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INNOVATIVE FATIGUE MANAGEMENT APPROACH IN THE TRUCKING INDUSTRY

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Summary: Driver fatigue, recognized as a major safety problem in the transportation industry, is strongly influenced by employee work and sleep schedules. The work and rest hours of truck drivers have been regulated by Hours-of-Service (HoS) rules in the U.S since 1938, but it has become increasingly apparent these rules are inconsistent with the science of sleep and fatigue. We present and assess an innovative alternative safety management system, which takes a pro-active, science-based complimentary approach. This Risk-Informed Performance-Based (RIPB) safety system for sleep and fatigue management was implemented at one major trucking company, and involved the training of managers and dispatchers on scientific aspects of work assignments and a regular feedback system that assessed the fatigue risk of the work schedules. Driver fatigue was assessed using the Circadian Alertness Simulator (CAS) software system for simulating sleep and alertness based on work-rest patterns (Moore-Ede et al., 2004). Each driver was assigned a cumulative fatigue risk score based on logbook data processed for multiple one-month periods before and after the implementation of the safety management system. The implementation of the RIPB safety management system resulted in a significant reduction of fatigue risk scores, a reduction of the rate and costs of accidents, and improvement of other operational parameters. The success of the RIPB system was sustained over an extended time period of more than three years, and thus could permit the relaxation of overly prescriptive HoS regulations.

INTRODUCTION

Driver fatigue has been recognized as a major safety problem in the transportation industry. Although directly related to daily work and rest schedules, driver fatigue has proven difficult to control effectively. Since 1938, the duty, driving and rest hours of truck drivers have been regulated in the U.S. by Hours-of-Service (HoS) rules. However, advances in scientific research on sleep and circadian physiology over the past 50 years have made it apparent that the hour glass model of fatigue on which the original HoS rules were based is not adequate. Rewriting these rules has not been easy, since the principles of circadian sleep physiology are too complex to be written into simple, understandable and enforceable prescriptive rules. When new rules were finally implemented by the Federal Motor Carrier Safety Administration (FMCSA) in January 2004, they were immediately challenged by public interest groups, resulting in their rejection by a federal appeals court in July 2004, forcing yet another attempt to redesign the rules.

One of the main criticisms of both old and current HoS rules relates to the fact that these regulations are based on the assumption that accidents are directly related to the number of consecutive hours of work or consecutive hours of rest, and fail to take into account the circadian principles of sleep physiology or circadian time-of-day effects. For example, at certain times of the day, drivers can be impaired and unsafe while following these HoS rules, and at other times, they may be able to safely drive beyond the legal limits. Other criticisms of the trucking HoS regulations relate to the one-size-fits-all approach. Lumping together a diverse group of workers (e.g., local short-haul drivers who make multiple stops and return home every day vs. long-haul drivers on irregular non-scheduled routes who may be away from home for many days and sleep in the sleeper berth) does not effectively address the specific needs of these driver groups and trucking operations.

Alternative flexible HoS systems that focus on scientifically validated sleep and fatigue management rather than prescriptive regulations have been proposed, and their implementation has been pioneered in Australia. Such systems offer pro-active, complimentary approaches for enhancing the benefits of HoS regulations, and could eventually offer sufficient protection under relaxed HoS regulations. Here, we present and assess such an innovative system, specifically, a Risk-Informed Performance-Based (RIPB) safety system for sleep and fatigue management. The RIPB approach is an alternative result-driven compliance process which has been adopted to regulate safety in other industries (e.g., nuclear power industry). This approach places the responsibility on the operator to find the most effective way to get desired safety outcomes, rather than writing excessively complex prescriptive regulatory rules.

METHODS

The RIPB fatigue management system (Figure 1) was implemented and tested for the trucking operations of Dupre' Transport, LLC. A population of approximately 500 drivers operates three different types of operations—a slip-seat two-shifts per day Hazmat (gasoline delivery) service, which is a dedicated fixed-route service for manufacturers, and a non-scheduled, irregular-route truckload operation. The system involves the training of managers and dispatchers on scientifically determined risks of work assignments and a regular feedback system that assessed the fatigue risk of work schedules. The system allows managers to identify individual driver work-rest patterns with high fatigue, and managers are personally held accountable for managing driver fatigue risk scores.

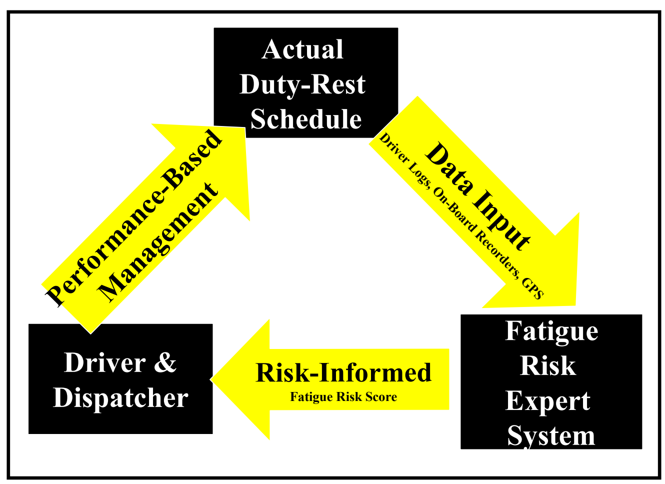

Figure 1. RIPB Fatigue Management System

Driver fatigue was assessed using the Circadian Alertness Simulator (CAS) software system for simulating sleep and alertness based on work-rest patterns (Moore-Ede et al., 2004). Individual logbook data of all drivers was processed for multiple one-month periods before and after the implementation of the safety management system. Each driver was assigned a cumulative

Fatigue Risk Score, in which the driver was ranked on a scale from 0 (no fatigue) to 100 (extreme fatigue). The CAS Fatigue Risk Score has been shown to describe the statistical distribution of fatigue risk in trucking operations while being sensitive to work schedule-related fatigue and accident risk (Moore-Ede et al., 2004). Figure 2 illustrates the relationship between CAS fatigue risk score and the probability of DOT-recordable accidents for the drivers of one trucking operation over one year, demonstrating an exponential relationship as fatigue scores increase. It has to be recognized that the exact scale of the probability axis is not generalizable across trucking fleets as it depends on the intrinsic risks of the operation (e.g., type operation and work hour scheduling, nature of load, age of vehicles, road conditions, training of drivers, etc.).

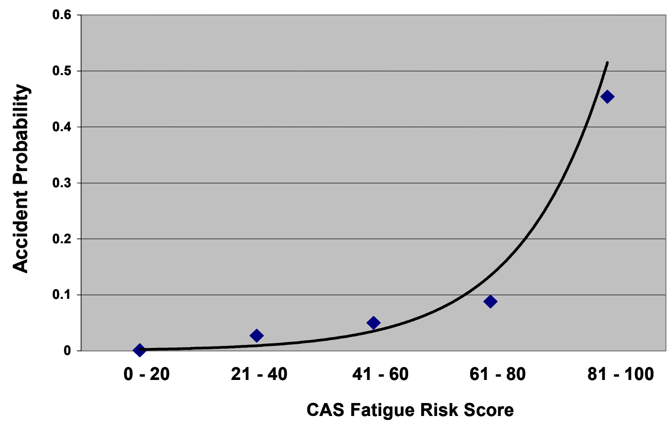

Figure 2. Fatigue Risk and Accident Probability for Drivers of a Selected Trucking Operation

In this study, the distribution and group means of individual fatigue risk scores were analyzed and tracked over consecutive months. Managers/dispatchers were educated on how they could reduce the risk of driver fatigue by adjusting the timing and duration of daily and weekly work rest patterns while still providing the 24/7 service required by the customers. This education included information on adjusting the daily start and end times of work, providing rest breaks that allow two consecutive nights of sleep, minimizing night work, avoiding rapid rotations in the work starting times, reducing the number of consecutive shifts worked and schedule compliance. Based on the CAS fatigue risk analysis, the managers/dispatchers received monthly feedback about the fatigue risk of the drivers' work schedules. To re-enforce dispatcher decisions, senior management implemented a policy that made every dispatcher and local manager accountable for the CAS fatigue risk scores of the drivers who reported to them.

RESULTS

Initial Intervention Study

CAS fatigue risk scores and work pattern of the driver population were compared for the one-month time periods before the intervention and then nine months after the implementation of the RIPB system. The RIPB program resulted in changed work schedules, including alterations of duty start times to optimize night sleep and a shift in the sequence of work and rest days from a 6-on/1-off to 5-on/1-off pattern. This led to a shift of CAS fatigue risk scores (Figure 3). The score was significantly reduced from a pre-intervention mean of 46.8 to 28.9 ($t=9.41$, $p<0.0001$). The percentage of elevated fatigue risk scores (61 and over) fell from 28.9% to 3.9%, and the percentage of minimum fatigue risk scores (20 and under) increased significantly from 14.9% to 44.6% ($X^2=170$, $df=3$, $p<0.0001$).

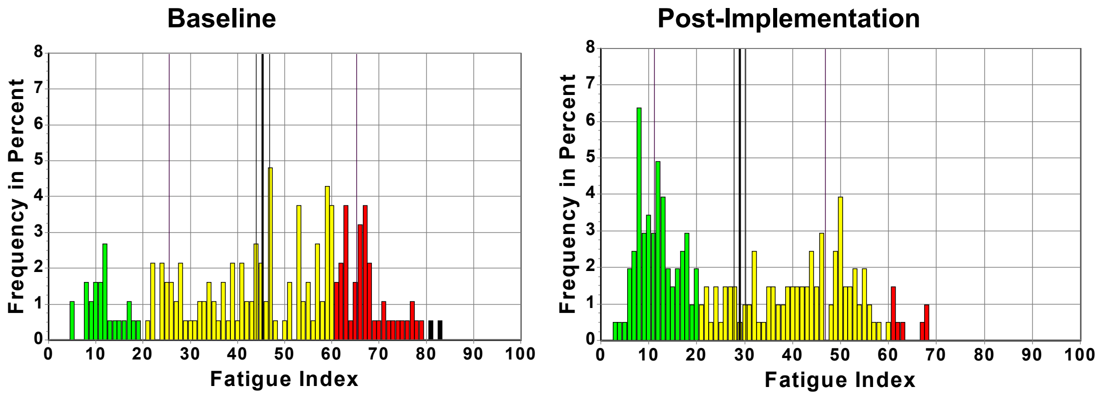

Figure 3: Frequency Distribution of Fatigue Risk Scores for Drivers Before (left) and Nine Month After (right) the Implementation of the RIPB Fatigue Management System. The Fatigue Risk Score Scale (Horizontal Axis) Ranges From 0 (No Fatigue) to 100 (Extreme Fatigue). Fatigue Score Group Averages are Indicated by Vertical Lines. A Significant Shift Towards Lower Fatigue Risk Scores was Observed after the Implementation of the RIPB Fatigue Management System.

The reduction in fatigue risk scores was associated with fewer incidences and lower costs of accidents (Figure 4). The total number of truck accidents dropped 23.5% from an average rate of 2.30 per million miles for the three years prior to the intervention, to 1.76 per million miles for the first year with the RIPB safety management system. The average cost per accident dropped 65.8% from $12,088 to $4,820 (t-test, $p<0.05$). Severity accidents (over $20,000 cost) dropped 55% from an average rate of 0.20 per million miles to 0.09 per million miles, and the average cost of severity accidents dropped 66.7% from $152.384 to $50,809 per accident over the same time period (t-test, $p<0.05$). Further, the total cost of loss-of-attention accidents (defined as collisions hitting the rear of another vehicle, loss of control) dropped 80.9% from a pre-intervention level of $1,187,699 to $226,627 per year.

As a result, the cost of insurance claims (primary insurer) dropped significantly after the implementation of the safety management intervention. As seen in Figure 5, the costs of insurance premiums (gross written premiums – GWP) and claims for any given time period tend to have a gap that is largely due to the lag between the insurer's recognition of changes in the rate of claims and subsequent premium adjustment. As a result of the RIPB program, the loss ratio (insurer losses / gross written premium) dropped from 147% to 26%.

Long-term Effects

Recognizing the effectiveness of the RIPB fatigue management program, the trucking company maintained the program in place for several years after the completion of the initial intervention study. Here we report the results of a three-year follow-up study with approximately 125 drivers from Dupre' Transport's truckload division, which operates non-scheduled irregular-route services. In addition to the described management-related interventions of the RIPB process, the program also included driver sleep and alertness management training.

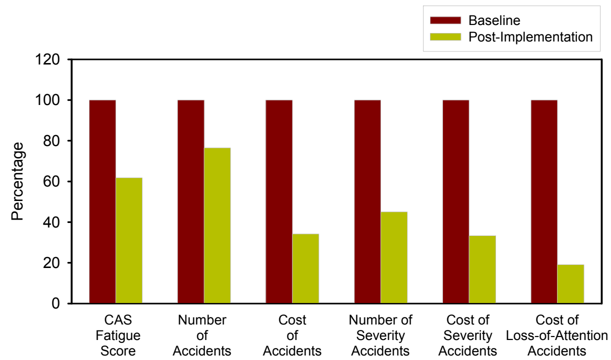

Figure 4. Effect of the RIPB Fatigue Management Intervention on Fatigue Risk Score and Accidents. Post Implentation Data Are Shown as a Percentage of Baseline.

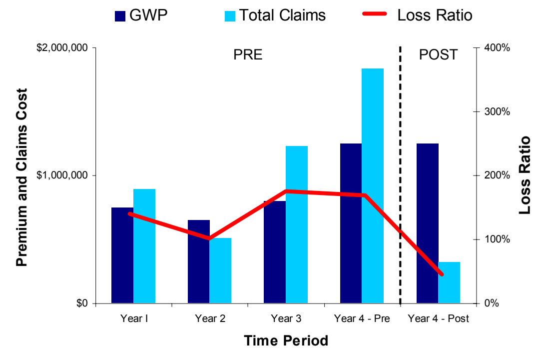

Figure 5. Gross Written Premium (GWP) and Insurer Losses (Primary Insurer Only) Before and After the Implementation of the RIPB System

The average of the individual monthly CAS fatigue risk score at the end of the third post-intervention year showed significant improvement compared to the baseline month, and the number of drivers with scores in the highest risk zones was substantially reduced (Figure 6). The progressive change in the mean fatigue risk score during the post-intervention period is shown in Figure 7.

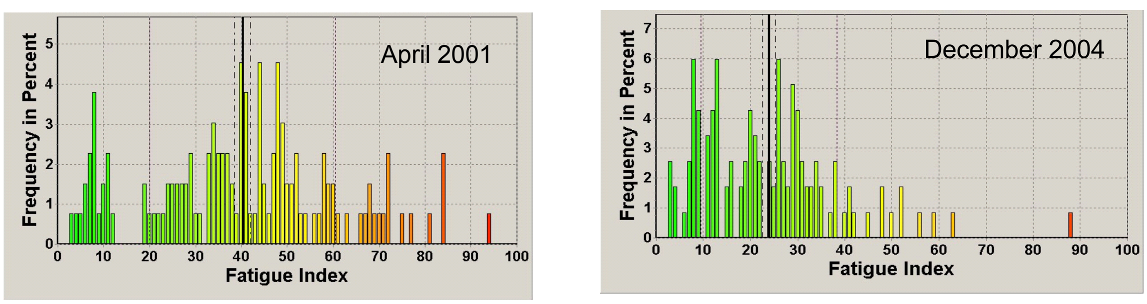

Figure 6. Frequency Distribution of Fatigue Risk Scores for Truckload Drivers Before (left) and After (right) the Implementation of the RIPB Fatigue Management System

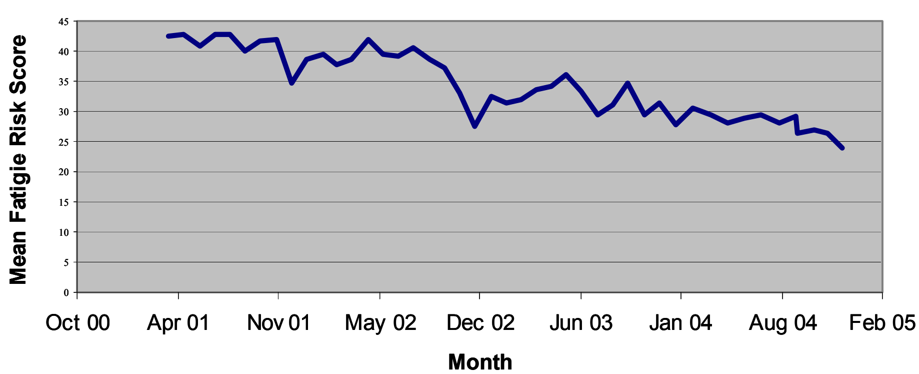

Figure 7. Mean Fatigue Risk Score for 125 Truckload Drivers Month-by-Month During the Implementation of the RIPB Fatigue Management System

The reduction in fatigue risk scores was associated with a decrease in accidents, personal injuries and turnover for this driver group. Figure 8 (left) shows the decrease in the "Big Four" accidents (rollovers, rear-end collisions, lane change accidents, intersection accidents) most likely to be associated with driver lapses of attention. The accident rate of 1.29 per million miles found in the three baseline years (fiscal years 98/99, 99/00, 00/01) fell during the next three fiscal years to 0.9 (01/02), to 0.8 (02/03) and to 0.5 (03/04). Personal injuries (Figure 8, right), standardized per 200,000 hours worked, showed an equal improvement during the same time period (three baseline years: 4.89; third post-intervention year: 1.1). The benefits of the program extended beyond safety statistics, which is illustrated for example by improved turnover rates (three baseline years: 107% per year; third post-intervention year: 69% per year). These long-term effects were not only observed for the selected operation. Similar improvements due to the RIPB system were seen across the entire company including drivers on fixed routes and local deliveries (Figure 9).

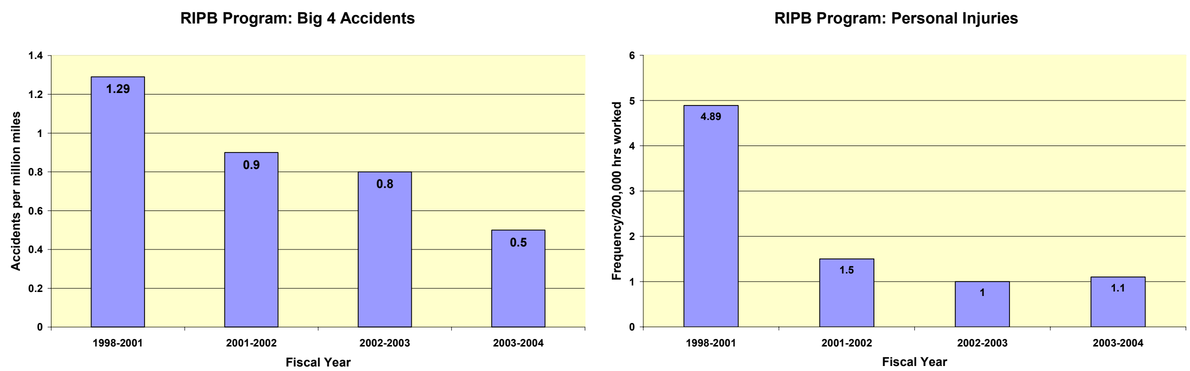

Figure 8. Accidents (left) and Injuries (right) for Drivers (Truckload Division) During Baseline (Three Fiscal Years 1998-2001) and During Three Years after the Implementation of the RIPB Fatigue Management System (Fiscal Years 2001/2002, 2002/2003, 2003/2004). Accidents (Incidents per Million Miles) Include the "Big Four" (Rollovers, Rear-End Collisions, Lane Change and Intersection Accidents)

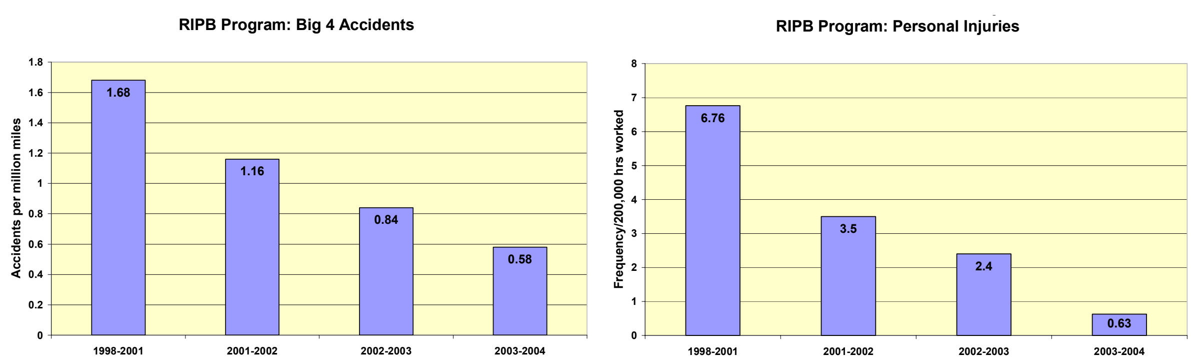

Figure 9: Accidents (left) and Injuries (right) for Drivers (Entire Company) During Baseline (Three Fiscal Years 1998-2001) and During Three Years after the Implementation of the RIPB Fatigue Management System (Fiscal Years 2001/2002, 2002/2003, 2003/2004). Accidents (Incidents per Million Miles) Include the "Big Four" (Rollovers, Rear-End Collisions, Lane Change and Intersection Accidents)

CONCLUSIONS

Managing by performance-based measures is a well-established method for achieving tangible business outcomes. The key is determining the right performance measure. The most obvious measure for trucking safety might have seemed to be accident rate, but accidents are infrequent events and do not provide a measure of individual driver risk on a month to month basis. Furthermore, it could encourage under-reporting of accidents. In contrast, using a fatigue risk score in an risk-informed performance-based safety management system enables managers to judge the relative risk of various work assignment and scheduling options, and gives them incentives to address some of the most important causes of driver fatigue, and therefore, of fatigue-related accidents. This approach enables managers and dispatchers to make safety-conscious decisions while having sufficient flexibility to balance the specific business needs of their operation, and therefore, stay competitive.

The application and assessment of the RIPB safety management system was very successful, resulting in a reduction of accident rates and costs as well as an improvement of other operational measures. Effectiveness of the RIPB program has now been sustained over a period of more than three years.

This study opens the door to introducing sleep and fatigue management systems, which can not only compliment Hours-of-Service regulations, but also could allow the relaxation of overly prescriptive rules that prevent drivers from making sensible choices as to when to rest and when to drive. In the future, such safety management systems can be further enhanced by incorporating other elements. These could include the application of emerging technologies such as electronic truck monitoring (e.g., telematics) to objectively confirm hours of rest, in-truck devices for monitoring driver alertness which warn drivers of dangerous impairment, or terminal-based fitness-for-duty testing.

ACKNOWLEDGMENTS

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REFERENCES

Moore-Ede, M.C., Heitmann, A., Guttkuhn, R., Trutschel, U., Aguirre, A. & Croke, D. (2004). Circadian alertness simulator for fatigue risk assessment in transportation: application to reduce frequency and severity of truck accidents. *Aviation, Space, and Environmental Medicine*, *75*(3): Suppl. A107-18.