

ICAO / IATA / IFALPA

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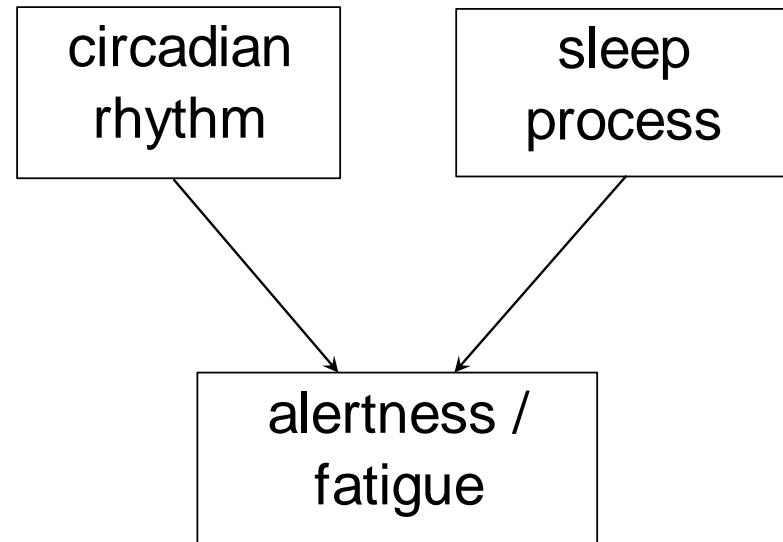
Captain Jim Mangie

# Bio-Mathematical Models: Where do they fit?



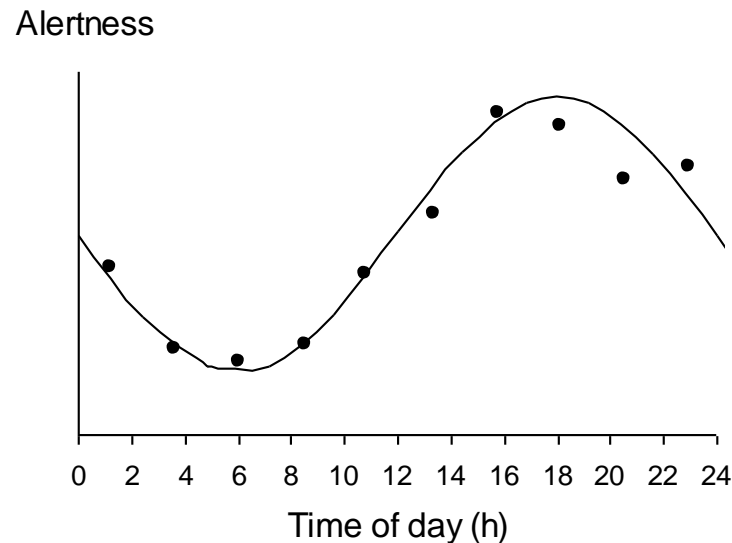
# Background

- ➔ The first fatigue models were developed in the 1980s, based on results from laboratory studies
- Two main factors contribute to the development of fatigue:
  - circadian rhythm (the chronobiological process)
  - sleep (the homeostatic process)
- This is known as the ‘two-process model’
  - it is the basis of most fatigue models that are used today



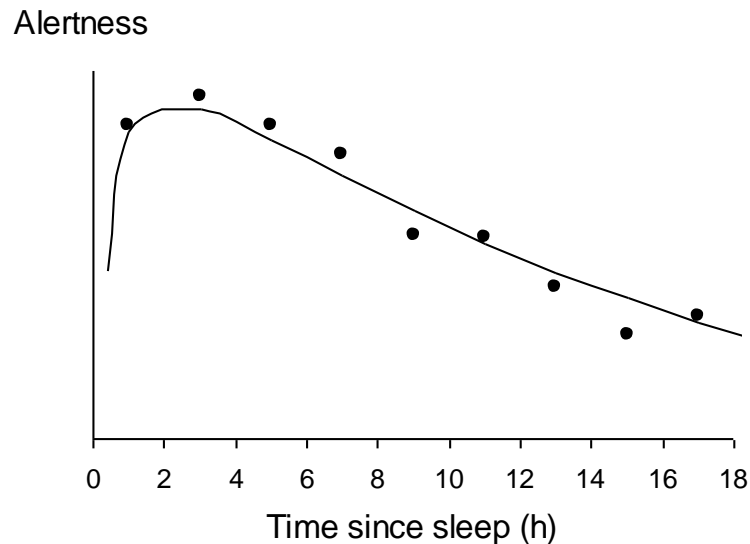
# The circadian component

- The circadian component of alertness follows a sinusoidal trend
- The peak in the late afternoon (1700-1800)
- The trough is in the morning (0500-0600)

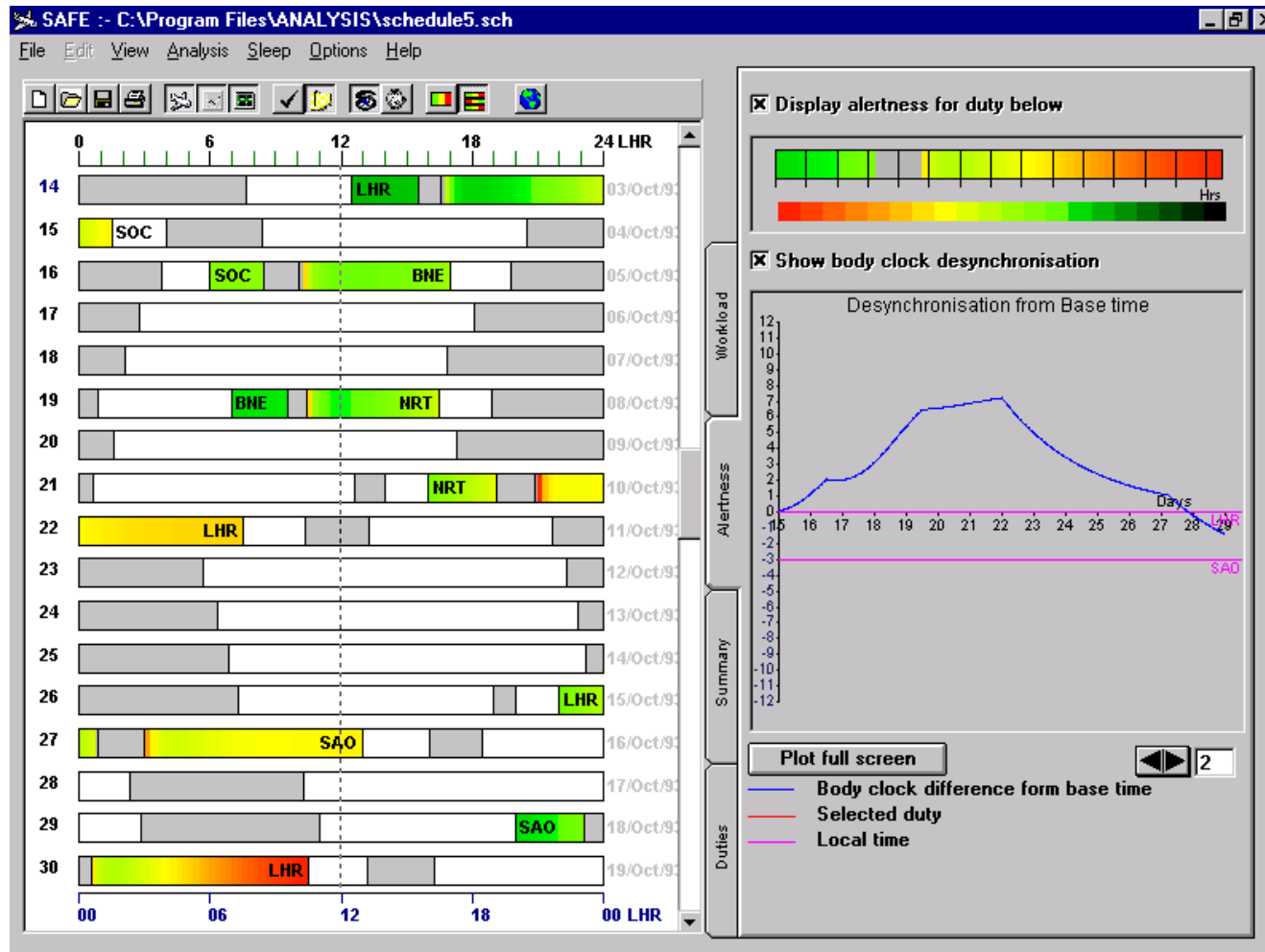


# The component related to sleep

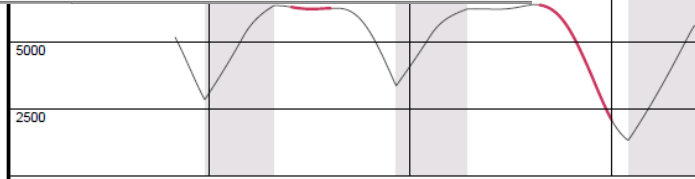
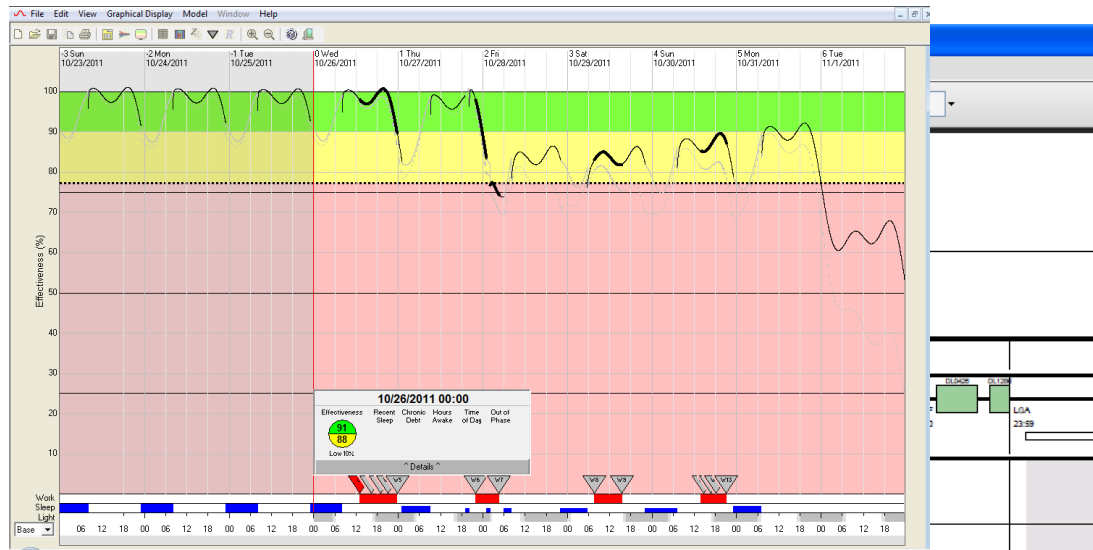
- Alertness is low immediately after waking
  - effect of sleep inertia
- It increases to a peak 2-4 hours after waking
- Thereafter it decreases exponentially



# Examples

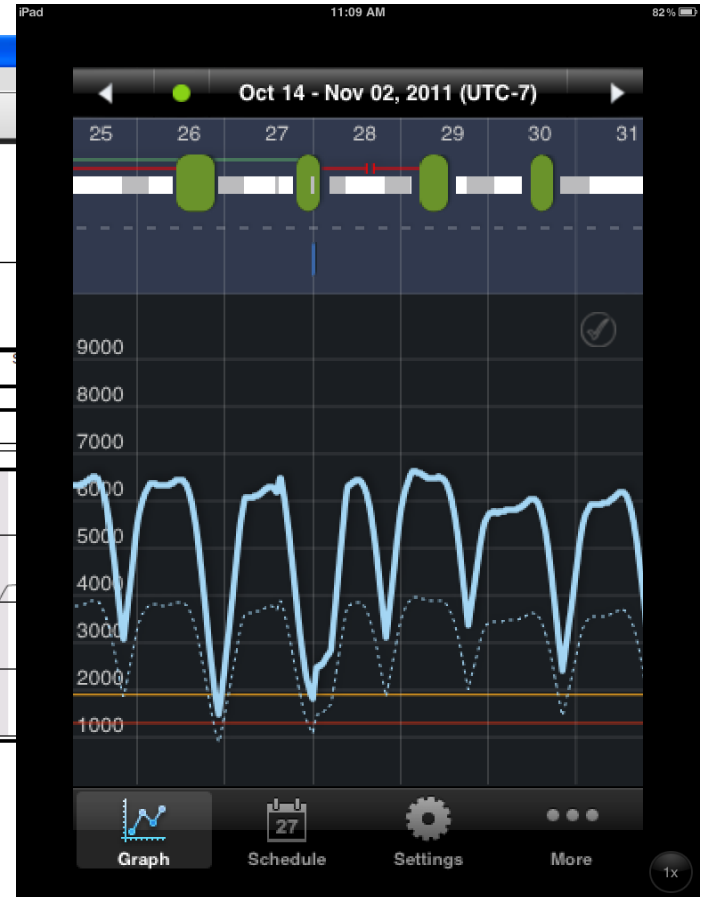


# Examples



Leg with lowest value: 14AUG2011 03:05 Value: 834 Time resolution: 0.05

Jeppesen Crew Fatigue Assessment Service



DL\_01\_graph\_BAM\_738.pdf - Adobe Reader



# Bio-mathematical Models

## Used for:

- Pairing/Roster Comparisons
- New Routes
- Evaluation of Mitigations
- Incident Investigation
- Complaint Resolution
- Evaluation of New Regulations

## Not Used for:

- Firm Go/No Go Decisions

# Possible Future Uses

## ✈ Pairing/Roster Construction

- Pre-Optimization
- Post Optimization

## ✈ Day of Operation

- Pairing Evaluation
- Pairing Construction



## → 5 Models Commercially Available

- BAM
- CAS
- FAID
- SAFE
- SAFTE/FAST

## → 3 Models Public Domain (maybe more)

## → 1 Model Operator Produced

## → More Being Discussed

- No International Standards
- No International validation process
- Experience with most has been outside of aviation



# Challenges

- Straight science vs. reality
- Which Model is the best?
- Over reliance by stakeholders
- User education
- Accuracy of predictions-limited data
- Validation
- Accounting for crew mitigations
- Additional constraint during optimization



# Questions/Discussion