Fatigue Risk Management

FRM-based crew scheduling provides control of predicted crew alertness level and associated risk. The system provides powerful "what-if" capability to evaluate effects on productivity and fatigue resulting from rule changes.

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Control of fatigue and fatigue risk

Boeing and Jeppesen have jointly developed FRM functionality for allowing airlines to control crew fatigue and fatigue risk in crew planning and operation. The functionality is built into the Jeppesen Crew Management products so that scientific fatigue/alertness models can be accessed while constructing and maintaining crew schedules.

The FRM functionality allows for individual predictions on each flight of both crew alertness and associated risk. The alertness and risk information is available both in the GUI for the end-user but also to the optimizers during pairing and roster creation.

The availability of this information makes it possible to "build" alertness into rosters in the planning stage and to control and monitor it during manual roster maintenance and day-of-operation changes.

Alertness can be built into the crew schedules where it decreases fatigue risk the most – thus addressing the "tail" of the risk distribution. An operator may both use strict limits on fatigue risk, incentives to avoid the risk, alerts on risk thresholds, or any combination of these.

The Jeppesen rule engine RAVE, used in the Carmen suite of products, is able to connect to any scientific fatigue model compliant with CAPI; the "Common Alertness Prediction Interface". CAPI enables high-speed integration with optimizers and aligns alertness prediction output to the 0-10 000 scale.
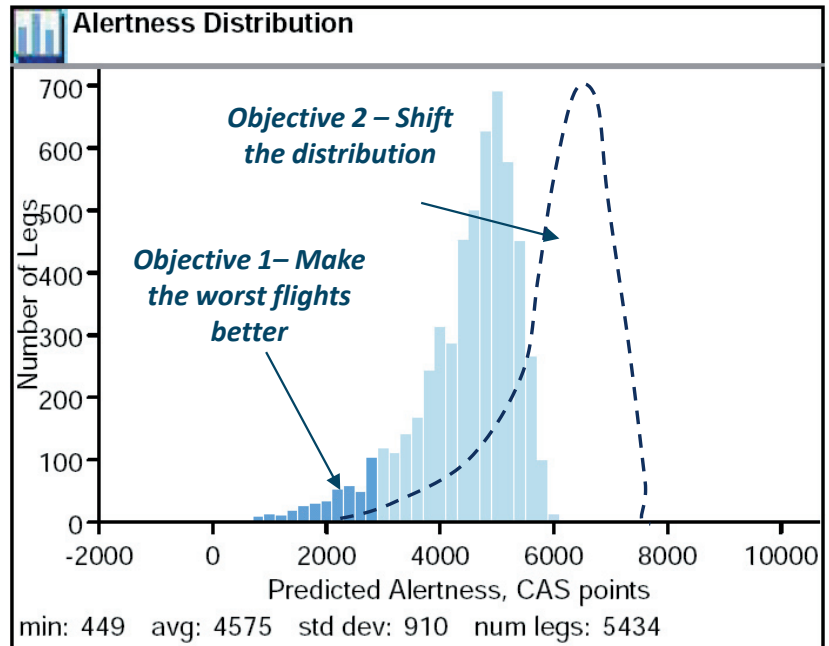
A graph showing the distribution of predicted alertness over a rostering solution on 5434 flights.
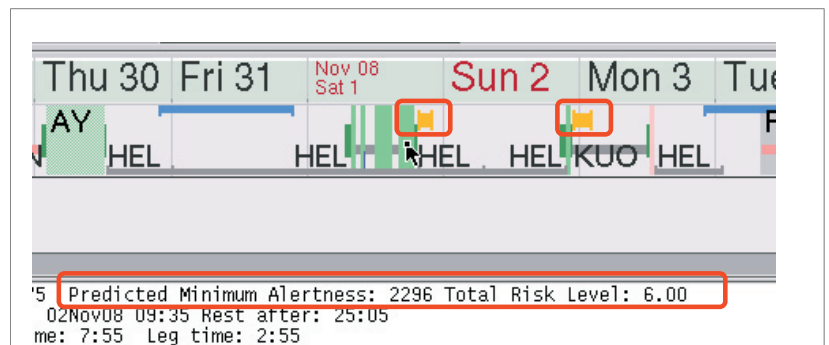
The user interface provides the planners with both fatigue markers on the flight and more details when pointing on the flights.
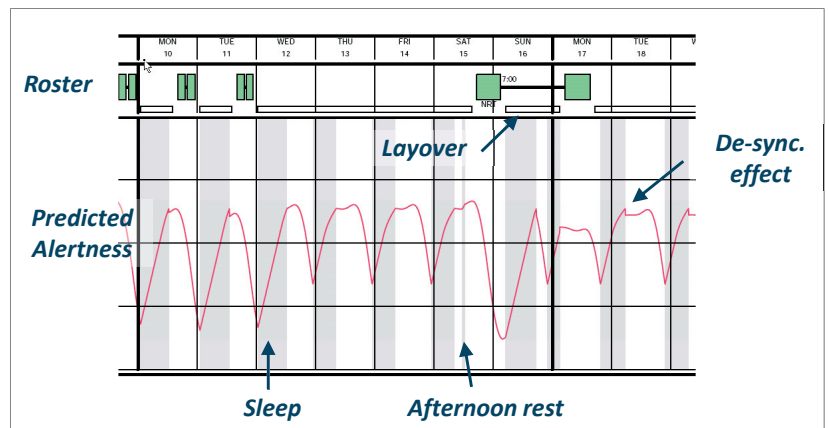
A detailed alertness plot report for a crew roster. The read line illustrates the return values for predicted alertness – in this case from the Boeing Alertness Model.

Boeing Alertness Model

The Boeing Alertness Model, BAM, is a biomathematical model of alertness, built on the Three Process Model of Alertness and extended with advanced sleep prediction, task load, augmentation, and ability to blend in sections of actual sleep when available. BAM has been tested with the Jeppesen Crew Management product suite and is fully CAPI compliant.
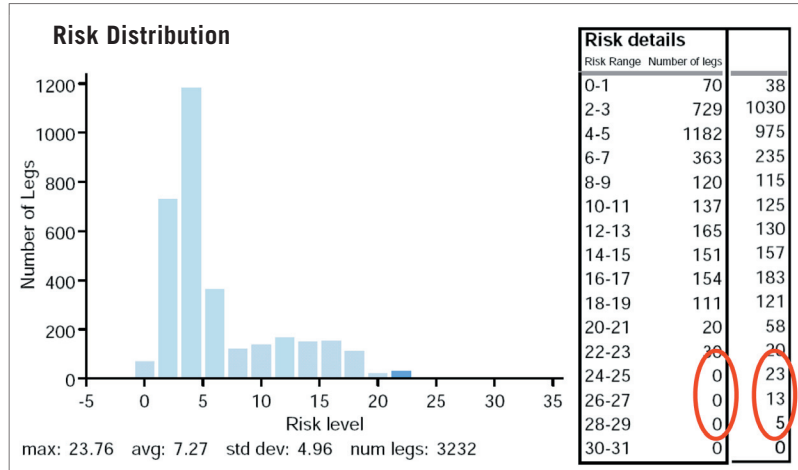
SMS Integration

In the Carmen suite, an add-on "risk layer" is available, forming an essential part of a Safety Management System (SMS) – built from FAA InFO 07015.

The risk layer is fully configurable per operator and allows for a detailed pre-flight risk assessment to be automated considering factors such as pilot experience, airport properties, airport approach properties, light conditions, weather, and tail characteristics etc.

"What-if" scenarios

The "what-if" scenario capability allows schedulers and airline safety officials to assess possible schedules in terms of predicted alertness, overall risk, productivity, and other key dimensions, such as quality of life and robustness.

Methodology and services for rule-analysis is available for identifying both loop-holes (potentially unsafe conditions) as well as sensible alleviations. The methodology allows for a reformulation of rules to "catch" fatigue best possible, while retaining, or even enhancing, crew productivity. Talk to a Jeppesen representative for more information on these services.

Risk Distribution

max: 23.76   avg: 7.27   std dev: 4.96   num legs: 3232

Risk details

Risk Range	Number of legs	
0-1	70	38
2-3	729	1030
4-5	1182	975
6-7	363	235
8-9	120	115
10-11	137	125
12-13	165	130
14-15	151	157
16-17	154	183
18-19	111	121
20-21	20	58
22-23	30	20
24-25	0	23
26-27	0	13
28-29	0	5
30-31	0	0

A "what-if" scenario comparing the risk distribution with and without the risk layer activated.

Threat

Name	Value	Unit	Risk level
TwilightLanding	0	1/0	0.0
NightLanding	1	1/0	5.0
ILS	0	%	4.0
MountainsOrObstacles	0	ft	0.0
CATII	0	%	2.0
Unit conversion	0	1/0	0.0
AirportElevation	0	ft	0.0
WetRunway	20	%	0.8
StoppingDistance	None	%	0.0
OutOfEUOperation	None	1/0	0.0
CeilingHeight	2500	ft	0.0
Visibility	300	c.miles	1.5
HeavyRain	5	%	0.2
IceOrSnowOnRunway	10	%	0.4
IcingCondition	5	%	0.2
SurfaceWinds	15	knots	2.0
CrossWind	12	knots	3.2
MEL_or_CDL_items	None	1/0	0.0
CongestedApproach	0	1-5	0.0

Detailed view of risk assessment for a particular flight.

What fatigue models are supported by the Jeppesen product suite?

All model implementations compliant with CAPI - the Common Alertness Prediction Interface. Investigate with your Jeppesen representative for a current list of compliant implementations. (CAPI has been discussed with most major model "providers" in the market.)

I use Carmen products for crew management. Which products are CAPI compliant?

CAPI is integrated into RAVE. All Carmen products from Version 16 forward contain CAPI and the ability to communicate with a CAPI-compliant fatigue/alertness model.

Can Jeppesen assist in evaluating our existing rosters, even if we use non-Jeppesen tools for crew management today?

Yes. Rosters must be exported in Carmen Transfer Format or in a CAPI-compliant data file. Appropriate license agreements may be required for external models.

Can Jeppesen also assist in re-building our rosters with optimizers taking fatigue, or fatigue risk, into account?

Yes. This is however a bigger task as it includes implementation of all/most business rules and objectives for pairing planning as well as rostering planning. A typical project reaching close-to-production-quality would require 2-3 man months of work.

Can BAM be used with our existing crew scheduling solution?

If your scheduling solution is CAPI-compliant – yes. Investigate with your Jeppesen representative.

Does BAM define a clear limit for a "safe" level of alertness?

No. BAM should be used for establishing the relation between flights in terms of predicted alertness. Boeing recommends using BAM in a SMS-context – combining the alertness prediction with other vulnerabilities and hazards for a flight.

I'm interested or required to implement a FRMS by my regulatory authority. Does this system meet all regulatory requirements for FRMS?

No. This system provides FRMS-based scheduling, but does not replace your airline's FRMS. Check with your regulatory authority and your Boeing or Jeppesen representative for advice on implementing FRMS in your airline.

I'm representing a regulator (or crew union, or airline management) working with formulating/ interpreting and evaluating rules and rule changes. What help could I get from this functionality?

Detailed "what-if" analysis of the rules can help you identify loop-holes and potential alleviations and find the best rule formulations from both a fatigue and crew productivity perspective.

For more information on FRMS, please contact:

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