
- **Attention**: The faculty or power of mental concentration.
- **Vigilance**: The process of paying close and continuous attention.

*Vigilance is especially susceptible to fatigue*

- **Watchfulness, Wakefulness, Alertness**

ATENÇÃO

Three attention situations/modes:

- **Selective attention**: Pick one of a variety of stimuli / targets (to the relative exclusion of others).
- **Divided attention**: Attending to multiple targets or carrying out more than one thing at a time.
- **Vigilance**: Attend for a long time at a rare target at unpredictable intervals.
Arousal/Stress and Vigilance:

- Arousal influences attention and performance.
  - Yerkes-Dodson Law: Poor performance for low and high arousal
  - Depends on complexity of task

Potential Solution: “Adaptive Automation”

- Redefine assignment of tasks: “integrated approach”
- Goal: Maximize benefits of both human and automation
- Increases human engagement (Parasuraman)

Periodic manual control

- Pre-set intervals
- Or “Neuroergonomics”
The airworthiness “fit” in the context of operational approval – like a propeller blade

- **Design Criteria**
- **Operational Procedures and Standards**
- **Air Traffic**
- **Equipment / System Standards**

**SISTEMA AVIAÇÃO: HELMRIECH**

- Regulatory Environment
- Organizational Environment
  - “Corporate Culture”
- Physical Environment
- Crew

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