PULSAR INFORMATICS

Fatigue Model

Fatigue estimates provided by Fatigue Meter are based on a biomathematical model[1] that has been validated based on laboratory data collected at the University of Pennsylvania and Washington State University.

This model accounts for the two primary biological processes that govern human sleep/wake cycles and alertness levels: the homeostatic process and the circadian process. The homeostatic process represents the buildup of sleep pressure over time awake. The circadian process ("circadian" means "about a day") is what makes people alert during their biological day and sleepy during their biological night.

An additional model component accounts for circadian misalignment—a mismatch between a person's internal circadian rhythm and the time that he or she is asleep/awake. Circadian misalignment is most commonly associated with working at night or crossing time zones (this is what causes jet lag). It is because of a difference between internal "body clock" time and local time that an individual who travels to a new time zone and hasn't had adequate time to adjust will typically experience fatigue during daylight hours and be unable to sleep well during local nighttime.

The effects of jet lag are temporary; eventually the internal body clock will synchronize with the local environment. This synchronization is a complex process that occurs gradually over time. One commonly used model is that the internal body clock adjusts towards the local time zone at a rate of 1/2 of the difference every 24 hours[2]. This is the model that Fatigue Meter uses to account for performance deficits due to jet lag. So, for example, after traveling from a domicile at Z+0 to a location with time zone Z+10, the internal body clock is assumed to adjust to Z+5 after 24 hours, Z+7.5 after 48 hours, Z+8.8 after 72 hours, etc.

Fatigue Meter will automatically estimate the individual's sleep periods (calculated in terms of time spent in bed) given their duty schedule. Estimates of sleep timing and duration are based on mathematical model inputs related to sleep history, internal circadian phase (internal body clock time) and time of day. At baseline with no imposed work schedule constraints or flights, the individual is assumed to spend 8 hours' time in bed, starting at 23:30 in their domicile time zone. This off-duty behavior model has been validated based on operational data collected across various industries.

Lastly, in our aviation specific version, the model also accounts for fatigue due to sleep inertia[3] and fatigue due to the number of take-offs and landings[4].

1 (McCauley, Kalachev et al. 2013)
2 (Darwent, Dawson et al. 2010)
3 (Hilditch, Centofanti, et. al. 2016)
4 (Honn, Satterfield, et. al. 2016)

Originally developed for NASA and DOD Special Forces, our validated technologies offer the best in test accuracy, data analytics, security, and ease of use.

Fatigue Meter shows you exactly how operational factors such as long duty hours, night shift work, and restricted sleep opportunities combine and contribute to elevated fatigue risk in your operation.

In-depth understanding enables smarter mitigation strategies such as a worker reassignment, nap and break strategies, and schedule changes.

Request a live demo today!

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