Railroad Fatigue Risk Management: Balancing Scheduling & Fatigue Risk

Dr. Martin Moore-Ede & Todd Dawson

CIRCADIAN™ 24/7 WORKFORCE SOLUTIONS
Elements of a Railroad Fatigue Risk Management System

Oversight

- Education & Training Employees & Managers
- Working, Napping & Sleeping Facilities

Policies

- Sleep Disorder Screening & Treatment
- Scheduling Optimization & Fatigue Risk Assessment

Monitoring & Reporting

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  - Monitoring

- Policies
  - Sleep Disorder Screening & Treatment
  - Scheduling Optimization & Fatigue Risk Assessment
  - Reporting

Dynamic, Operational Impact with Highest Benefit
The Missing Factor in Crew Cost
Optimization

: Human Fatigue Risk

Operational Cost (CERTAIN PRESENT COST)

Human Fatigue Risk (POTENTIAL FUTURE COST)

True Optimum

Operating Cost

Crewing Level

Large

Small
Goals of CAS Fatigue Risk Model

- To provide a reliable Risk-Informed Performance-Based tool for reducing the risk of fatigue-related human errors, accidents and injuries in 24/7 transportation & shiftwork operations.

- To continuously optimize CAS against the target of preventable errors, accidents & injuries.
  - **NOT** Sleep Laboratory data (e.g. PVT) modeling.

- To provide a safety balance against crew optimization software
In the real world accurate predictions are critical

MY REAL-TIME ANALYSIS TELLS ME IT’S SMOOTH SAILING.
## Comparisons of model predictions against sleep laboratory data – Seattle June 2002

<table>
<thead>
<tr>
<th>Author</th>
<th>Model</th>
<th>Scenario #1</th>
<th>Scenario #2</th>
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CONCLUSION:

- Different models are better at predicting different variables
- Depending on desired use it matters what you optimize model against
- There is quite a lot of unexplained variability
PVT is not the gold standard for testing or optimizing models of fatigue & accident causation

- Lack of direct relevance to railroad tasks
  - No learning curve (unlike operating train)
  - Must take a 10-min break from duties to perform test
  - Single task vs. multi-task test
  - Single person measure – not team performance
  - No consequences from failure to perform

- No relationship has ever directly been shown between PVT scores and real-world transportation errors or accident rates
Progressive separate optimization of fatigue risk models

Preventable Errors, Accidents & Injuries

Sleep Lab Performance Tests e.g. PVT

Alertness on Duty (10,000 railroad 24 hr days)

Circadian Sleep Theory

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CAS Fatigue Score vs. Accident Risk

Histogram of Fatigue Index - mean: 40.58 std_dev: 20.44 std_err: 0.69

(n=868 drivers x 30 days)
Prospective Proactive Validation
Risk-Informed Performance-Based Safety

- Actual Duty-Rest Schedule
- Electronic Data
- Risk-Informed Fatigue Score
- CAS Fatigue Risk Model
- Daily feedback of fatigue risk & daily planning to minimize fatigue score

Performance-Based
ADJUST WORK SCHEDULE

Operator & Dispatcher

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Risk-Informed Performance-Based Fatigue Management

Before

After

CAS Fatigue Scores

Accident Risk

$32,430 / million miles

Accident Rate

2.3/mm

$14,100

23%

$8,160 / million miles

Accident Rate

1.7/mm

$4,800

66%*

X²=68.1

P<0.0001
Risk-Informed Performance-Based Results
Big 4 Accidents per million miles

Dupre' Transport, LLC. Truckload (ABL) Division
RIPB Program: Big 4 Accidents

Baseline

1.29
0.9
0.8
0.5


Accidents per million miles
Fiscal Year

• Rollovers • Rear End • Lane Change • Intersection

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Crew Scheduling Software Requirements

- Must balance operational requirements, crew preferences and fatigue management
- Enable efficient crew resource planning
- Enable the simulation and optimization of various scheduling scenarios.
- Continuously track crew performance and places accountability on crews
- Incorporate crew scheduling preferences for quality of life issues
- Manage crew fatigue risk and provides documentation for FRA reviews
Software Solution: FRCOS

- Data Acquisition
- Traffic and Crewing Analysis
- Analysis of Service Plan
- Schedule Analysis
- Schedule Development
- Link to Crew Management
- Operations Analysis
- Fatigue Risk Analysis
Example Schedules

- Software must be able to simulate and optimize a wide range of schedules.
  - Days on/off patterns
  - Time windows
  - Extended rest at home

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Crew Utilization

Crew Use Comparison

Run Length Analysis

Number of Available Crews (Home+Away)

Date/Time

Chain Gang 23/25
with Schedule 23/25

Roundtrip Duration Histogram
Average: 36.1 Hours
95% Value: 46.2 Hours

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Analysis Requirements

Trainflow

Deadheads

Traffic by Time of Day

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Operational Cost Analyses

Deadhead Rate
10.3% reduction

Absenteeism and Missed Calls
8.2% reduction
Impact of Scheduling on Crews

Pre and post self-reported fatigue

Problems finding time for family and social activities

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CAS Fatigue Score: Pre & Post Crew Scheduling Optimization

Before Optimization
fatigue range: 5 to 76

After Optimization
fatigue range: 3 to 16

Low Risk  High Risk

Low Risk  High Risk

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• The greatest fatigue management benefits come from addressing crew scheduling

• Balancing crew scheduling and fatigue risk optimization requires a dynamic solution

• A comprehensive fatigue management plan requires integration of scheduling with education, sleep disorders screening and napping policies, etc.