Joint Session

Top-Down Safety Focus: Fatigue Risk Management Systems (FRMS)

Fatigue Risk Management Systems within SMS

R. Curtis Graeber, Ph.D.
Boeing Commercial Airplanes

13:10 - 13:30

June 17, 2008

Presented at the FAA Fatigue Management Symposium: Partnerships for Solutions; Vienna, VA: June 17-19, 2008

R. Curtis Graeber, Ph.D.
Biography

Curt Graeber is a Boeing Senior Technical Fellow and serves as the Chief Engineer for Human Factors and Director of Regional Safety Programs at Commercial Airplanes. He holds a PhD in Neuropsychology from the University of Virginia and has served in several management positions in research, airplane design, and safety at Boeing. Dr. Graeber currently leads Boeing's efforts to improve Regional Safety including industry implementation of the Global Aviation Safety Roadmap which he co-authored as a member of the Industry Safety Strategy Group. Before joining Boeing he led the flight crew fatigue research program at NASA's Ames Research Center and served as Chief of Flight Human Factors. His seminal research on crew fatigue has formed the basis for much of the recent progress in addressing fatigue risk management in aviation. He has authored over 100 scientific and technical articles, and is a Fellow of the Royal Aeronautical Society and the Aerospace Medical Association. He also served as the Human Factors Specialist for the Presidential Commission on the Space Shuttle Challenger Accident.

Curt chairs the Flight Safety Foundation's "think tank" (the Icarus Committee), FSF's Ultra Long-Range Crew Alertness Initiative, and the ICAO Operations Panel's Fatigue Risk Management Subgroup. His safety related awards include the Guild of Air Pilots and Air Navigators' "Cumberbatch Trophy", the Aerospace Medical Association's Boothby-Edwards Award, the International Federation of Airworthiness "Whittle Safety Award", an *Aviation Week & Space Technology* "Laurel" (1999), and the FSF-Airbus Human Factors Award for 2006. He also serves as a Visiting Professor at the Cranfield University College of Aeronautics.

Fatigue Risk Management Systems within SMS

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Agenda

- Today's Situation
- Some Basic Facts
- Enabling Fatigue Risk Management
- Integrating FRM into SMS
- Alertness Management
- Conclusions

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Today's Situation

- Fatigue related accidents and incidents
- Fifty year old flight time limitations without scientific basis
- Unsuccessful attempts to set new limits
- Inability to address key alertness factors
- Exemptions for unanticipated operational situations
- No worldwide standards enabling fair competition
- Over 25 years of scientific results awaiting application
- Other countries embarking on FRMS

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Alone, Rx Duty Times Do Not Manage Fatigue Risk

Performance Factors:

- Differing ability to adapt to sleep/wake changes
- Poor ability to assess own alertness & performance
- Differences in "susceptibility" to fatigue

Key Alertness Factors;

- Multiple time zones
- Night work/shift work
- Sleep at inappropriate circadian times
- Effects of sunlight, caffeine, drugs, etc.

Operational Factors:

- Unexpected ops demands
- Novel ops not fitting within existing prescriptions
- Do not assess fatigue related safety risk levels

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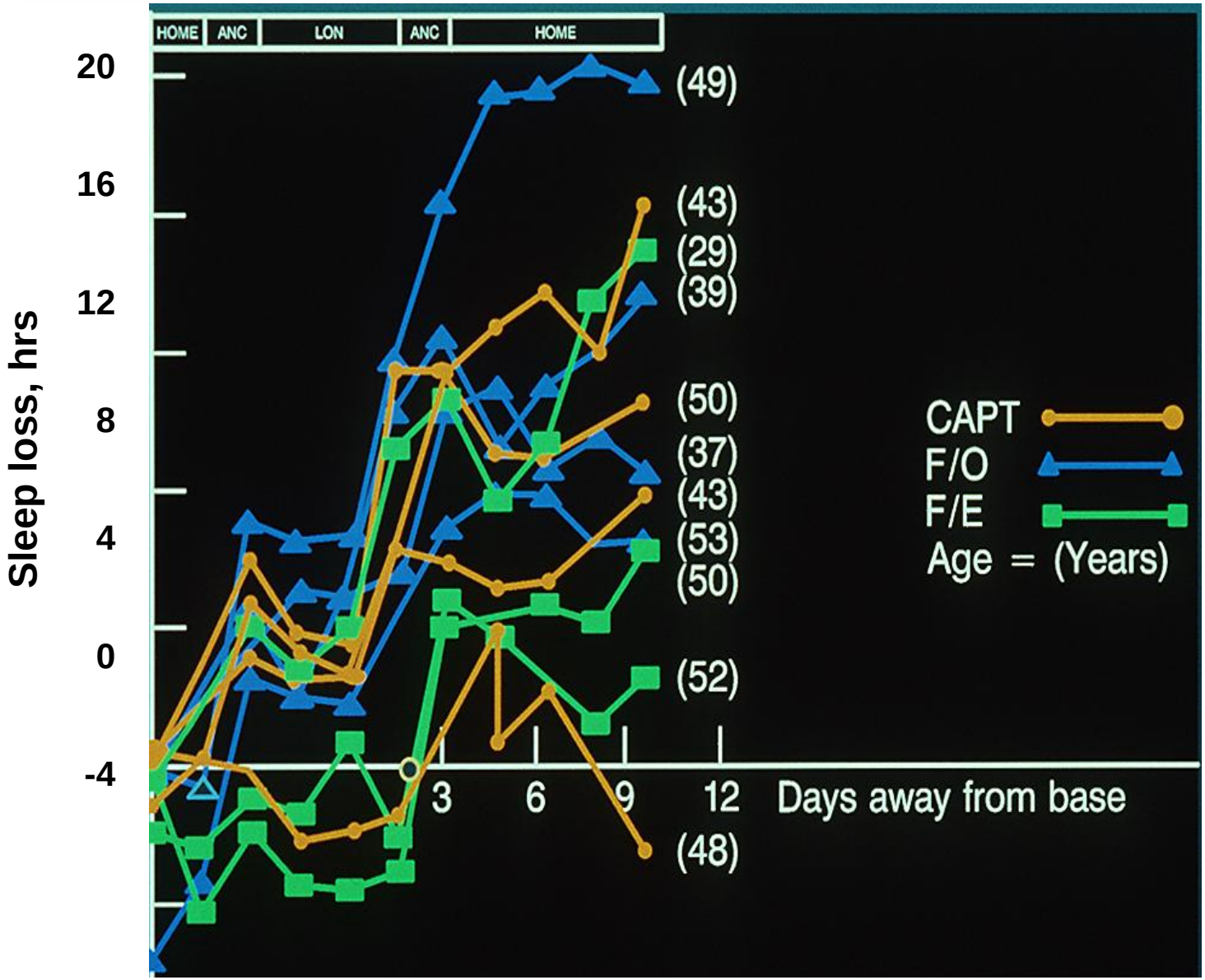
Basic Fact: Sleep Differs Among Pilots



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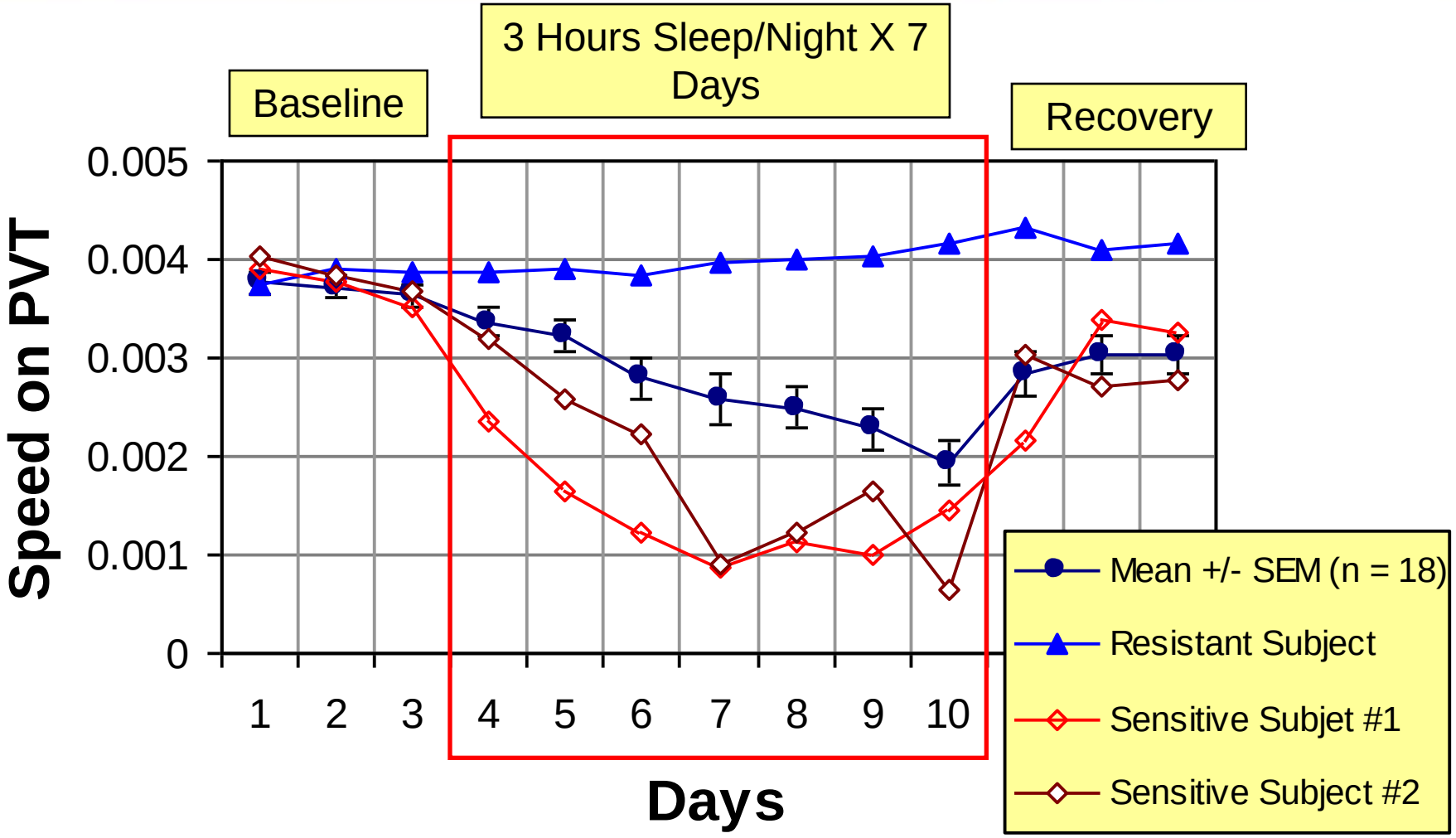
Basic Fact: Individuals' Performance Differs



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Belenky et al, J. Sleep Res. 2003

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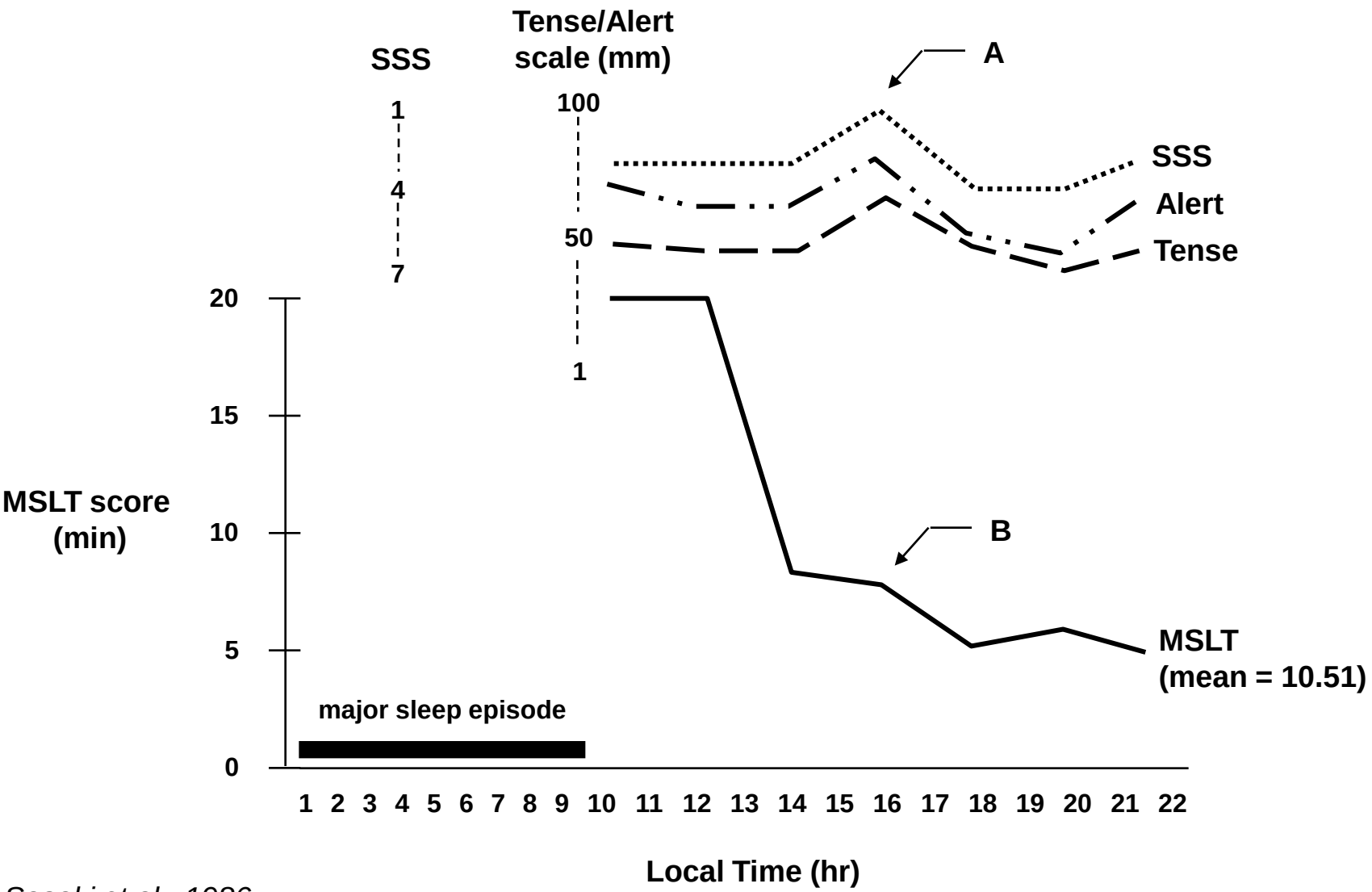
Basic Fact: Pilots Are Poor Estimators of Own Alertness



Sasaki et al., 1986

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What Has Enabled Fatigue Risk Management?

Two Decades of Evolutionary Change

- Worldwide adoption of SMS
- Commitment to “just culture” enabling:
  - Non-jeopardy incident reporting (e.g., ASAP)
  - Flight Data Monitoring (FOQA)
- Scientific studies on sleep, fatigue and performance
- Computer modeling capability
- Digital, portable technology to collect data
- Recent development of ULR operations

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Miniaturized Portable Digital Recording Devices

Psychomotor Vigilance Task

Solid State EEG

Actigraph

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Flight Data Recorders

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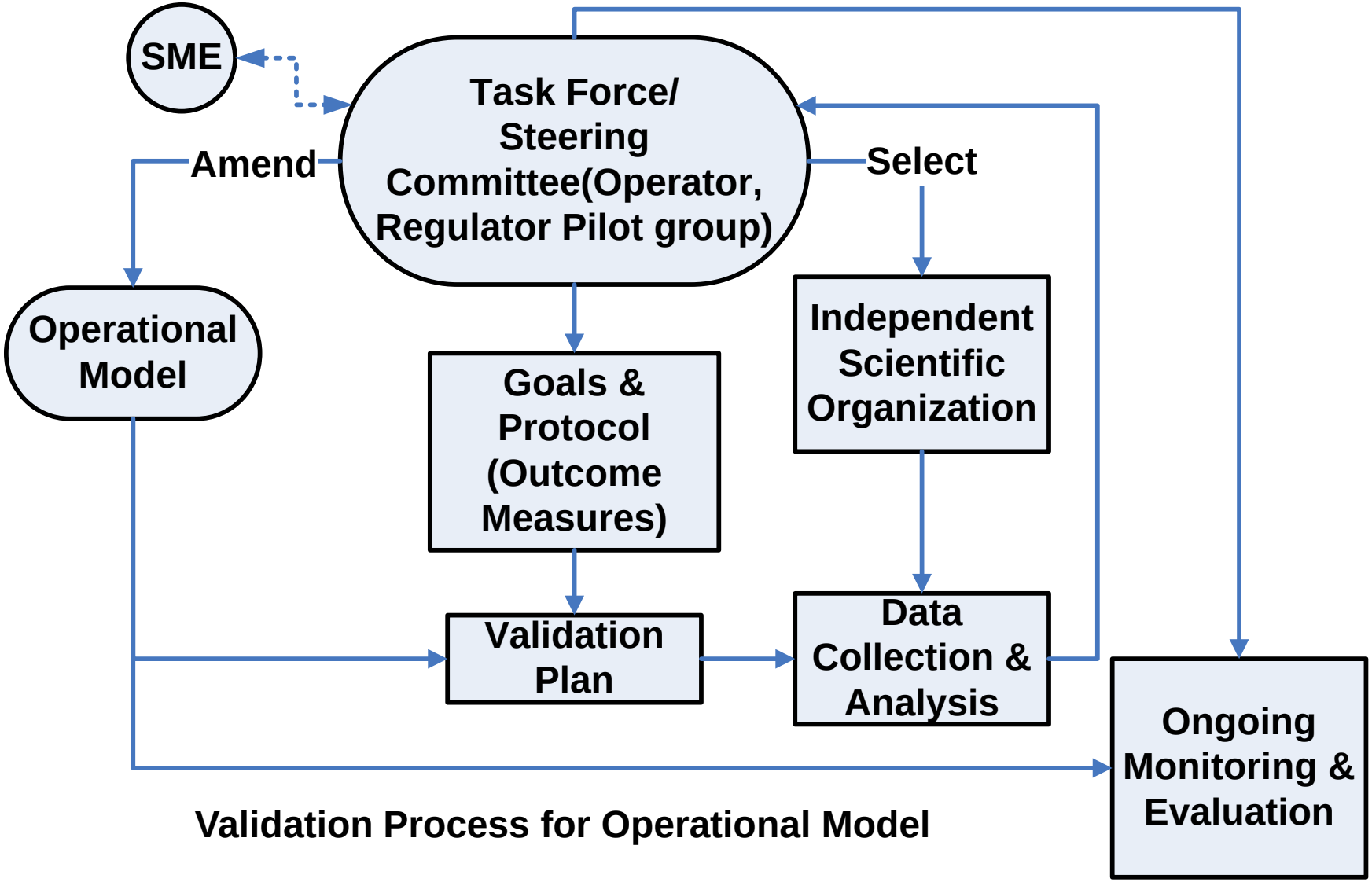
ULR Initiative: A Precursor to FRMS



Validation Process for Operational Model

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Fatigue Risk Management – Annex 6 SARP

Draft Definitions

Fatigue Risk Management

- The management of fatigue in a manner appropriate to the level of risk exposure and the nature of the operation, in order to minimize the adverse effects of fatigue on the safety of operations.

Fatigue Risk Management System

- A scientifically-based, data-driven flexible alternative to prescriptive flight and duty time limitations that forms part of an operator's Safety Management System and involves a continuous process of monitoring and managing fatigue risk.

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FRMS and SMS Share Fundamental Concepts

FRMS Characteristics

- Should be an integral part of an established SMS.
- Applies SMS principles and processes to proactively identify and continuously manage fatigue safety risk.
  - Uses data driven systems designed to identify risks.
  - Implements multi-layered defenses to manage risk.
  - Requires shared responsibility among management and employees.
- Can provide an alternative to prescriptive duty limits and can enhance safety within prescriptive rules.
- Enables equivalent safety with more operational flexibility.
- Functions within a regulatory oversight framework.

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FRMS Major Structural Elements

- **Fatigue Risk Management Policy (FRMP).**
  - Establishes commitment of senior management to the general philosophy and goals of the operator's FRMS.
  - Defines management and employee responsibilities at all levels for the elements of the FRMS.
- **Fatigue Management Steering Group (FMSG).**
  - Coordinates all fatigue management activities (e.g., SOP recommendations, rostering, data collection & analysis).
  - Includes all stakeholders, including those with scientific, data analysis, operational and medical expertise.
- **Sleep/Fatigue Awareness and Countermeasure Training**
  - Educates relevant staff about sleep and performance.

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FRMS Structure

Safety Management System
- Based on a just culture
- Collaborative
- Proactive

Fatigue Risk Management System

Fatigue Risk Management Policy

Fatigue Management Steering Committee

Education and Training Programs

Inputs Initiated by Others
- Fatigue-related incident reports
- Voluntary reports of crew fatigue
- Other fatigue-related crew reports
- Internal audit reports

Outputs/Activities
- Monitor fatigue information and identify trends
- Establish triggers for action
- Propose, implement and monitor fatigue-reduction strategies
- Assess new rosters/operations
- Keep higher management and work force fully informed

Inputs Initiated by the FMSC
- Planned versus actual work
- Roster modeling
- Fatigue-data acquisition
- Objective flight data
- Audit of unplanned events
- Tracking of absenteeism

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SMS Principles Embedded in FRMS:

ICAO's 10 Steps to SMS:	***Essential FRMS Elements:***
1. Planning	• **Non-punitive Fatigue Risk Management Policy** • **"Just Culture"**
2. Senior Management Commitment	
3. Organization	• **Fatigue Management Steering Group**
4. Hazard Identification	• **Fatigue Risk Assessment Tools** • **Crew Fatigue Reporting** • **Employee Communication Channels for Feedback**
5. Risk Management	• **Strategic, Scientifically-Driven Crew Scheduling** • **Validated, Timely Fatigue Mitigation Strategies** • **Data driven processes for monitoring alertness**
6. Investigation Capability	• **Procedures to Investigate and Record Fatigue Related Incidents**
7. Safety Analysis Capability	• **Data Collection & Assessment**
8. Safety Promotion & Training	• **Education and Awareness Training Programs**
9. Safety Management Documentation	• **Documented SOPs for FRMS Implementation**
10. Oversight and Performance Monitoring	• **Operator Internal Audit Program** • **FRMS Validation Program** • **Safety Performance Measurement**

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FRM = Alertness Management

- We cannot measure fatigue, we can only measure decrements in alertness
- FRMS Scheduling and Rostering tools are only one mitigation strategy
- FRM applies any mitigation tools that can help sustain alertness in support of safe operations
- Other mitigation techniques can include:
  - Lifestyle behaviors – exercise, diet, sleep habits, etc.
  - Equipment design
  - Use of mild stimulants
  - Preplanned in-flight rest

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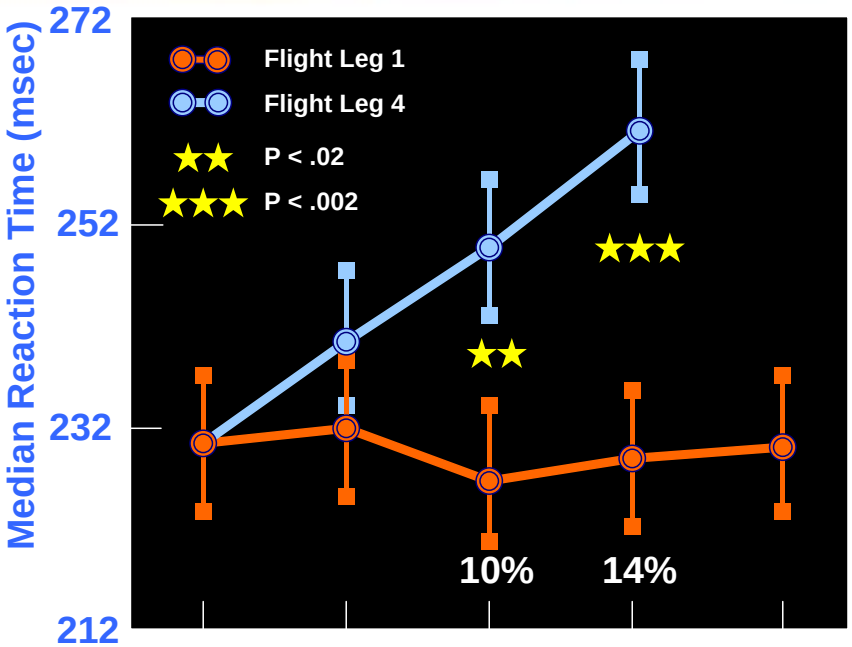
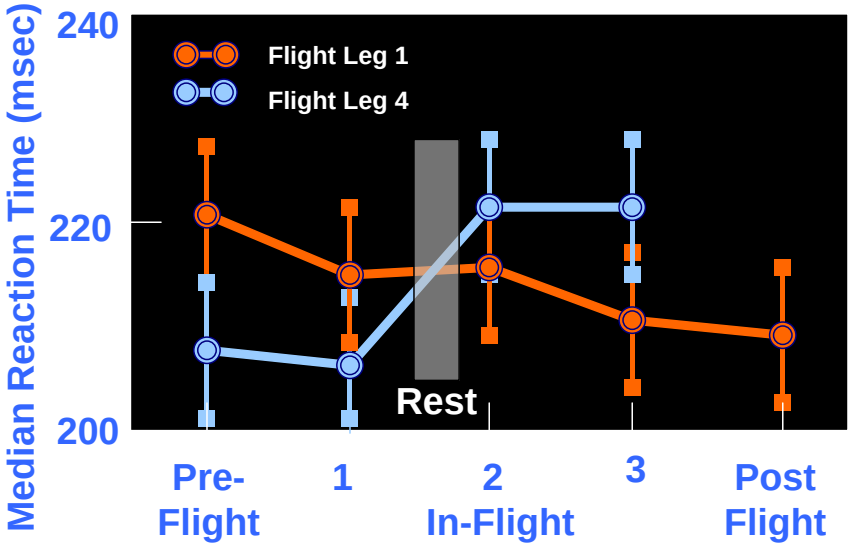
Cockpit Rest Improves Psychomotor Performance

Non-Rested



Rested



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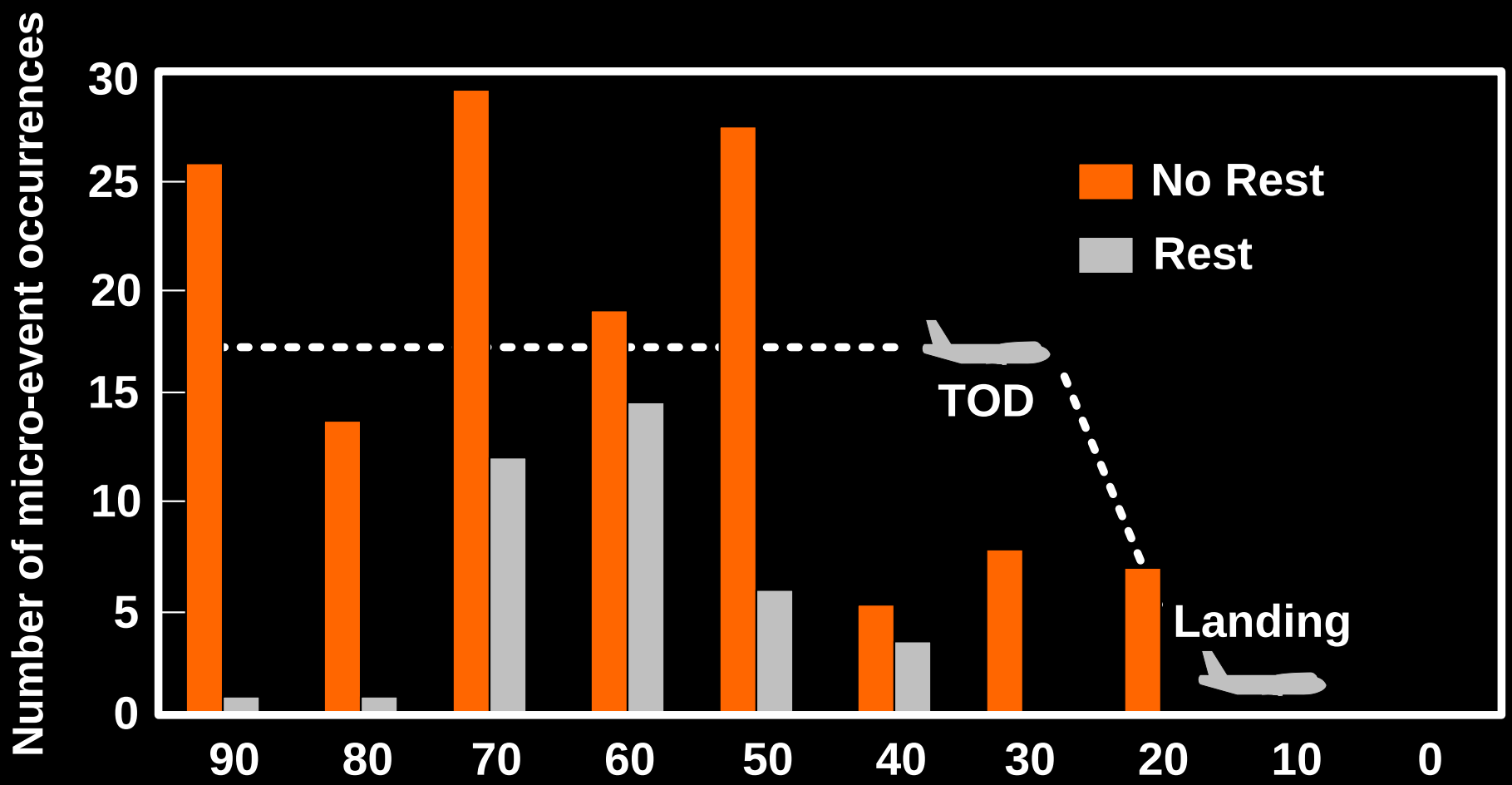
Cockpit Rest Improves EEG Indicated Alertness



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Regulatory Approval of Preplanned Controlled Rest

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Conclusions

- Prescriptive limits are not based on science, are inadequate safeguards, and can be too restrictive.
- FRM is valid, scientifically based, and can manage fatigue risks for all critical aviation domains.
- FRMS can address variables not addressed by limits and can be readily integrated into SMS.
- FRMS is one of several tools for mitigating alertness decrements.

We have the science, the tools and the systematic framework to address the issue.

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NASA Ames and Pan AM - Bombay 1982