

# Fatigue Management from a Pilot's Perspective



**Capt. German Diaz-Barriga Martinez.**

# Charles A. Lindbergh

“The nose is down, the wing low, the plane is diving and turning. I've been asleep with open eyes... I kick left rudder and pull the stick back... My eyes jump to the altimeter...I'm at 1600 feet. The turn-indicator leans over the left - the airspeed drops - the ball rolls quickly to the side...My plane is getting out of control!”

# Is Fatigue a Concern in Flight Operations?

- Incidents
  - About 20 percent of reported incidents to NASA Aviation Safety Reporting System (ASRS) mention factors that are fatigue-related
- Accidents
  - Hard to document, but NTSB cited fatigue as a factor in 1993 DC8 accident
  - American 1420 at Little Rock
  - Colgan Air
- Research

# Can we measure fatigue ?

- Fatigue, per se, can not be measured.
- Alertness and degradation to alertness, on the other hand, can be measured, by response time in visual watchfulness, complex reactions and lost reactions
- They can be compared to:
  - Blood alcohol content
  - Karolinska scale of sleep
  - Samn-Perelli fatigue scale.

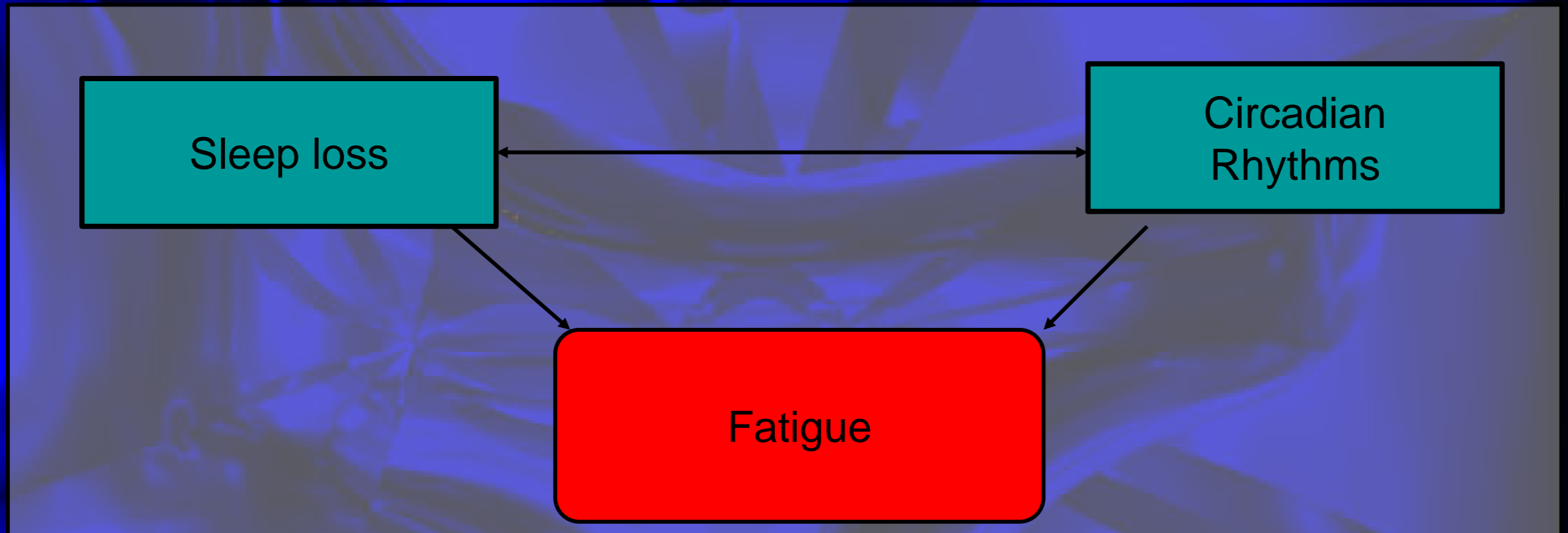
# NASA Fatigue Countermeasures Program

- Since 1980, research on fatigue, sleep, and circadian rhythms
  - evaluated over 500 pilot volunteers
  - line operations, simulations, laboratory
- Now providing feedback to the aviation industry
  - “Alertness Management in Flight Operations”

# Primary Physiological Causes of Fatigue

- Sleep loss
- Circadian rhythm disruption

# Fatigue's affect on operations



Effects of fatigue  
in aviation operations

# Sleep and Sleep Loss

# Charles A. Lindbergh

“My mind clicks on and off... I try letting one eyelid close at a time when I prop the other open with my will. But the effort's too much. Sleep is winning. My whole body argues dully that nothing, nothing life can attain is quite so desirable as sleep. My mind is losing resolution and control.”

# What Research Shows

- Sleep is a vital physiological function
- Sleep loss is cumulative
- Sleep loss and sleepiness can degrade essentially every aspect of human performance

Sleepiness should be taken seriously

# Sleep loss can affect performance like alcohol

- After being awake for 18 hours, mental and physical performance on many tasks can be like having a blood-alcohol content (BAC) of 0.05.
- After being awake for 23 continuous hours, people perform as badly as people who have a BAC of 0.12.
  - Dawson and Reid, as reported in Reason's "Managing Maintenance Error."
  - BAC = Blood Alcohol Content

# BAC Chart

# Drinks in 1 Hour	Body Weight in US Pounds								Individual percentages may vary. Based on .08% legal Blood Alcohol limit
	100	120	140	160	180	200	220	240	
1	.03	.02	.02	.01	.01	.01	.01	.01	<b>.00% - .03%</b> <b>Drive With Caution</b>
2	.07	.06	.05	.04	.03	.03	.03	.02	
3	.12	.10	.08	.07	.06	.05	.05	.04	<b>.04% - .07%</b> <b>Driving Impaired</b>
4	.16	.13	.11	.10	.08	.07	.07	.06	
5	.20	.17	.14	.12	.11	.10	.09	.08	<b>.08% and UP</b> <b>Intoxicated!</b>
6	.25	.21	.17	.15	.13	.12	.11	.10	
7	.29	.24	.21	.18	.16	.14	.13	.11	

# In Mexico

- El Artículo 100 del Reglamento de Tránsito del Distrito Federal, establece que "ninguna persona podrá conducir vehículos por la vía pública si tiene una cantidad de alcohol en la sangre superior a 0.8 gramos por litro, o de alcohol en aire expirado superior a 0.4 miligramos por litro.

# How Sleepy Are You?

- It is difficult for most people to accurately estimate their own fatigue level and alertness
  - It may actually be worse than you think

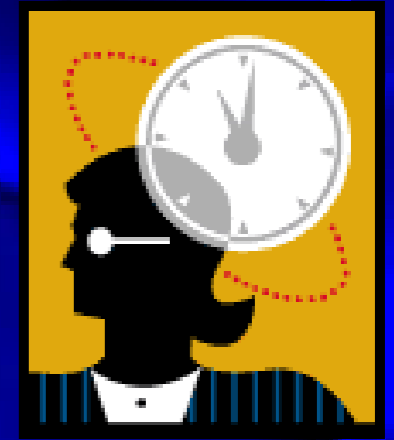
# Sleep Changes with Age

- Amount of sleep and structure of sleep change as a person gets older
  - Less deep sleep, and more disrupted sleep
  - Daily percentage sleep loss is 3.5 times greater in long-haul pilots aged 50-60, compared than pilots aged 20-30

# Quality versus Quantity

- 8 hours of disrupted sleep can be like getting very little sleep

# The “Body Clock”



- Programmed for two times of maximal sleepiness during a 24-hour period
  - 3-5 AM and 3-5 PM
- Performance and alertness can also be decreased
  - 2 AM to 6 AM

# According to NASA

- "Sleep loss and sleepiness can decrease physical, psychomotor, and mental performance, and negative mood can increase and positive mood can decrease"
- "It can lead to a reduced safety margin and increased potential for operational incidents and accidents."

# Alertness Management Strategies

What crews can do to minimize the effects of  
fatigue

**Go to FSF AeroSafety World**

## Fatigue Countermeasures in Aviation

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tigue countermeasures in aviation. Aviat Space Environ Med* 2009;  
80:29-59.

Pilot fatigue is a significant problem in modern aviation operations, largely because of the unpredictable work hours, long duty periods, circadian disruptions, and insufficient sleep that are commonplace in both civilian and military flight operations. The full impact of fatigue is often underappreciated, but many of its deleterious effects have long been known. Compared to people who are well-rested, people who are sleep deprived think and move more slowly, make more mistakes, and have memory difficulties. These negative effects may and do lead to aviation errors and accidents. In the 1930s, flight time limitations, suggested lay-over durations, and aircrew sleep recommendations were developed in an attempt to mitigate aircrew fatigue. Unfortunately, there have been few changes to aircrew scheduling provisions and flight time limitations since the time they were first introduced, despite evidence that updates are needed. Although the scientific understanding of fatigue, sleep, shift work, and circadian physiology has advanced significantly over the past several decades, current regulations and industry practices have in large part failed to adequately incorporate the new knowledge. Thus, the problem of pilot fatigue has steadily increased along with fatigue-related concerns over air safety. Accident statistics, reports from pilots themselves, and operational flight studies all show that fatigue is a growing concern within aviation operations. This position paper reviews the relevant scientific literature, summarizes applicable U.S. civilian and military flight regulations, evaluates various in-flight and pre-/postflight fatigue countermeasures, and describes emerging technologies for detecting and countering fatigue. Following the discussion of each major issue, position statements address ways to deal with fatigue in specific contexts with the goal of using current scientific knowledge to update policy and provide tools and techniques for improving air safety.

**Keywords:** alertness, sleep, hypnotics, stimulants, flight time regulations, duty time regulations, sustained operations.

### FATIGUE COUNTERMEASURES IN AVIATION: OUTLINE OF CONTENTS

- I. Description of the Problem
- II. Current Regulations, Practices, and an Alternative Approach
  - a. Crew Rest Guidelines
  - b. Flight and Duty Time Guidelines
  - c. Fatigue Risk Management System (FRMS): An Alternative Regulatory Approach
  - d. Ultra-Long-Range Flights: A Nontraditional Approach

*Position Statement on Crew Rest, Flight, and Duty Time Regulations*
- III. In-Flight Countermeasures and Strategies
  - a. Cockpit Napping
  - b. Activity Breaks
  - c. Bunk Sleep
  - d. In-Flight Rostering
  - e. Cockpit Lighting

*Position Statement on the Use of In-Flight Countermeasures*
- IV. Pre-/Postflight Countermeasures and Strategies
  - a. Hypnotics
  - b. Improving Sleep and Alertness
    - i. Healthy Sleep Practices
    - ii. Napping
    - iii. Circadian Adjustment
    - iv. Exercise
    - v. Nutrition
  - c. Non-FDA-Regulated Substances

*Position Statement on Improving Sleep and Alertness*  
*Position Statement on Non-FDA-Regulated Substances*
- V. New Technologies
  - a. On-Line, Real-Time Assessment
  - b. Off-Line Fatigue Prediction Algorithms

*Position Statement on New Technologies*
- VI. Military Aviation
  - a. Relevant Regulations and Policies
  - b. Crew Rest and Duty Limitations
  - c. Stimulants/Wake Promoters
  - d. Sleep-Inducing Agents

*Position Statement on the Use of Stimulants to Sustain Flight Performance*  
*Position Statement on the Military Use of Sleep-Inducing Agents*
- VII. Conclusions and Recommendations

### I. DESCRIPTION OF THE PROBLEM

Pilot fatigue is a significant problem in modern aviation operations, largely because of the unpredictable work hours, long duty periods, circadian disruptions,

This Position Paper was adopted by the Aerospace Medical Association. It was prepared by a special subcommittee of the Aerospace Human Factors Committee chaired by Dr. David Neri and consisting of the authors. The paper is intended to review the relevant literature, describe fatigue-related issues and challenges, summarize applicable regulations, and present the Association's position with respect to fatigue countermeasures.

This manuscript was received and accepted for publication in September 2008.

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# Alertness Management Strategies

- Preventive strategies
  - Used before duty and on layovers to reduce adverse effects of fatigue, sleep loss, and circadian disruption
- Operational strategies
  - Used in-flight to maintain alertness and performance

# Preventive Strategies

- Begin a trip as rested as possible
- At home
  - Maximize sleep 1-2 days before departing on trip
- Layovers, too
- Strategic napping can be very effective
  - 45 minutes or less, if just before duty

# Preventive Strategies

- Alcohol consumption can have “major disruptive effects” on sleep quality
- Exercise regularly, but avoid just before bedtime
- If you can't fall asleep in 30 minutes, get up and engage in some relaxing activity
  - Don't just lay in bed and be frustrated

# Operational Strategies

- Strategic caffeine consumption
  - Best not to constantly drink caffeine before, during and after duty
  - Use it to best increase alertness
  - Don't use it when already alert (start of duty or after a nap)
  - Avoid caffeine near bedtime
- Sensible nutrition and stay hydrated

# Know your Caffeine Content

## 8-Ounce Coffee Beverage

– Instant	25 – 102 milligrams
– Drip	115 – 250
– Brewed	80 – 135
– Espresso (4 ounce)	120 - 200
– Decaf	2 – 10

## 8-Ounce Tea Beverage

– Instant	15 – 30
– Brewed	25 - 83
– Iced Tea	10 – 50
– Decaf	1 - 5



Source: NBAA "Alert"

# Know your Caffeine Content

## 12-Ounce Soft Drinks

– Cola	35 - 47 milligrams
– Orange Soda	40
– Mountain Dew	55
– Jolt	71

## Food

– Frozen Desserts	8 - 85
– Chocolate	5 - 31
– Yogurt	1 - 45



Source: NBAA "Air

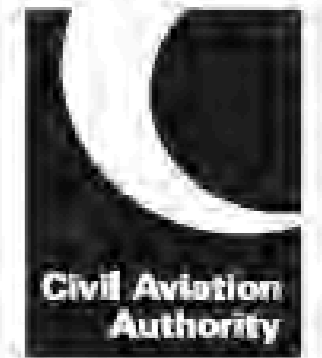
# Stay Active In-flight

- Engage in conversations with other crewmembers
- Frequent stretching helps, too

# NASA Recommends

- Sleepiness can have severe consequences
  - take it seriously
- People are different - **tailor this information to your own needs**
- There is no one single answer - find out what works for you

Safety Regulation Group



CAA PAPER 2005/04

Aircrew Fatigue: A Review of Research Undertaken on Behalf of the UK Civil Aviation Authority

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# ICAO Annex 6 Operation of Aircraft

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*Fatigue.* A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness and/or physical activity that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety related duties.

*Fatiga.* Estado fisiológico de capacidad reducida de desempeño mental o físico resultado de la perdida de sueño o vigilia de sueño extendida y/o actividad física que puede deteriorar la vigilancia y habilidad de operar una aeronave o desempeñar trabajos relacionados a la seguridad de un tripulante

# ICAO Annex 6 Operation of Aircraft

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- 9.6 Flight time, flight duty periods, duty periods and rest periods for fatigue management
  - For the purpose of managing fatigue, the State of the Operator shall establish regulations specifying the limitations applicable to the flight time, flight duty periods, duty periods and rest periods for flight crew members. These regulations shall be based upon scientific principles and knowledge, where available, with the aim of ensuring that flight crew members are performing at an adequate level of alertness.



## **FAA's Airline Safety and Pilot Training Action Plan**

**June 24, 2009**

### **Immediate and Short Term Action Items (June-July 2009)**

**Fatigue Rulemaking:** By July 15, FAA will charter an aviation rulemaking committee (ARC) consisting of representatives from FAA, industry and labor organizations. The ARC will have until September 1, 2009, to draft recommendations to the FAA which would inform a new, science-based notice of proposed rulemaking (NPRM) on flight and rest limits.

**Focused Inspection Initiative:** Recognizing the urgency of proposals in the Call to Action, FAA has reordered priorities contained in a prior June 16 Notice to FAA inspectors and is directing that a focused program review of air carrier flight crewmember training, qualification, and management be completed sooner. This notice will be published by June 24.



# Aviation Rulemaking Committee



# Beyond ARC – EASA- CAP 371.....

- FRMS- should be implemented
- ULR flights
  - Must develop a process for a “Basic” and “mature FRMS
  - Should develop a Central FRMS office
- Advisory Circulars
  - FRMS
  - Flight Crew Rest Facilities

# Fatigue Risk Management-en Español

- Fatigue Risk Management: Un método de administración empresarial de la fatiga que incluya proceso de medición , mitigación y gestión del riesgo de la fatiga
- FRMS: Un sistema de gestión basado en evidencia para el control del riesgo de fatiga

# FRMS ¿Qué hay de nuevo?

## FATIGUE RISK MANAGEMENT SYSTEM (FRMS) IMPLEMENTATION GUIDE FOR OPERATORS



### EXECUTIVE LETTER

Dear Colleagues,

Air travel continues to be the safest means of transportation, but that does not allow for us to become complacent. We continually strive for improvements in our industry safety record, which is a testament to our ongoing commitment to safety.

Fatigue Risk Management Systems (FRMS) continues the move from prescriptive to performance based regulatory oversight. As in Safety Management Systems (SMS), FRMS strives to find the realistic balance between safety, productivity and costs in an organization, through collection of data and a formal assessment of risk.

Traditionally, crewmember fatigue has been managed through prescribed limits on maximum flight and duty hours, based on a historical understanding of fatigue through simple work and rest period relationships. New knowledge related to the effects of sleep and circadian rhythms provides an additional dimension to the management of fatigue risks. An FRMS provides a means of adding this safety dimension, allowing operators to work both safer and more efficiently.

This FRMS Implementation Guide for Operators is a significant milestone. It marks the successful collaboration between IATA, IFALPA and ICAO to jointly lead and serve industry in the ongoing development of fatigue management, using the most current science. The input of these three organizations has ensured that this document presents a scientifically-based approach that is widely acceptable to the operators and the crew members who will be using it. It also offers this information in an accessible and practical way to assist implementation.

We are extremely proud to mutually introduce this FRMS Implementation Guide for Operators, which will contribute to the improved management of fatigue risk, and to ultimately achieve our common goal of improving aviation safety worldwide.

Guenther Matschnigg  
Senior Vice President  
Safety, Operations &  
Infrastructure, IATA

Nancy Graham  
Director  
Air Navigation Bureau  
ICAO

Don Wykoff  
President  
International Federation of  
Air Line Pilots' Associations

# FRMS – Who is responsible?

- STATE – INDUSTRY – AIRLINE - INDIVIDUAL
- The Objective is always AN ACCEPTABLE LEVEL OF SAFETY ..... still
  - We should capitalize on everybody's experience
  - Work as a team
  - Gather and SHARE data
  - Norm on a Scientific base
  - Use of Technology

# The New York Times

<http://www.nytimes.com/>

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## LACK OF FATIGUE REGULATION KILLS 300 IN RUNWAY EXCURSION



Even after aviation authorities were gathered in a safety seminar, early this year in **LIMA, PERU**, nothing was done. There is no fatigue Regulation and no one is even worried about the increased work hours for pilots and crewmembers. Market is dictating new labor rules everyday and authorities around the world are too startled to react, or play the game of the capitals.

In efforts to cut costs, pilots are asked to be more productive, or they will be left jobless.

Manufacturers are suggesting bizarre solutions too, they are offering new harnesses for passengers to travel standing up, and went as far as proposing only one pilot in the cockpit during long-range flights.

¿Preguntas?

MUCHAS GRACIAS