

Validation of Fatigue Models through Operational Research

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Outline



- Introduction
 - easyJet Fatigue Risk Management
 - HFMP and Fatigue Modelling
- Literature review
- Findings
- Future

Fatigue Management at easyJet



- UK CAP371 FTL – based on rules devised in the 1970s
- Higher levels of crew utilisation and increased air traffic.
- One size does not fit all – different airlines have different operating risks.
- FRMS is a way of identifying and managing the risks specific to the individual airline.

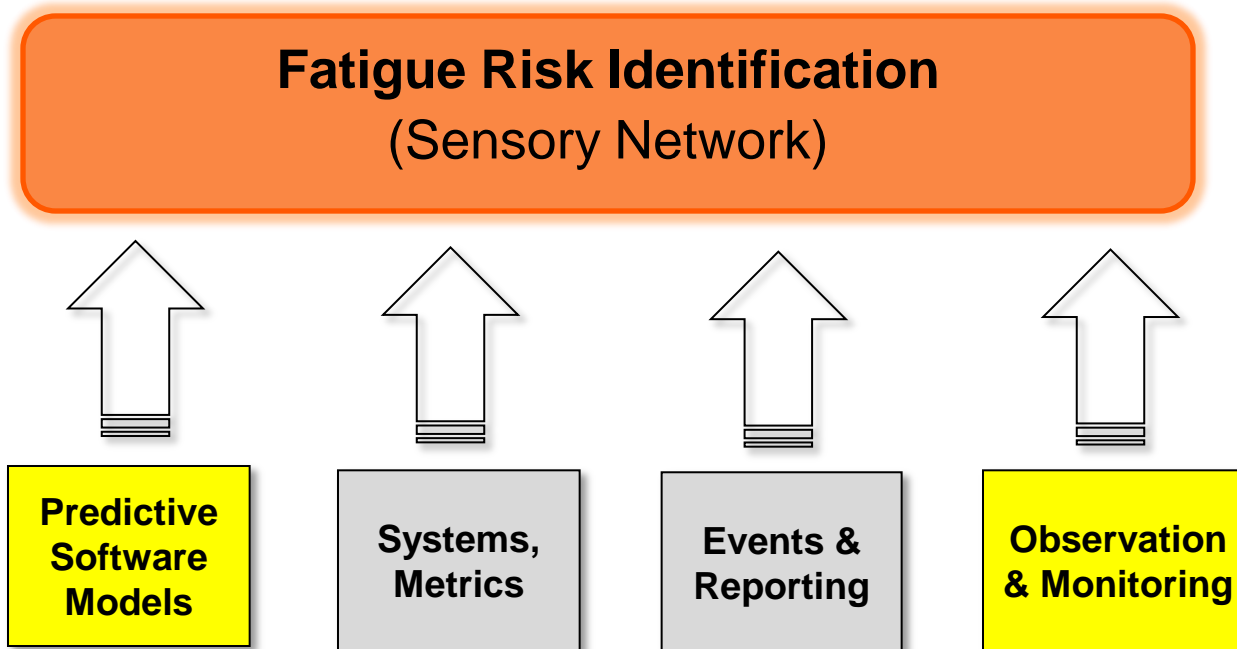


Fatigue Risk Identification



→ ICAO Definition:

- A data-driven means of continuously monitoring and managing fatigue-related safety risks, based upon scientific principles and knowledge, that ensures relevant personnel are performing at adequate levels of alertness.



HFMP



→ Human Factors Monitoring Programme (HFMP):

- A protocol for simultaneously assessing flight-crew work hours, workload, sleep, fatigue, and performance.
- The specific purpose of study is to provide objective measures of alertness and performance, which may benefit investigators in identifying fatigue levels of operators in commercial aviation.
- The study aim is to seek reliable associations between objective, subjective and predictive measurements related to fatigue.
- This collaboration will provide expertise and analysis capability in support of the easyJet FRMS and against the risk oversight requirements of the easyJet FTL scheme.



Literature Review



- Effect of **fatigue** on performance
 - Issues with single measure of fatigue & **reliability of subjective measure**
 - Lack of **fatigue related risk control** from organisation
 - Need for a multi-layered approach to the assessment of fatigue based on data driven evidence and decisions (control schedule related fatigue risk)
 - Current study is broader: consideration of overall performance, not just negative performance

- Effect of **scheduling practices** on crew fatigue (therefore performance)
 - Use of scheduling tools to monitor fatigue

- Impact of **workload** on fatigue/performance
 - Crew workload can be influenced by:
 - Factors induced from scheduling practices
 - External factors on the day (e.g. weather)
 - Lack of literature on the impacts of workload on fatigue and on performance



Study Design

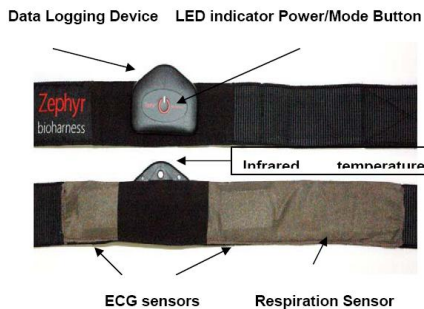


- Selecting study subjects:
 - Demographic, base, crew population, flights, management/union support
- 3 week specially designed schedule:



| | | | | | | | | | | | | | | |
|----------------|----|-----|----|-----|----------------|----|-----|----|----|----------------|-----|----|-----|--|
| | | | | | Block A | | | | | | | | | |
| D/O | | D/O | | D/O | | E1 | E2 | E3 | L1 | L2 | D/O | | D/O | |
| Block B | | | | | | | | | | Block C | | | | |
| E1 | E2 | E3 | L1 | L2 | D/O | | D/O | | E1 | E2 | E3 | L1 | L2 | |

- Measures - physiological, cognitive, subjective and objective:



| Degree of Fatigue | Scale Rating |
|--|--------------|
| Fully alert, wide awake | 1 |
| Very lively, responsive, but not at peak | 2 |
| Okay, somewhat fresh | 3 |
| A little tired, less than fresh | 4 |
| Moderately tired, let down | 5 |
| Extremely tired, very difficult to concentrate | 6 |
| Completely exhausted, unable to function effectively | 7 |

NASA Task Load Index

Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

| | | |
|------|------|------|
| Name | Task | Date |
|------|------|------|

Mental Demand How mentally demanding was the task?

Very Low Very High

Physical Demand How physically demanding was the task?

Very Low Very High

Temporal Demand How hurried or rushed was the pace of the task?

Very Low Very High

Performance How successful were you in accomplishing what you were asked to do?

Perfect Failure

Effort How hard did you have to work to accomplish your level of performance?

Very Low Very High

Frustration How insecure, discouraged, irritated, stressed, and annoyed were you?

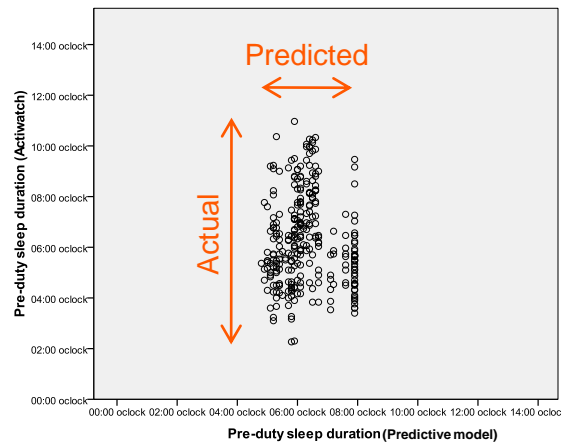
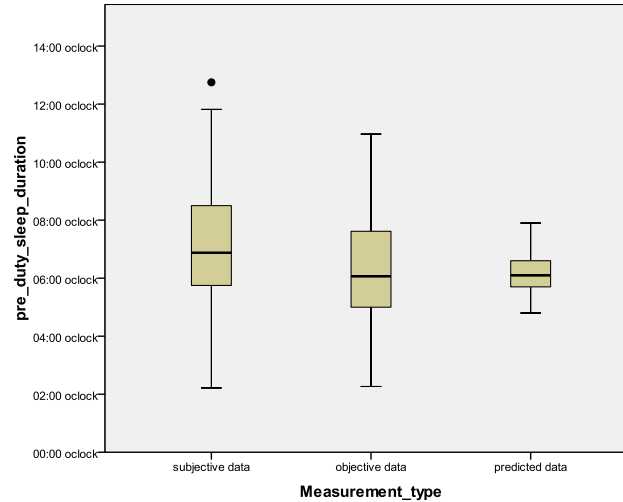
Very Low Very High

Study Design Parameters

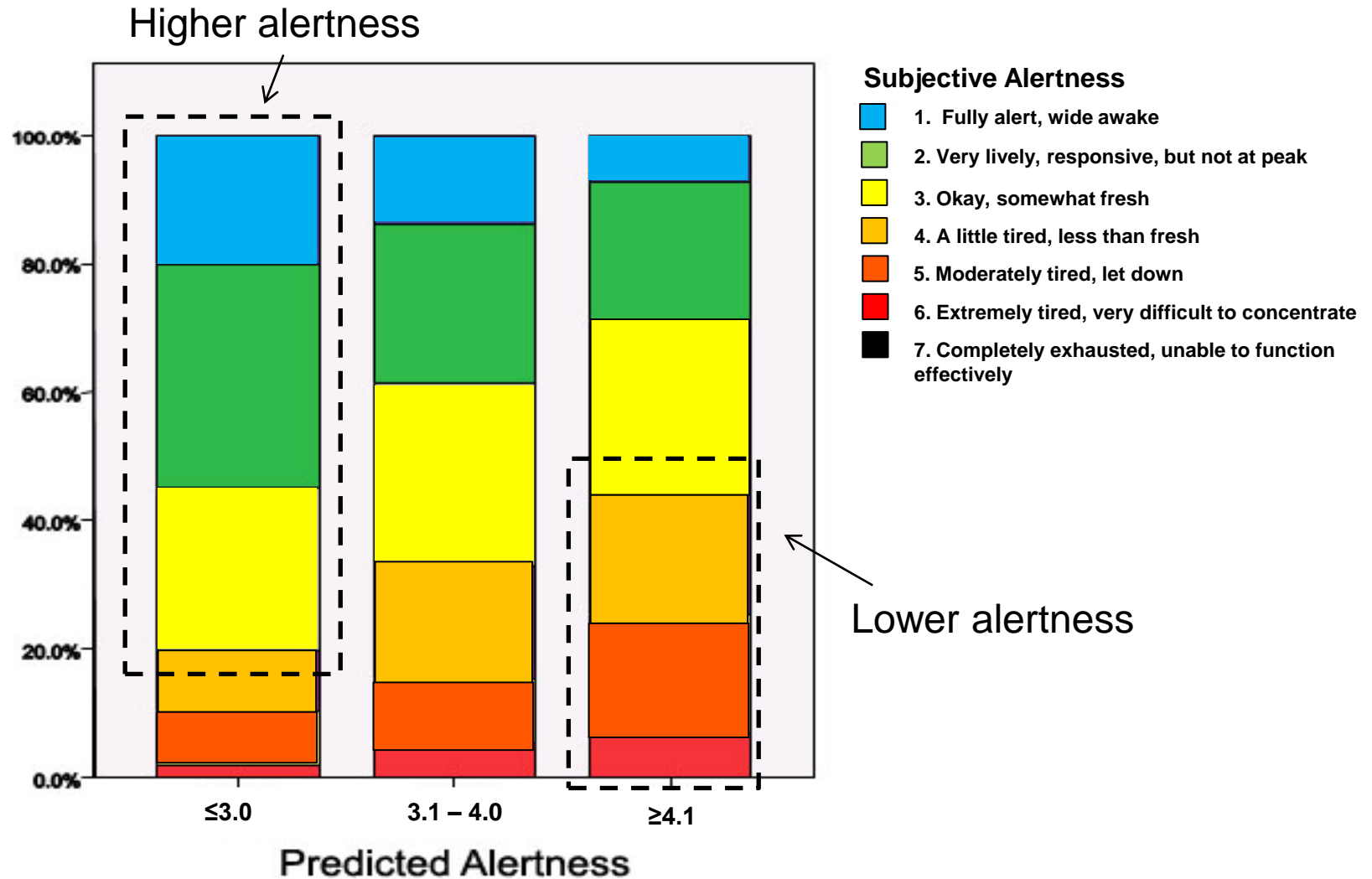


- The two fatigue models currently utilised within easyJet were assessed against objective and subjective data
- Correlations and variance
- Correct “direction”
- Validation and verification

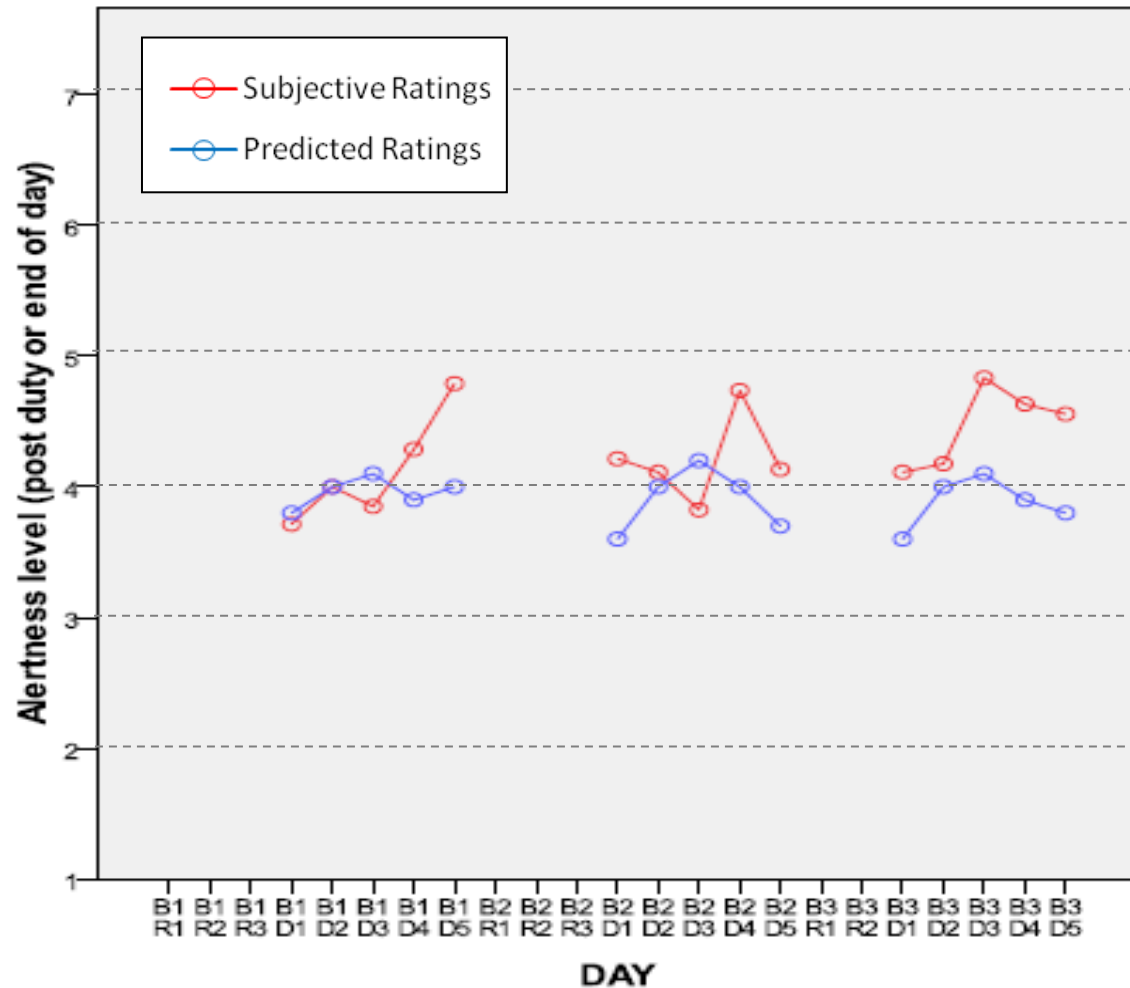
Subjective, Objective and Predictive Sleep Duration Correlation



Subjective & Predictive Alertness Correlation



Study Findings - predictive fatigue models



Summary of study findings



Sleep

- Poor correlation for predicted and actual
- Small range compared to actual

Alertness

- General correlation between predicted and subjective ratings
- Right directions throughout work sequences
- Model underestimates fatigue

Workload Influence



- ✈ No significant difference in workload (TLX values) across the schedule blocks

| Block | Mean | Std. Deviation | Minimum | Maximum |
|-------|--------|----------------|---------|---------|
| B1 | 723.28 | 106.31 | 498.00 | 919.58 |
| B2 | 760.20 | 104.61 | 569.00 | 965.00 |
| B3 | 728.28 | 137.90 | 496.00 | 965.00 |

Future of predictive modelling for easyJet



- Ability to feed operational data back into the system for development and for user specific scenarios;
- Ability to incorporate individual characteristics into the modelling inputs;
- Improved prediction of cumulative fatigue;
- As knowledge increases throughout the industry – factoring to be applied to different duty types, routes, etc
- Improved correlation between fatigue assessment and performance outcomes