The use of modeling in a Fatigue Risk Management System

A Critical Review
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“I checked with the scientists and they said their fatigue model was good for at least another 100,000 miles and you will get 150 mpg, easy…”
Summary of Review: 1

- Lack of clarity over the validity of model inputs and outputs

**ONE STEP MODELS**

SLEEP/WAKE ➔ FATIGUE

**TWO STEP MODELS**

WORK/REST ➔ SLEEP/WAKE ➔ FATIGUE
Summary of review: 2

- Lack of clarity about what is being predicted
  - Subjective Fatigue?
  - Work-related fatigue
  - Sleep opportunity
  - Neuro-behavioural Performance [eg. PVT]
  - Task Performance
  - Risk/Safety

- We believe the current models probably measure SLEEP OPPORTUNITY or WORK-RELATED FATIGUE
Summary of review: 3

- B-M models are useful as an element within an FRMS
- We want models used within a
  - OH&S rather than HR/IR/LR context,
  - Safety Management Systems,
  - Risk Management framework.
- Use of the Defenses-in-depth model
Summary of review: 4

- **Level 1 controls** – ensure provision of adequate sleep opportunity

- **Level 2 controls** – ensure adequate sleep has been obtained

- **Level 3** – ensure behavioural indicators of fatigue are identified and managed

- **Level 4 controls** – ensure the likelihood that errors becoming incidents are minimised – fatigue proofing

- **Level 5 controls** – ensure fatigue-related incidents are prevented from re-occurring unnecessarily
Summary of review: 5

- Lack of clarity about the relationship between the surface features of fatigue modeling software and the underlying scientific evidence

- Lack of real world data informing the Work/Rest -> Sleep/Wake transfer function in 2-step models

- Complexity of interfaces misrepresents the lack of supporting evidence for ‘advanced features’

- Interfaces creates an illusion of sophistication and precision

- Graphical representation of the time course for fatigue does not include indicators of the level of variability or uncertainty in predictions
Summary of review: 6

- What is needed and soon
  - Best-practice guidelines for
    - Organizations
    - Regulators
    - Commercialization partners

- Accredited Training & Education in the use of b-m models
  - Line managers
  - Accountable executives
  - Regulators/Inspectorates
Recommendation: 1

- The only scientifically defensible use of current fatigue-modeling products that transform a work pattern into estimated fatigue is as a global risk assessment tool for determining the average ‘sleep opportunity’ or the level of work-related fatigue associated with a pattern-of-work.

- That is, as a Level 1 control using the defenses-in-depth framework.
Recommendation: 2

- While fatigue models have significant utility when used at a systems level, current fatigue-modeling products are unsuited to predicting whether a given individual on a specific occasion or involved with a specific event is fatigued due to the high level of inter-and intra-individual variability in sleep-wake behaviour.

- This is the role of level 2-4 controls
Recommendation: 3

Where possible, the use of fatigue models should be integrated within the framework or context of relevant and appropriate national and/or international standards for Occupational Health and Safety, Risk Management and Safety Management Systems.
Recommendation: 4

- Specific fatigue models or software packages should not be identified as part of a regulatory framework. Regulatory bodies should develop regulations that permit the use of an approved bio-mathematical fatigue model and establish a process for accrediting approved models and dis-establishing obsolete ones.
Recommendation: 5

There should be an international working group charged with setting a performance standard for what constitutes an acceptable b-m model. The resultant performance standard should evolve over time so new models can enter the market and obsolete ones can be removed. This standard could be integrated within national and/or international standards organizations such as ISO.
Recommendation: 6

An international benchmarking data set of time-locked work-rest, sleep-wake and performance data should be established in the public domain so that commercial model providers can demonstrate that a model meets a specified performance standard for prediction of sleep/wake and fatigue as part of an independent accreditation process.
Recommendation: 7

Regulatory agencies should require that the theory and methodology for describing and/or parameterizing any fatigue-modeling algorithm be published in the public domain so it can be subject to peer review and public scrutiny. Models that are not published in the public domain should be precluded from use.
Recommendation: 8

- Establish an international working group charged with establishing initial quality assurance guidelines for ensuring that
  - appropriate use of fatigue-modeling products,
  - post-implementation guidelines on how to evaluate effectiveness
  - Improvements in modeling are identified and adopted as they evolve.
Having looked into the still waters at his feet he fell in love, deeply in love, with the beauty of the image he beheld...

fatigue modeler