



ALERTNESS 2000

TOOLS FOR MANAGING
FATIGUE IN TRANSIT
OCTOBER 26-27, 2000

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**ALERTNESS 2000:
TOOLS FOR MANAGING FATIGUE IN TRANSIT**

Day One

October 26, 2000

**Doubletree Hotel
Arlington, Virginia**

PROCEEDINGS

**Chairperson Lynn Sahaj
Deputy Associate Administrator for Program Management
Federal Transit Agency**

This symposium is a follow-on to the Fatigue Symposium that was held in February 1998. It is known as the Alertness Symposium, which reflects the positive rather than the negative.

Since the first symposium, transit professionals have obtained more experience with this issue and have been able to put some of this experience into practice. They have also begun some education efforts. This symposium is a joint effort of the American Public Transit Association, the Community Transportation Association of America, the National Sleep Foundation, and the Federal Transit Administration.

SESSION I: THE NATIONAL IMPERATIVE

**Patrick Reilly
Chief Council
Federal Transit Administration**

Safety is a top priority of the Department of Transportation and Secretary Slater. This is not rhetoric; it is a commitment to the American public. For example, the Department established a Human Factors Coordinating Committee and the DOT Safety Council to stress the importance of safety. Safety is a major issue for all transportation modes. Jolene Molitoris, the Administrator of the Federal Railroad Administration, will discuss this later in the session.

Promoting public health and safety by working toward the elimination of transportation-related deaths, injuries, and property damage is the number one goal in the Department's Strategic Plan. Secretary Slater always reminds DOT employees that safety is a promise that they all must keep together.

Last year, transit ridership continued to increase, reaching a record high of nine billion trips. Bill Millar, President of APTA, makes note of that fact at every public forum he attends. With current FTA funding at record levels, there has never been a greater need to integrate system safety concepts into the project development process.

As Acting Administrator Nuria Fernandez says, "Early integration of system safety concepts in the planning, design, and construction of major capital projects directly supports the Department of Transportation's number one strategic goal by working toward eliminating all transportation-related deaths, injuries, and property damage." That is a tall order, but it is an excellent marker to work toward for everyone who is part of the transportation industry.

FTA's Office of Safety and Security is committed to fulfilling Secretary Slater's number one priority of safety. Working with all organizations involved in the development of rail-fixed guideway systems, FTA assists the transit industry, as well as state and local organizations, in providing the highest practical level of safety for passengers and employees of the nation's mass transportation systems.

FTA partners with the American Public Transportation Association and rail transit agencies in revising rail safety guidelines. It develops training and technical assistance for use by the industry in maximizing system safety programs. FTA integrates its state safety oversight programs with the safety and oversight activities of the other agencies.

FTA's concern with fatigue was heightened after a transit incident in 1995. The National Transportation Safety Board investigated it and concluded that fatigue was the probable cause. NTSB then recommended, and Congress directed, that FTA develop training in fatigue awareness.

FTA has responded to this Congressional directive. In collaboration with the Transportation Safety Institute (TSI) in Oklahoma City, FTA developed a training course on fatigue awareness designed to improve the operational safety of transit service providers and promote the personal security of the riding public and transit employees. The fatigue course has been offered to more than 1,500 people since 1998.

TSI strives to raise awareness levels of the safety risks of fatigue. Together, FTA and TSI offer training that provides the transit industry with the tools it needs to solve and/or prevent any potential risk to the safety of transit riders. In conjunction with APTA, FTA sponsored a Fatigue Symposium in February of 1998 that brought together fatigue experts from around the country, as well as transit industry staff responsible for fitness-for-duty programs and training. Alertness 2000 includes a more extensive cross-section of fatigue experts and others concerned with fatigue and its effects on transit operations.

The agenda includes everything from operational and labor issues to methods to identify those at risk for fatigue to the use of over-the-counter and prescribed medications. FTA, FRA, and DOT are all committed to transit safety. Through collaborative efforts and hard work, they will continue to be responsive and will work to prevent safety risks for the American traveling public.

Jolene Molitoris
Federal Railroad Administrator
Federal Railroad Administration

Working together is the only way we can mitigate, alleviate, and finally eliminate fatigue in our transportation industries.

A great deal has happened since the Fatigue Conference two-and-a-half years ago. Some of the major themes of these events will be touched on at this conference and, hopefully, they will resonate with transit professionals who face fatigue issues.

Pat Reilly's comment concerning partnerships should be underscored. The problem of congestion; i.e., increases in transportation use, people driving, trains traveling, buses, bicyclists, and transportation demand is going to double and probably triple in the next 20-25 years. Those who do not walk to work have some sense of what this might mean.

The exciting thing about the last eight years at FRA was the opportunity to see historic things happening. First, partnerships became a new way of doing business. In 1993, FRA was encouraged and, in fact, mandated to look at the current way of doing business and determine how it could be improved.

A lot of time was spent on the listening process: listening to customers, as we they began to call them, listening to FRA's work force, listening to citizens. The message received was: The Federal Railroad Administration, and the themes were pretty consistent for all operating administrations within the Department, had to be more responsive, more action-oriented, and more willing to listen to and involve its customers.

Throughout the entire process, the Federal Railroad Administration had an opportunity to examine itself. It had been doing a good job of giving tickets and fines and had increased those numbers. However, when the actual amount of safety for the investment was examined, there was not a good return. The targeted hazards were not decreasing.

FRA had to find a solution. There were only 400 inspectors for the whole country, which we knew were not enough. That was the first fundamental, underlying fact. Whatever APTA decides on must be done through each individual member, not alone; it must be a cooperative effort.

Cooperation is very interesting. When the history of the railroad industry is considered, communications and trust might not be the words associated with it, but they are the foundation for partnership.

FRA established two new venues—the Safety Assurance Compliance Program and the Railroad Safety Advisory Committee. Both were composed of diverse groups of people invited to help accomplish FRA’s task.

What is the connection with fatigue? As FRA employees listened and learned, focused on data and facts, they delved into the facts about crashes and tragedies, and learned from experts about the science of fatigue mitigation, it became obvious that FRA could not take on the task alone.

It was at this point that FRA proposed establishment of the North American Rail Alertness Partnership, or NARAP. It was an historic undertaking—all of the major constituents of the railroads, including rail labor organizations, members of APTA, and members from Canada and Mexico, met, discussed, and developed best practices to eliminate fatigue. Thus far, these efforts are succeeding.

We must eliminate fatigue in order to save lives. The science of fatigue mitigation and its data prove that fatigue is related to many different types of transportation tragedies and probably costs over \$3 billion a year. In a Department of Transportation (DOT) publication entitled *Focus on Fatigue* it is stated that DOT “...considers fatigue to constitute a significant risk factor in a national annual loss that totals \$137.5 billion from highway crashes alone.” Within the railroad industry, approximately 35 percent of all reportable accidents/incidents are related to human factors, and fatigue plays a significant role in these factors.

The North American Rail Alertness Partnership was recognized in Australia this year at the International Fatigue Symposium.

FRA always challenges APTA because it is up to every challenge we present, and gets the job done. A NARAP, or NATAP (North American Transit Alertness Partnership), is something that should be considered since the problem must be discussed and considered from all perspectives and with as much information as possible. Partners can discuss successes and failures and can avoid repeating the mistakes of others.

All of the major railroads in this country, and many of the smaller ones, have activities that have moved from being the exception to being the rule. Education on the causes and effects of fatigue is number one, foremost and not only for individual team members or employees, but for their families too. This education is not just about the quantity of sleep, but also its quality. It is about nutrition and other life practice habits that contribute to fitness for work. There is a focus on scheduling. The railroad freight industry is not as fortunate as transit with regard to having schedules. It is a goal FRA is working toward with APTA's help, but it has not yet been achieved.

We must focus on finding ways to maximize a healthy work schedule. Where do freight employees rest when they are not at their home base? What kinds of lodging do they have? What about napping? Five years ago, nobody could take a nap while on duty. Today, under certain conditions, they can, and they are more fit for work. There must be sleep disorder screening procedures that are voluntary and confidential. It is critically important to guarantee a minimum period of undisturbed rest, generally eight hours at home terminals, and to not call workers before 7:00 a.m. when they have been on vacation or off duty for 72 hours.

These are some of FRA's accomplishments. Every railroad has a success story. Their employees are energized, feel more valued, are less prone to absenteeism, and their health is better. These are all reasons to give this a try. FRA believes this will contribute to a 21st century transportation system that can respond to the demands that it must face.

There is no time to wait. FRA has set schedules that others have labeled as too aggressive, but usually meet our goals. Aiming too high and falling a bit short gets you further than aiming too low.

How much time is needed to get started—about six months. We must have organizational meetings and the beginnings of a NATAP by that time. Not only is this possible, it will provide returns that cannot even be dreamed about now. The Federal Railroad Administration and its fatigue team are available to assist in this endeavor. It will benefit the transit industry and, more importantly, it represents one more step towards the prevention of injuries and fatalities.

Robert Clarke
Safety & Health Team Leader

Office of Transportation Policy
Office of the Secretary of Transportation

I would like to inform you about the role of the Safety Council and its Human Factors Coordinating Committee and the activities that relate to both human factors and fatigue across all the modes with an emphasis on activities involving fatigue and alertness in transit operations.

Fatigue and alertness are obviously not just issues specific to a single mode of transportation. Transportation operators are, after all, human beings. Many of the issues and concerns that are evident in one mode are evident in others as well. This is especially critical in commercial or public transportation settings where people are operating transportation equipment for a living.

There are common themes, information and techniques that can be learned and applied across modes. This information, however, must be tailored and focused differently for each mode.

The point that Administrator Molitoris made about a transit partnership is absolutely crucial. Ultimately, it is the people in the transportation setting of individual companies that have to take put this information into practice.

All modes can learn from each other. Administrator Molitoris noted that she is willing to help by sharing the experiences from the rail industry that are applicable to transit. The trucking industry will have speakers expressing similar thoughts later in the session.

Through collaborative efforts in the Department, we have learned that there is a great deal of work going on in the maritime industry, the pipeline industry is interested in it, and so are rail and transit. It cuts across all modes of transportation and each can learn from the others. There is no need to duplicate efforts.

As Administrator Molitoris has pointed out, the key is collaboration. This is not a problem that the government is going to solve. Transit professionals must solve this problem in collaboration with the operators and managers in their organizations. It will take the efforts of researchers, government officials, and everyone else to accomplish.

Alertness and fatigue are something that can be worked on cooperatively across all modes, and efficiencies can be achieved. In the Department, this work on fatigue is being done through the Human Factors Coordinating Committee. This group has existed in DOT for about 10 years, but it has been receiving heightened importance and recognition within the Department recently. It is comprised of individual staffers and researchers from each operating administration.

The group meets relatively frequently to share findings of studies and other information that applies to fatigue and other human factors. It has helped formulate a unified and cohesive approach to human factors issues in the Department.

The group, under the auspices of the Safety Council, sponsored a symposium this past August on the issues of fatigue and alertness. Representatives from operating companies in all the modes of transportation, as well as researchers and others, were invited. The participants met for a day-and-a-half in Virginia to discuss commonalities. Speaker after speaker, from maritime, pipeline, transit and other industries, emphasized similar themes and needs, as well as varying levels of awareness about information that was available and techniques that could be applied.

The maritime and rail industries seem to be farthest along in terms of formalized programs and partnerships. Much can be learned from this for other transportation modes. As more techniques and procedures are discovered in all transportation industries, those professionals involved must not look only to each other but to the professionals in other modes as well.

At the conference, we discussed a unified One DOT fatigue management program. This past summer, the Department announced a solicitation for a collaborative industry/government partnership program that would be multi-modal in nature. The Department believes that many of the techniques that can be learned from aviation, maritime, and other modes can and should be applied here.

The Department is looking to validate this point by getting collaborative partnerships wherein operators from more than one mode combine with a consortium to develop tools, analytical methods for assessing operations, and best practices and then identify areas where there are commonalities and where exchanges can take place.

Ultimately, all this work can and must be tailored to individual situations. No two operating companies will have the exact same issues and situations, but there are certainly common themes and common techniques that have applicability.

The closing date for that solicitation is December 15, 2000, and the Department hopes that some of you in attendance here today might bid on this partnership. The results of that symposium will be posted on the Internet at <http://scitech.dot.gov/reeng/hamperf/hamperf.html>. There will also be some paper copies of the proceedings, along with a list of the approximately 140 participants.

William Millar
President
American Public Transportation Association

Keeping a focus on this issue is an important service for APTA's industry, employees and customers; we are very pleased to be a part of it.

Public transit has historically been one of the safest modes of transportation. The statistics indicate that one is 47 times less likely to die on a a trip if one travels by bus rather than by driving a personal automobile. The various accident rates and injury rates indicate that transit is a safe industry.

It is safe, but, as Administrator Molitoris, the National Transportation Safety Board and others have pointed out, just because it is comparatively safe relative to other means of transportation, does not mean that it cannot be better and safer.

One component of becoming better and safer is dealing with the issue of fatigue and alertness and fitness for duty. It is a complex issue and it is sometimes difficult to get a handle on it. As Administrator Molitoris said, transit professionals have to start by realizing that they do not know what they do not know. Once they have that realization, they need to plot a course that will teach them what they do know. In areas where no one knows anything, a research program must be established that will provide data and information, so that the path forward can be defined.

While fatigue is an issue in virtually every industry, in public transportation the risks of not dealing with fatigue-related issues are very high. APTA served over nine billion customers last year. Thirty million Americans will board transit vehicles today. That represents a great number of opportunities for problems to occur, and it helps illustrate the great responsibility that transit providers have in serving those 30 million riders.

As the various accidents, crashes, and incidents that occur in the transit industry are analyzed, researchers have begun to realize that fatigue plays a much more important role than was believed just a few years ago. While the industry is doing well, while its ridership and its financial base are growing, while its importance to the economy and citizens is being better understood, now is a great time to deal with this issue and to build on the knowledge base from the other industries.

There is a need to understand what the impact of fatigue is on transit. When employees suffer from fatigue, their judgment and performance can be seriously affected. It deserves high priority status. The various agencies at this symposium, have made it clear in one way or another that they expect APTA to work with them in this area, to make progress, and to serve its customers by dealing with the issues.

Mr. Lauby is going to discuss the fact that fatigue is the number one most wanted safety improvement at the National Transportation Safety Board. Administrator Molitoris already discussed its importance in FRA. FRA's proposed improvements to the Rail Safety Act contain there is one for fatigue mitigation plans.

Patrick Reilly discussed the emphasis that FTA is putting on this, particularly the approach they have taken to not only increase awareness on the issue, but also to encourage the Transportation Safety Institute and others to offer courses in dealing with the problem.

So it is clear that many of the agencies in the transit industry have given this high priority and have expressed their willingness to help APTA deal with this issue. APTA has already recognized this as important and was part of the seminar on the subject held a couple of years ago.

Its importance is seen by the fact that we are here a couple of years later at a follow-up symposium, by the fact that in the interim period at nearly every major conference there have been sessions on the issues surrounding fatigue management and alertness, and by the fact that several of the major APTA committees, not just the safety committees but various operations committees as well, are taking on fatigue as serious policies and something for which we must develop procedures and best practices to benefit its customers, employees, and industry.

A great deal is happening, but until every transit property makes fatigue one of its top issues and puts together an appropriate plan for the situation that they face, and every employee is involved in understanding what the implications are and what can be done to address it, every few years these symposiums will be held. Accident rates will be still higher than they need to be and there will still be causes that relate to fatigue.

Some critics feel the price for this is too high, as it is already a safe industry. A high price is a very relative issue. Is the price of the bodily injury that results from an accident caused by fatigue high? Is the price of a loss of life high? Is the price of the loss of a loved one high? Is the price of lost workdays high? Is the price of families torn apart high? Is the price of people having their lives changed forever high?

The list could go on and on. Changing the way business is done probably does have a high price and APTA is not oblivious to the economic costs. In running a transit system, a budget has to be met and tough decisions about resource allocation have to be made every year, so the money costs of this issue should not be minimized. These costs are potentially staggering, but what is really at stake here is whether the agencies have the courage to change their priorities. At present, transit agencies do not want to add additional employees, which would enable shifts to be shortened and mandatory and/or voluntary overtime to be eliminated. This is a very real problem.

Employees will not want to give up the overtime, as it has become a lifestyle issue for them. Their base pay may earn them a certain amount of money, but as overtime has become plentiful, they have adjusted their lifestyle and they are not going to want to give it up.

In looking at costs, however, one should look at the costs of service delays that result from accidents that occur, the costs of the crashes on the line, and the costs of maintenance that is not done properly due to fatigue. Who benefits from that? Who benefits from courts settling tort claims resulting from these incidents? The costs involved are very high.

The question, again, is whether the agencies have the courage to change. This symposium is about figuring out the way to go, so that the agencies can have that courage and that confidence. It is now widely known that there is a problem and that something needs to be done about it, but what are the right strategies to go forward? What will work in each community? What will different agencies' employees accept and what will taxpayers accept? All these balance issues need to be worked out.

Much more information is needed, especially about what works and what does not work. There is also a need to appreciate the impact on the transit properties. It is fine to learn about what other organizations have done, but how many agencies collect data on their own operations that would allow them to understand the issues that affect them.

Some symposium attendees have participated in a survey APTA has been conducting over the last year. The results should be announced soon. This will paint a better picture of what is going on in the industry. The overall picture of the industry will then have to be applied to each property and issues resolved.

Much of the discussion at this symposium will relate to lifestyle, to what agencies expect of their people, and to how employees have learned to live. These are some basics. The employees are whole people, and they are involved with their families and communities. Yet, if they have the basic understanding of how important rest is to their ability to do their jobs effectively and safely, it will help them better balance the choices that have to be made.

So there are many things to think about and no shortage of issues to discuss, define, research, and solve. However, the ultimate question is whether the agencies have the courage to change.

**William Keppen
Consultant
Fatigue and Alertness**

There must be something to the power of partnership because a couple of speakers have already discussed partnership efforts. You are now going to learn of how it is dealt with in the freight railroad sector.

Over twenty years ago, I, the speaker, woke up in the middle of the night terrified. I was going down the track at fifty-plus miles an hour and did not know where I was. I seemed to be in between automatic block signals and blindly running around curves, not even knowing if I was approaching an intersection. That was my first real experience with being overcome by the effects of fatigue. It snuck up on me, him and I did not even know what was happening. It was a baptism by fire, and it transformed me, turning me into a crusader for fatigue mitigation.

At that time, I viewed this as my problem. It took what seemed like hours to get the train under control and see the next signal. I heaved a big sigh of relief when it was green and we were able to go onward. That was just a dream, but I had nowhere to go with the problem.

Certainly, it could have been a much bigger problem for the my employer, for the industry, and for the crewmembers of another train had he been meeting a train on a siding or some other similar situation, but that was not the case. At the time, fatigue was dealt with in the railroad industry by a rule that did not allow employees to sleep. Thus, there was no problem.

The reality was that a culture existed that, as with drugs and alcohol, supported putting these things underground. This meant that I could not go to his peers because they would have laughed and scoffed. I was stuck and did not know what to do. At the time, I was a local chairman for the Brotherhood of Locomotive Engineers, and a lowly locomotive engineer without much stature in the industry. No matter where I went with the problem, I could not change the outcomes.

I felt I had generally been a conscientious employee. I had had no injuries or rules violations on my record. However, I did not understand the issue of fatigue and how it affected performance. I had only this one experience from which to draw. I decided to get some education on the subject and to do what I could to start to address fatigue and resolve this huge safety issue that was affecting a large number of employees. The bottom line was that an accident was going to affect the employer as well as the employee. It could also affect an entire community if the accident involved others.

So I began in the late 1970s to involve myself and to try to keep pace with the science. I also began, through my experience, to try to promote fatigue mitigation and alertness management in the freight railroad sector of the industry, trying to branch out into other areas.

In 1983 and 1984, there was a series of accidents on the railroad for which I worked that killed about a dozen operating employees. None of those accidents resulted in a finding that fatigue was a contributory cause. All of them took place at night and, because of my experience and research, I was absolutely convinced that some of the accidents were, at least in part, due to fatigue.

At that time, having learned from my studies, I was able to talk to people. They put together an initial training program that was ready by the mid-1980s. It was a good start, but interest rapidly waned. There was not really a partnership at the time, so they were essentially right back where we started, a rule that you do not sleep when you are working on the railroad.

In the middle of the night on November 7, 1990, on a siding in Corona, California, two Atchison-Topeka and Santa Fe trains (ATSF) met head on. The ensuing report found that: “The engineer of train 818 failed to stop his train on the Corona siding at the stop signal because he was asleep, or in a micro-sleep brought about by chronic and acute fatigue.

“The chronic and acute fatigue of the engineer of train 818 was a result of the irregular and unpredictable work schedule. Because of fatigue, the conductor of the train 818 either was asleep or was experiencing a micro-sleep. As his train approached a stop signal on the west end of Corona siding, the brakeman of train 818 failed to take action to stop the train, probably because he fell asleep as a result [of] acute fatigue.

“ATSF Company did not have a policy or procedure in place to address the issue of employee notifying the carrier of his or her lack of sufficient sleep. When the engineer of train 891, the opposing eastbound train that had been signaled, proceeded down the main track at normal

speed, saw the two R signal at Corona suddenly turn red, it was too late to take action to avert the accident.”

The price was four employees killed and two seriously injured. The damage was estimated at \$4.4 million. A lot of fatigue mitigation efforts could be funded with that kind of money, and the loss of life and serious injury cannot be overlooked.

NTSB recommended that railroad management and labor cooperate to develop an education and counseling program designed to improve the knowledge of crew members on health and diet regimens and methods of avoiding sleep deficits and sleep deprivation.

In addition, NTSB recommended to railroad labor and management that they develop a policy that would allow the carrier to stop employees from accepting assignments and would allow the employee to report off-duty when impaired by lack of sleep.

At that point, I felt that I finally had a partner. I saw the NTSB drawing attention to fatigue and actually directing an activity as the first help I had received in these efforts. At that time, I was a vice president with the Brotherhood of Locomotive Engineers and had just moved to the Cleveland office. When I went to the files, I discovered that the response to NTSB was simply a general acknowledgement of the recommendation. The Brotherhood said they would move forward with the effort, but nothing more has been done.

So I went to the union President and asked permission to follow up on these recommendations. The President authorized to write a letter to the Association of American Railroads for his signature. In this letter, I suggested to AAR that the BLE, and its sister union, the UTU, were ready to sit down and talk about the recommendations contained in the investigation of the Corona accident.

That was the beginning of the first such partnership, one that actually predates NARAP. It is something many people can feel proud about. It marked the first time the important players got together in the same room. Labor and management sat down together, they recognized that a problem existed, and they decided to seek solutions.

That was the way it had to be approached because there wasn't enough known about the issues. A program to address fatigue and alertness could not be fashioned overnight. This effort has now been ongoing for eight years.

This partnership is anxious to share its experiences with other transit professionals and is hopeful that other groups and agencies will share their experiences and initiatives with us.

Lately, I have seen a level of commitment from management on this issue that he had not previously witnessed. I am proud to have been part of this effort for over 10 years. I have also seen labor do things that no one ever thought they would be willing to do. They have addressed issues like overtime and working too many miles because the pay system is, for the most part, based on miles. Hours, however, were not even considered, in most cases, until we began to examine the issue of fatigue.

Labor has stepped forward to and taken a leadership role on fatigue. And although they have to take the heat from that group of members that would like to work whenever they want and run as many trains and miles as they want, they will move toward finding solutions for fatigue in the railroad industry.

Although you cannot measure accidents that do not occur, my organization has had far fewer of them, and it is because of our efforts.

I am not an abolitionist when it comes to regulations, but I do believe more progress can be made through collaborative efforts than through well-intentioned but inflexible rules and regulations. Transit professionals should not allow inaction to be the cause for further regulation.

Robert Lauby
Director, Office of Railroad Safety
National Transportation Safety Board

The acknowledgement of the challenges of fatigue by the modal agencies from the DOT and from the American Public Transportation Association is very heartening. This means that the National Transportation Safety Board and others in the transportation industry have done their job and brought the attention to fatigue that is needed.

Simply having this conference is a success story, but it is not complete. There is plenty of work to be done, but just having you folks here today really puts us on the right road. The Safety Board's perspective on fatigue and examples of areas where it is important are my reason for being here today.

A number of good examples have already been given at this symposium, so those will be skipped. However, NTSB does have a unique perspective on the problem, so there are areas remaining areas to be discussed.

Human fatigue is one of the most widespread safety issues in the transportation industry. According to NTSB's statistics and statistics from other areas of the industry, 80 percent of the accidents that occur in the transportation industry are caused by human error. A significant number of these are directly related to fatigue. It may not be so concrete as an NTSB Probable Cause that says that the operator was asleep, but whenever there are errors in judgment, there is a strong possibility that fatigue might be involved.

NTSB has issued over 100 fatigue recommendations to all modes of transportation. These recommendations, in general, have covered areas like scheduling practices, fatigue educational programs, and hours of service. This is an enormous problem that cuts across all boundaries. Everyone is subject to fatigue, irrespective of age, gender, or occupation. Airline pilots have no more ability to resist fatigue than does a locomotive engineer, a transit operator, or a bus driver.

NTSB has identified fatigue as a causal factor in several accidents. One of them was the June 5, 1995, rear-end collision of two subway trains on the Williamsburg Bridge in New York. This accident resulted in the operator of the striking train being killed, but it also has resulted in some positive changes in the transit industry concerning fatigue. NTSB determined that the probable cause of that accident was failure of the striking operator to comply with the stop indication because he was asleep.

As a result of the accident, NTSB issued several recommendations, to which FTA, APTA, and FRA have been very responsive, and much work has been done since. There was the symposium in February 1998 for the purpose of educating the transit industry on transit operator fatigue issues. FTA hosted the Fatigue Awareness Roundtable on March 26, 1998, the result of which was development of a fatigue awareness course.

New York City Transit also deserves recognition because they independently developed a fatigue training and educational module. They currently provide that training to train operators and other safety-sensitive employees.

Although New York City has developed this and incorporated it into their standard training program, not many other transit agencies have done the same. This is an area where there is real opportunity for transit operations to come forward and include this in their standard employee training.

Fatigue programs need to be assigned the same level of importance as other safety programs. Transit companies typically prepare a System Safety Program Plan that demonstrates their commitment to safety. These plans cover traditional safety concerns such as hazard analysis, operating hazards, and emergency preparedness. Fatigue education, however, is not required to be part of these plans. It is a mystery, however, how a fatigue countermeasures program that would affect everyone that works in transit operations would not be considered an essential part of any comprehensive safety program plan.

NTSB understands that fatigue is a multi-faceted problem. The most obvious source of fatigue is the amount of time that one works. As part of an investigation, NTSB interviewed one transit bus driver. He indicated that he typically chose to work 16-hour days, six days a week. That schedule translates into 96 driving hours a week and over 400 hours per month. Allowing any transportation worker who is performing a safety-critical operation to work this many hours is unconscionable.

A second factor influencing fatigue is sleep disorders, such as sleep apnea, which can prevent a person from getting quality sleep and from ever being well rested. The light rail accident that occurred at Baltimore-Washington International Airport in August 2000 is an example of this. In this accident, a light rail train traveled past a stop signal and struck a barrier in front of the doors of the airport terminal injuring several people. It is still being investigated and the final cause has not yet been developed, but the operator of that train testified to NTSB that he had blacked out shortly before the collision. Following this accident, the operator's personal physician sent him to a sleep clinic. He was diagnosed with severe, obstructive sleep apnea, a condition that causes a person to temporarily stop breathing during sleep and results in poor

sleep quality. An operator suffering from this type of condition is more susceptible to a decrease in performance due to fatigue.

How commonplace is this condition? Dr. Mark Rosekind will discuss that later, but, of the 24 people at the NTSB Office of Railroad Safety, at least three, including myself, are using continuous positive airway pressure, or CPAP, machines. These machines are a treatment for sleep apnea.

A third factor is the manner in which medications, both prescription and over-the-counter, can cause drowsiness during the day and affect an operator's performance. NTSB has investigated numerous accidents where over-the-counter drugs have been involved, including the first one I investigated as an NTSB employee, an accident that occurred in Palatka, Florida in 1991.

In that accident, an engineer and an assistant engineer were operating an Amtrak train. The engineer was in charge and was supervising the assistant engineer to make sure that operations were according to the rulebook. The engineer had a bad cold, was taking a cold medication, and felt drowsy as the train approached a curve in Palatka, Florida. The train failed to slow from 73 miles per hour to 30 miles per hour, the speed at which they were supposed to enter the curve, went into the curve in excess of 70 miles per hour, derailed, and knocked a local house off its foundation. It was quite interesting for the residents to wake up and find a locomotive lying in their front yard.

This is just one of many examples in which over-the-counter or prescription medications have contributed to fatigue problems. Since 1979, NTSB has issued 43 recommendations on the use of over-the-counter and prescription drugs. Twenty-three of these were issued in January 2000 after NTSB issued a report on the effect of drugs and medication on people in safety-sensitive positions in the transportation industry.

Looking ahead to where the transportation industry is headed, there are some developments that stand out. Transit companies are being created across the country to serve the needs of growing communities and the needs of America's fast-paced society. For example, Seattle's Sound Transit Commuter Rail Service just started operations last fall. Transit is a rapidly growing industry.

Technological advances are being introduced as part of these new systems, and some of them are highly automated, sophisticated systems that will hopefully increase the safety and efficiency of transit. In the near-term, however, systems will remain dependent on human operators with all their good qualities and all their shortcomings to provide safety.

The industry must be sensitive to the needs of these operators as their role is redefined with the new technology that is coming and with the challenges that they are going to face operating ever more complex systems.

The organizers of this symposium and the work that has been done are to be applauded. These complex issues are not just in transit, they are in all modes of transportation. Aviation, highway, truck drivers, and pipelines are good examples. If transit professionals continue to work together, they can move forward and get the message out to those in the transportation industry,

to whom many lives are entrusted each and every day.

SESSION II: ALERTNESS 101

Mark Rosekind
President/Chief Scientist
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The speaker began by asking how many attendees got at least eight hours of sleep the night before the symposium. This is the first question in a six-question quiz. He will reveal at the end of the presentation why he is asking these questions. It will be graded only by each attendee, but, as will be seen by the end of the presentation, everyone sitting around or driving near him/her will want to know how he/she did.

Three main topics will be discussed here today. First, we will talk about the science of fatigue and the scientific data that is available. It will provide a larger context on the issue of fatigue in society, as well as specifically in transportation.

Second, the challenges will be addressed. Fatigue is slowly coming to be acknowledged as an issue for safety, productivity, and health. The big challenge ahead, however, lies in moving beyond acknowledgement to a search for appropriate and meaningful change.

Finally, I will discuss the fact that there has been a tremendous amount of progress toward cultural changes required to reduce fatigue-related risk in society and in transportation. The grading at the end of this presentation is going to be hard on the attendees in order to emphasize, encourage, and reinforce the fact that while tremendous progress has been made, there is still a long way to go in order to reap all of the potential benefits in this area.

In fact, in February 1998, the first conference that was held related to fatigue was partially in response to an NTSB recommendation that public transit should look at fatigue. That move was extremely responsive. It demonstrated that public transit professionals get their hands on an issue and they go with it immediately, especially if it is safety related.

This conference is part of the positive change, as no agency required that it be held. The name is generating a lot of talk already, too. "Fatigue" is the word that has been widely used for a long time to discuss this issue. A number of years ago, many transit professionals were really trying to push "fatigue," as it was something everybody could relate to. However, a transition to the other side has to be made. Illness is not being talked about as much as health and wellness now.

At some point, we have to make the transition from fatigue to alertness. Again, while NTSB told industry professionals to hold the last symposium, Nobody mandated that this symposium be held. The name change from "Fatigue" to "Alertness 2000" was also unprompted by any agency. It was done because it was the right thing to do and because a lot of progress has been made.

What is the issue? The ways in which society has changed must be considered. In the past, shift workers were those who worked in hospitals manufacturing or the military who had to be alert all the time. Energy was also an issue around the clock.

Nowadays, who doesn't operate around the clock. The 24/7 society is an accepted fact of life. Who is not affected by the 24/7 society? My dentist is the only person he knows who has someone else to cover for him at night.

Almost anything is imaginable, such as is 24/7, but now it is also global. An e-mail message sent now will be replied to when they wake up in Japan or Europe or wherever sent. It can be referred to as "globalization" or whatever term you want to use, but these activities have really been happening in society, not just in the United States, but around the entire world.

Technology has evolved greatly as well. The capability to communicate and to get things done has been changed. Automation is not discussed much, but it is another major change. Fifteen to twenty years ago, as computers were coming on line, it was generally expected that productivity would be greatly increased and that everyone would consequently have more leisure time. This has not been the actual result, however. As an example, while one is at a meeting, e-mails will flood in and must be dealt with afterwards.

There are many other by-products, good and bad, of things like automation that do not receive attention. Buses, trains and airplanes are highly automated now. In fact, one of the best situations to create fatigue is a dark cockpit, whether it is in an airplane, train, or bus. The human is passively monitoring the system, it is in the middle of the night, and a good buzz is going on in the background. If one wanted to create a place to fall asleep, that would be it. The adverse effects of automation are not given enough consideration.

Putting all of these together illustrates that a great deal of change has occurred is continuing rapidly. What is really interesting, however, is that while society has evolved, humans have not changed at all. They still have a vital need for sleep due to an internal clock, known as the circadian clock, that literally times everything that happens on a daily basis, physiologically and in their performance. If the clock is disrupted, then that person pays for it. The loss of sleep is one way in which the clock can be disrupted.

It was interesting when Bill Millar talked about the costs, because it meant there are potential benefits of dealing with this issue too. The point is that a price is already being paid for either ignoring or underestimating how much fatigue plays a role in how people operate, individually or in a company, because people lose sleep, disrupt their cycle, and pay for it, whether they know it or not.

In *U.S. News and World Report*, there was a cover story on "Sleepless in America." It started out discussing health issues and expanded into the 24/7 issue, stating that everyone is in trouble. It is a societal problem, and it leads to my second question. Over the past seven days, have you accumulated a sleep debt of at least eight hours? It is simple to calculate. People need eight hours every night, so any night with less than that brings sleep debt. If a person got six hours, then he/she is two hours in debt for that night. It can be thought of in the same way as a bank account. The further you are in the red, the worse off you are.

What are the costs? When the circadian clock is disrupted, basically every human function and capability is degraded, and that includes performance. This means that reaction time, memory, judgment, attention, mood, and other such functions are all degraded. None of these are degraded by only one or two percent. Instead, it is a huge drop. There are some studies that show that judgment/decision-making can be degraded by fifty percent. So think of four really important decisions a day that people make.

If we do not get enough sleep, then functions are degraded. Which functions are degraded, however, is not a choice. Memory can go down twenty percent. Attention can decrease one hundred percent. Mood can go down one hundred percent. Many people probably wonder what the significance is if an employee is a little moody. So what if good mood goes down and bad mood goes up? In these days of crew communication, coordination, etc., moods are a big deal. Performance really is the pathway that affects safety and productivity on the job. These issues are why this symposium is being held. There is a need to talk about why this is a safety issue for the transportation industry.

There are other things affected by lack of sleep—health, for instance. In fact, in *U.S. News and World Report* it was nice to see that there is a lot of new data coming out showing that sleep loss compromises the immune function. It is like grandparents and parents always said, if you do not sleep, then you are going to get a cold or some other sickness. This has now been proved. Sleep loss studies have shown that not getting enough sleep can compromise immune function, which leads to being more open to certain health issues. This article actually got into some of the more interesting work that is going on, showing that with sleep loss comes early signs of diabetes. It may also be related to obesity. So there are larger health problems that could be affected by the sleep loss as well. The bottom line is that we pay for sleep debt.

The issue, of course, is that these are costs that are paid all the time these days. This, as a safety issue, applies to all modes of transportation. It is not just a public transit issue or a rail issue or an aviation issue; it crosses all modes of transportation.

There is scientific data that demonstrates this. In 1987, Torbjorn Akerstedt wired up train engineers and let them do their runs. He measured brain activity, eye movement, EEG and EOG in order to measure sleep. He found that one-third of the time during the night they were asleep. This is not anecdote-based, but instead is based on physiology. Engineers are asleep one-third of the time they are running at night. During the episodes, half of them failed to respond to a warning signal. That is why this is called risk mitigation, because there were no accidents in this study. That was just luck. If an engineer falls asleep once and a situation occurs in which he/she does not respond, there could be an accident.

They were asleep physiologically, and missing warning signals. They were just like Casey Jones. Casey Jones died on April 30, 1900, at 3:52 a.m. in a rail accident, five hours into his second shift. If the NTSB existed then, Casey Jones would have died in a fatigue accident. Nobody gets in a train, car, or plane and decides to try and kill himself/herself by falling asleep. It does not matter whether someone has the right stuff or not. This affects everybody. Fatigue is not a new issue that has suddenly become a problem. It has been around for a long time.

The third question in the quiz is whether, over the past month, the attendees have had one period when he/she was awake for 16 hours or longer.

In an NTSB study of commercial truck accidents where the drivers died, 40 percent were identified as being related to fatigue. About five years ago, there was a Safety Summit where fatigue was identified as the number one safety priority in bus and trucking.

Even Charles Lindbergh talked about how fatigue was a big issue for him. In the book about his historic journey he wrote, “[n]othing life can attain is quite so desirable as sleep. My mind is losing resolution and control.” That was seventy years ago. Fatigue is an issue in aviation. There used to be five people in the cockpit, then it was reduced to three. Now planes are so automated that there are only two. So fatigue has been an issue in aviation for a long time.

NASA operates a confidential reporting system for the FAA, and there is some debate about these statistics, but only one in five incidents is reported. What kinds of incidents are reported? Examples are flying at the wrong altitude, which is only a problem if there is another airplane there, and landing on the wrong runway. One out of five such incidents is related to fatigue, with most of them happening in the middle of the night.

Fatigue is even a problem in space. Astronauts work in the ultimate high-risk, high-performance environment. Even with the “right stuff,” there are all kinds of procedures to deal with sleep and fatigue issues. NASA has a specific program that uses bright light to help the astronauts switch their schedules to their orbit requirements. In fact, Neurolab, which was an experiment conducted on John Glenn, involves the measurement of sleep. NASA was also trying to measure melatonin on that particular shuttle mission.

Fatigue measures have evolved a great deal due to automation and demand. This evolution will continue to advance as technology continues to advance. Yet it is interesting that while the demand is going up, the resources, the number of people involved in this, are decreasing. That puts the pressure on the human resource to get the job done safely, and that pressure will continue and probably increase.

In May 2000, Torbjorn Akerstedt held a meeting at the Karolinska in Stockholm, where they award the Nobel Prize. The issue of the percentage of accidents caused by fatigue has already been discussed at this symposium, but that group came up with a consensus statement that it is likely that fifteen to twenty percent of all transportation accidents are related to fatigue. Their article will be coming out in *Journal of Sleep Research*. It is generally accepted that seventy to eighty percent of accidents are related to human error.

Most official statistics underestimate the scope of this problem. There is no blood test for fatigue. While alcohol and other substances can be detected in a blood test, fatigue cannot. Through NTSB and other efforts, there have been attempts to understand how to quantify this better in accidents, but it is clear that it is underestimated. For example, I know a police officer who pulled a man over because he was all over the place. He thought he was drunk, but he was actually just tired. So the police officer simply let the man go and the incident was never reported.

The same thing is true of statistics from accident reports. A driver gets out of his/her car and admits that he/she fell asleep and the accident report cites inattention.

The problem is not simply restricted to sleep, either. When someone is tired enough, his/her performance is affected. Even if a worker is only at eighty percent, his/her reactions are not fast enough to get him/her out of trouble. So workers do not have to fall asleep to have fatigue play a role, they simply have to be below their optimal performance level.

Shift workers, many of whom work in transportation, fit into this category as well. Torbjorn Akerstedt found in a study that seventy-five percent of shift workers reported that they were sleepy on the job, and twenty percent reported that they fell asleep. At NASA, a couple of surveys of regional airplane pilots, i.e. regional commuters, found that seventy percent admitted that they had fallen asleep in the cockpit. Similarly, eighty percent of corporate aviation pilots have admitted falling asleep. Thus, Akerstedt's study is probably a low estimate. Still, it is clear that this is an issue for shift workers. In their 1999 Sleep in America poll, the National Sleep Foundation (NSF) found that approximately one-third of shift workers felt that sleepiness interferes with their daily activities at least a few days per week. Approximately seventy percent of these workers had a sleep problem at least a few nights per week in the last year. Their daytime activities and their sleep have been affected by their shift work.

A couple of years ago, a study of surgeons in a virtual reality simulator illustrated the scope of this problem. The surgeons were allowed eight hours of sleep for one trial and had to stay up all night for the other. In each case, they then had to perform a surgery simulation the next day. The results indicated that, without sleep, errors increased twenty percent and the procedures were carried out at a rate that was fourteen percent slower than with eight hours of sleep. These are significant drops in performance.

It is important to realize that dealing with fatigue is not a macho or right stuff issue. Fatigue is not related to how well paid, motivated, professional or well trained a worker is. It is a physiological issue, and those things lose all importance when a worker does not get enough sleep, is awake too long, accumulates a sleep debt, or works at either the wrong time or a difficult time of day.

Drowsy driving is a societal problem that affects everyone. NSF has done some great things in this area. In 1999, where they used the Gallup poll and took representative samples, they found that fifty-one percent of those surveyed reported that they had driven drowsy in the past year. Seventeen percent admitted having fallen asleep. Drowsy driving is quite prevalent and almost one in five drivers fell asleep in the past year.

This means that everything possible must be done to get workers through their shifts. There are regulations and transportation professionals are concerned about managing fatigue. After their shifts, workers still have to get home. Normally they drive home or use public transit. This is a huge issue and it is just starting to get the attention it deserves.

NSF found that twenty to thirty percent of shift workers admitted that they had had a fatigue-related mishap in the past year. In addition, the poll found that forty-three percent of the respondents felt that sleepiness interferes with their lives at least a few days per month, and twenty percent felt it was a hindrance a few days per week. A “few” can be seen as three to ten days a month. So for half a workweek, one out of five people are struggling with sleepiness in some way. Thirty-two percent of those polled showed significant daytime sleepiness. This is on a scale that is used if someone has sleep apnea or some other serious sleep disorders and stays awake for a long time. Twenty-seven percent reported that they are sleepy at work two days a week or more.

Businesses generally have at least one manager who objects to the establishment of a napping policy. He/she does not want to pay employees to sleep. However, without such a policy, they are paying for them to sit there, have their head nod, and be unproductive throughout the afternoon. They are not able to do the work assigned or be creative. The data bears out the fact that allowing employees to nap is more efficient.

This leads into the next question, and it is a critical one. In the last month, was there a time when anyone in this room acknowledged that he/she was fatigued and did something about it? The response could have ranged from taking a nap on the job to pulling his/her car over to drinking an extra cup of coffee.

Everyone, from corporations to individuals, pays for fatigue. There are a number of costs associated with fatigue. Safety, errors and accidents must be discussed, but so must health and quality of life. There is a tendency to dismiss quality of life issues, but it is as important an issue as safety. The costs of fatigue affect everyone's life, schedule and family.

There have been many major accidents and incidents related to fatigue. Many have blamed alcohol or the O-ring, but reports on them indicate fatigue played a role. The NTSB report on the Exxon-Valdez incident indicates that three of the five top probable causes are fatigue related. Like the others, the Exxon-Valdez was a major accident. It cost about \$5 billion because the pilot was awake too long and missed a left turn. A short nap would have prevented this, but instead, society as a whole had to pay for it.

Fatigue even affects politics. In February 2000, an article in the *San Francisco Chronicle* by John McCain stated that, “[e]very big mistake made in politics is made when you are tired. I keep telling these guys, the staffers, that I am up all the time, but this is a once-in-a-lifetime opportunity. I have to be up.” Although no specific connection is to be made here, McCain ended up dropping out. It will probably never be proved, but it is interesting that the gap between acknowledging fatigue as an issue and actually attempting to do something about it exists here. The amount of sleep he had the nights before he really blew up could be checked. It is a simple explanation, yet it will probably be totally ignored. It is something that likely can be applied to everyone.

What can be done about fatigue? After convincing people that fatigue is clearly a safety issue, there remains the challenge of advising them on how to deal with it. This is the toughest challenge we face. The diversity in the transportation operational environments is immense.

Trucks, buses, and public transit are just a few examples. The different operational environments all have different operational requirements. In addition, each environment includes a different work and maintenance schedule. Different individuals work in each environment. They differ in age, training level, the amount of sleep that they need, and physiology. We have not yet discussed sleep circadian rhythms, but they would illustrate just how complex physiology is.

Within operational diversity, individual differences, and physiology, it is clear that there is no single or simple solution. Two of the major obstacles to change are history and economics. We normally tiptoe around them, but experience dictates that they should not be ignored. Scheduling is one of the most complex and contentious issues in any transportation organization. The two biggest blocks to changing scheduling are history and economics. In terms of history, people point to how something has always been done and wonder why change is needed. In terms of economics, people tend to think that if the company would just spend a little more, everything would be fine. The reality is that economics crosses all bounds. Corporations have to understand what the costs are, and individuals have to realize that there are costs to them as well. Economics needs to be an area where people come together rather than point fingers. However, when there are attempts to make organizational changes, history and economics are the two biggest issues. They get in the way and have to be dealt with in order to achieve change.

I recently returned from meeting with an organization which needed help with union meetings. They wanted to develop some enhanced, advanced schedules. It was extremely difficult because they had already decided that the economics did not work. Everyone was in favor of the fatigue and scheduling, but the money just did not work. The negotiation process is just now starting. But if the economic aspect is ignored and they pretend that it does not exist, nothing will get accomplished. Instead it must be dealt with directly.

These challenges preclude a simple or single solution. There is no one-size-fits-all. Unfortunately, that is what the government typically has to find, at least on the regulatory side. One-size-fits-all creates one box that affects everyone the same way. That is precisely why this type of regulation does not usually work. Policies are required, but there are no magic bullets. Instead, partnerships and a great deal of scientific information are needed.

Although there are no magic bullets, people will still try to sell them. There are a number of famous snake oil examples that were suggested to NASA-Ames. People would sell products that they claimed would fix jet lag. An example is the Diopad, which is comprised of 47 herbs and minerals from the southwest. The sufferer sits on it and it cures his/her jet lag. It comes from the Sharper Image catalogue and costs \$59. However, the science of the circadian clock indicates that the internal clock of the human body knows what time it is from exposure to sunlight. There is a direct pathway from the eyes, through the retina, into the supra-chiasmatic nucleus or SCN of the hypothalamus, which is where the clock is. If the Diopad is meant to be sat upon, then how does the signal reach the SCN?

Another example is a book entitled *Twirling In Jet Lag*. It advises that, when a passenger flies in one direction, he/she twirls one way to cure jet lag; when he/she flies in the other direction, the passenger twirls the other way, ending in the dead-on-the-bed position, and that cures jet lag.

Before you start spending money or making decisions, the data must be looked at. Without existing data, the decision depends on willingness to take a risk. For example, at a meeting in Stockholm, data was presented indicating that the drink, Red Bull, actually works. It improved performance by about ten or fifteen percent in a particular study that was done. One can be open to everything, but look at the data before you spend money.

Then what can be done? I wrote a paper in 1995 that made the case that this issue must be dealt with from a comprehensive perspective. Comprehensive and integrative were the catchwords used. There were six things identified that needed to be done in order to deal with the issues of fatigue and risk reduction. In the interim, this list has increased from six to eight.

As previously mentioned, education is the foundation. If everyone does not have an understanding of what circadian means, then there cannot even be a conversation. We have to start with the basics since they provide a common, neutral, objective basis for conversation.

Scheduling is the first issue, and it is related to hours of service. Regulations and contracts allow for certain things, but how can they all actually be put into practice? There are still scheduling issues that to be addressed, and tremendous flexibility is needed.

Another issue is strategies. There are many different types of strategies, including napping, caffeine, good sleep habits, light social interaction, physical activity, and diet. Which of these to use must be decided which types to use, as well as how to actually fit them into the program being instituted. The issue of whether the strategies are sanctioned must also be considered.

There was an NTSB hearing on some accidents at Union Pacific. Jerry Davis, then the president, commented, "I never have thought, in my lifetime as a lifetime railroader, that I would be up here saying we now have a napping policy." In the past, if an employee was caught sleeping he/she got fired, but now napping was being endorsed. Some companies and employees thought it was a management trick in order to fire them. Jerry Davis endorsing a napping policy was a watershed event and an example of the type of cultural change that is needed.

A third issue is research. There are all sorts of data that establish fatigue as an issue. However, in the operational world, decisions must be made about such things as when does fatigue set in, what should the limits be, and what should be done in different situations. The answers are still not known. The fact that there are diverse operational needs makes it even more difficult. The science of fatigue exists, but it is nowhere near complete. Research is needed to resolve some of the issues.

Healthy sleep is another issue. Sleep disorders will be discussed later in the symposium, so I will not deal with it at length. There will be discussion of sleep hygiene, which is akin to good oral hygiene. This is called healthy sleep and is dependent upon both good sleep habits and whether or not one suffers from sleep disorders.

A fifth issue to be considered is design and technology. Issues such as cab design and technological innovation are important.

Hours of service, the sixth issue, are necessary, but not sufficient to solve the problem. Something must be done in this regard—employees cannot be allowed to work as many hours as they want. The problem has been the one-size-fits-all approach. A core set of hours of service that covers everyone needs to be developed, along with mechanisms that allow flexibility. Hours of service rules could then be tailored to different operational environments. At present, the transportation industry is nowhere near this point, but perhaps in five years those involved will be talking about what they can and cannot do. Hopefully, they will be trying to figure out how to construct a flexible, safe schedule while facing the constraints of real-world problems such as delays and mechanical issues. A complementary balance will likely be necessary.

Scientific guidance is issue seven. A great deal of scientific information is available to be used as input for a number of activities.

The final issue is early experiments in transportation. Humans have often gone from experimentation to success, and much progress has been made toward change.

How many attendees are in organizations or have actually participated in the creation, implementation, or use of an education program related to fatigue? How many are on a property or involved in an organization that currently has policies related to napping or fatigue management? How many attendees have actually formed a working group to look at schedules, done a pilot project, or at least have to start dealing with scheduling related to fatigue? Are any attendees getting out any information on fatigue? Have any attendees been screened for fatigue? Have any screened others in their organization? How many organizations have implemented any new fatigue policies in the last two years due to education? The responses to these all of these questions are positive except for the last one.

Here are some examples from government and other areas of things are happening. Public transit is not included here since it will be discussed later.

Although new, the DOT initiative that Robert Clarke mentioned must be at the top of the list because it is big and it is multi-modal. Progressing from coordinating committees to actual activities is precisely the kind of progress that is needed.

The Federal Highway Administration has an Advance Notice of Proposed Rulemaking (ANPRM) on hours of service that is extremely controversial. Federal Highway deserves a lot of credit because they actually convened a large group of scientists to help on the scientific part, and their input was very strong.

The actions at both FRA and NARAP, where legislation has been passed, have already been discussed and are well known. At FAA, there was an NPRM on flight duty rest for pilots for 1995. No action has yet been taken, but in September 2000 the Air Transport Association, which represents all the major airlines in the United States, announced a new Alertness Management Initiative with four different components. They want to lead the industry on these issues.

The NTSB has already been discussed. May 2000 was the tenth anniversary of their first fatigue recommendations. In those ten years, they have made over 100 recommendations. Most notably, hours-of-service regulations have stayed on their most wanted list. They will continue to make this issue visible and will let agencies know that they are watching.

There have been a large number of Congressional hearings on the subject. In both the Senate and the House of Representatives, there have been hearings on trucking, rail, and aviation. There are other people, such as Congress, paying attention to the question of fatigue.

There are other activities which others, such as APTA and AAR, have already discussed. The American Trucking Association has been doing research through their foundation, and, as mentioned, the Air Transport Association has announced a new initiative.

Corporations are doing something. Companies are taking this on as an issue and they are starting up programs to deal with the issue. There has been academic and operational research conducted and the applied side of the fatigue issue has become popular in academic circles. So there has been action both in the laboratory and in the field with operational research. There are attendees at this symposium from Volpe and other transportation agencies where operational research is actually taking place. There are professional scientific organizations, such as the Sleep Research Society, which anyone can join, that are getting much more involved. In fact, there was a large letter writing campaign to Congress about the Federal Highway hours-of-service issue by scientists.

The National Sleep Foundation is a nonprofit organization that the speaker feels everyone should join. They offer the Community Sleep Awareness Partnership where interested people can connect with them and receive material such as their "Sleep Matters" publication. They have a booth here and have a number of brochures and they have knowledgeable people. Their web site is Sleepfoundation.org.

There is a great deal of action going on, which is great. Another area we should discuss is technology. Dave Dinges from the University of Pennsylvania acknowledges, "[m]aking a claim is not the same as proving it." It does not apply only to technology, but to different strategies, mathematical models, etc. This is important because, for some of the other surface modes, such as trucking, the Federal Highway and NHTSA actually are working on technology as a specific way to deal with fatigue. In fact, Richard Grace, the Senior Systems Scientist at the National Robotics Engineering Consortium, is here at this symposium. The National Robotics Engineering Consortium has some materials that allow those interested to learn about what is actually going on in those areas. But Dave and Melissa Malis, former graduate students who are now with the NASA program, have a list of how many of these devices there are. There are 100 alertness devices under development or on the market such as alertness/fatigue monitors, fitness for duty devices, readiness to perform devices, etc.

It is important to remember when presented with a new device that there is a need to step back and understand all the schemes. There are questions that we must think about, whether the

product is a piece of technology, a mathematical model, or a new strategy. It is necessary to search out any science that can be used to evaluate these things. Currently, there are no standardized procedures, criteria, or standards for testing these products. In addition, there are no existing policies. Questions exist about who would actually get this information and whether it could be used for enforcement and/or improvement. There is much information being discussed, but little has been enacted. There is the tendency for technology to get ahead of people. Then they have to play catch-up on how it is utilized.

I was on a rulemaking group in aviation where most of the people felt they should be guided by science. One member finally suggested that they let scientists write the rule. The speaker felt that that would be a very unwise move. At present, various decisions about issues such as operations and policies are made without scientists typically being included. Science should be included for input and guidance to balance these things, but science should not necessarily make the decision.

Those who work in an operational environment and provide guidance understand operational issues better. There are scientists who do circadian rhythm research who will actually recommend that people stop working at night because it is dangerous. Instead, they need to be practical. Additionally, when scientific information is used, they must ensure that it is not going to have a negative effect. Lastly, these workers must really understand the operational environment because it is complicated. If the different issues and agendas are not understood, then science does not matter.

Returning to the personal quiz, have any of you here driven drowsy in the past year?

If transportation professionals want to successfully address reducing fatigue-related risk in transportation, then a cultural change is necessary. This change must support different attitudes and behaviors.

Attitudes encompass everything from “this is a serious, thought-provoking and important issue” to “it’s okay to call in and be tired” to “it’s okay to acknowledge and do something about it.” It is attitude and behavior that can get things changed at an individual, corporate, organizational, and societal level. This involves a big cultural change.

The best example of this is napping. NASA data indicates performance and alertness improve greatly with napping. However, in American society taking a nap is associated with being lazy, stupid, and dumb. This must be changed.

There are undergraduates now at Stanford and other places that refer to these as power naps. Pilots call them NASA naps. There has to be a change akin to the change from fatigue to alertness. There has to be a change in the whole culture and an acceptance that this is important to both health and safety issues.

In order to achieve this cultural change, a start has to be made now, because it is going to take a while. It must start with the children, so that the next generation can actually realize the benefits. At present, high school students are not being taught this. As an example, on the back

of a final schedule from a high school there is the slogan "Sleep is for Slackers." This is what is being taught.

In fact, a *U.S. News and World Report* article mentioned a lot about this. There is new information about starting times at schools and how much sleep kids need. In fact, last year, the National Sleep Foundation gave an award to Adina, Minnesota, the first school district to actually change their start times because of the sleep needs of their kids. The bus schedule usually dictates when kids go to school, not their parents or sleep needs. The fact that as kids change the fact that their sleep needs change is ignored. Then, for the first two hours of the school day, they are zombies in the classroom which is not a good situation. Change is needed so that perhaps this next generation actually gets to enjoy the benefits of our work.

Here is the last quiz question. Do the children of the attendees get enough sleep? Adolescents need nine to ten hours of sleep, while kids younger than that likely need ten, or maybe even more than ten, depending on how old they are. Most parents are not even aware how much sleep their children need.

At conferences in the past two years, King Abdul of Jordan spoke about Mideast peace, and one of the things he said, paraphrased slightly, was, "[w]e pronounce that we pursue peace for our children, but we need peace for all of us now." This sentiment received standing-room-only applause. The point was that it should not simply be done in the name of the children. Peace is needed immediately. This is analogous to the fatigue issue. As an example, how many attendees in this room know somebody who has been in a drowsy driving accident? Work on fatigue and alertness issues has to be done not only for the children, but also for the here and now. It will be a long path, but there is a need to start now and keep the vision as progress is made.

The issue can be thought of in the same way as the movie "*Pay It Forward*." In the movie, the teacher gives his class an assignment that says they have to pay their favor forward. If somebody does them a favor, they have to do it for three more people. They have to change the world. The idea can be applied to this issue. It is like sleep forward, which cannot really be banked.

This is how the attendees should grade themselves on their quizzes. It is absolutely fundamental to get eight hours sleep, to erase sleep debts, to limit the length of time one is awake during the day, to acknowledge and act on sleepiness, not to drive drowsy, and to ensure that children get the sleep they need. These are six simple things to do, but it will not be easy. Although they are very straightforward, they are gleaned more from the big picture; i.e., the corporate and organizational level, than the individual level.

The achievement of these six accomplishments is the job everyone at this symposium faces. This shared responsibility partnership starts with the attendees. Although Administrator Molitoris gave attendees six months to create a partnership, they should start immediately. No finishing deadline should be set, but a start should be made now. If there is a desire to do the pay-it-forward thing, each person should start with him- or herself, then get three others to join the effort. Even if only one other person is recruited, that is how the culture change is going to actually take place. There is a need to be pushy now. Everyone must get the three other people to do the same thing, and get their grades to see if they passed or not. While everyone surely

failed at least one question, the ultimate goal is for no failures at all.

Occasionally, somebody in a prominent position comes forward and admits to the costs. When such an opportunity is presented, it must be capitalized upon. If not, then everyone will pay for the missed opportunity. An example is President Clinton, who said in 1993, "[e]very major error I made in my life, I made when I was tired." So it can be inferred that every big mistake he made after 1993 was because he was tired. No one wants the same excuse. Now is the time to do something about this.

SESSION III: WE'RE DOING SOMETHING ABOUT IT—SO CAN YOU

Greg W. Percy
Director, Rail Services
GO Transit

GO Transit was created as a provincial agency in 1967. It is an inter-regional commuter bus and rail services provider that services, reports to and, since August 1999, is funded by the Greater Toronto area regions and municipalities. GO has over forty million annual rail passenger trips, and it operates over seven railway-owned corridors, with approximately 150 scheduled trains per day, using a fleet of forty-five locomotives and approximately 320 bi-level coaches. The ridership has increased 26 percent over the last three years, which is a great problem to have, but it certainly brings some challenges with it.

GO train crews are either CN Rail or CP Rail employees. They are comprised of two head-end locomotive engineers and either one or two on-board conductors, depending on the service corridor. Train crew schedules are primarily split shifts, which matches the heavy-user group of morning and afternoon peak commuters. On-duty times for the split shifts last from about 4:30 a.m. to about 8:00 p.m. and they have an off-duty period from about 10:00 a.m. until 3:00 p.m.

Regular GO train crews are supplemented, on an as-required basis, by the spare pool and the freight crews. Most supplemental crewmembers have had some prior GO Transit training in safety procedures and ambassador training, which is how to deal with customers.

GO Transit has embarked on an initiative to improve alertness. With many ventures there is a single catalyst, and that is the case here. On November 19, 1997, GO Transit experienced a low-speed collision of two of its trains at Toronto's Union Station during the evening commuter peak. Thankfully, there were no serious injuries, but there are civil actions still outstanding.

Subsequent investigation by Transport Canada and other involved stakeholders ruled out mechanical failure as the cause. Instead, the primary cause was found to be train crew noncompliance with the operating rules governing movement of trains through Union Station. As this was a seasoned crew with a great deal of seniority and experience, the involved railways and GO Transit felt it had to be something more than just pure negligence. In 1995, the freight railways had done something called "Can-Alert." GO felt there might be something here that could fit in with that. So GO embarked on a program called "Crew Alertness" in conjunction with Circadian Technologies, which is a consultant. They conduct a clinical review of everything the train crews do. They examine things such as when the crews come on, what they do, and what their sleep patterns are.

It was quickly realized, from GO Transit's point of view, that there were at least three critical success factors. The first one was to get GO senior management to buy into the program, which turned out to be rather easy to achieve. GO Transit recognized that there were a number of benefits from participating. The program could improve train crew safety practices, improve risk management for future incidents, and demonstrate to Transport Canada, its regulator, that GO

Transit is serious about crew safety. In addition, it could identify collateral opportunities to avoid operating expense because, at this level of detail, an organization learns a lot about itself and how to make changes to increase efficiency.

The second key success factor was to convince labor to buy into and trust the program. Without this commitment, the program could not happen. There was no immediate trust as labor feared that it was just a covert way to reduce crews. Labor became trusting of what GO Transit and, in this case, CN Rail were trying to do when they saw that it was increasing the safety of their own members, the onboard crew and the locomotive engineers. They realized the program was positive and represented a huge step forward. Plus, if GO and its crews were able to implement some of the recommendations of Circadian Technologies, then there would be a much-improved balance between work and family for the train crews themselves. This provided labor with a selfish intent as well, since they had a great deal to gain.

The third key success factor was to get the host railway to buy into the program. In this case, it was CN, but GO also worked with CP. As mentioned earlier, this program was a spin-off from Can-Alert, a 1995 freight initiative that targeted the same thing and was also a Circadian Technology Program. The implementation of Can-Alert saw the refinement of freight crew management practices. CP and GO Transit felt that they could also take advantage of this program in terms of managing crew fatigue and the associated risk.

Dr. Martin Moore-Ede will speak on Day Two about the clinical methodology used by Circadian Technologies. He will go into detail regarding the actual process, the methodology, the data, etc. He will also explain how they know they are measuring the right things.

As the bill payer for Circadian, GO had to convince itself, and it was not that difficult, that this program was worth it. It did so and the program was implemented. The next step was to ask, "Was this just smoke and mirrors, or was this true changed management?" In other words, were the expected program benefits realized, or was another binder simply added to the bookshelf?

The answer is that this kind of clinical review is not a panacea. It does not result in everything suddenly getting better. Instead, it is an evolution. It did result in a change in some basic ways of doing business. There were also some changes recommended that GO could not yet make. These will be touched on briefly here, as Richard Chorkawy, who is with CN, which worked very closely with GO Transit on this, may go into more detail.

GO Transit did evaluate train crew assignments. There was an attempt to reduce on-duty time, duty miles, the rest break between shifts, start time, and finish time. That was the micro-detail that the clinical review examined and that GO implemented.

There are some spin-offs from this, as well. GO Transit is now testing air conditioning in its locomotives for the first time. There are three units in test currently, and it is expected to be rolled out further. In 2001, GO will build a fitness facility in its crew center, something which had never been contemplated in thirty-plus years of existence. An electronic checklist is being tested that should provide some advantage. If it works, it will form a visible and a physical checklist that a head-end crew has to go through to move a train.

GO Transit has not, despite recommendations, eliminated split shifts. Pieces have been adjusted, but GO cannot change the basic tenet of a split shift because it is a key component of their business.

GO has also been unable to change seasonal dependence on the spare pool. These are crew that will either work in freight or GO, depending on where they are needed and what seniority they have. The review determined that the spare pool rates lowest in terms of alertness on the job because they are not used to the split shift concept. GO is lucky in that its spare pool crews are in its particular area for a long time, so they get used to the split shift. They know how to nap in between and GO provides bunking capability at its Willowbrook facility, which is their crew center. The workers are used to it and can adjust. When new to it, however, it takes a long time to adjust.

The understanding of train crew fatigue requires a clinical third party review, and it has to be customized to the specific service needs of each given commuter agency. Since 1998, when GO Transit embarked on this, its experience has been very positive. It has implemented progressive change in its crew management practices, and has developed a new respect for the operating environment, within which the train crew is integral to delivering a high level of customer service.

Richard Chorkawy
Director, Commuter Operations
Canadian National Railway

I work for the Canadian National Railway, CN, as Director of Commuter Operations. CN is contracted by GO Transit to operate a large portion of the commuter operations in the Greater Toronto Area. My comments will expand on Greg Percy's.

CN is contracted by GO Transit to operate approximately 95 percent of the commuter rail operations in the Greater Toronto Area, which has a population of approximately six million. It transports 115,000 passengers a day into and out of Toronto, with Union Station being the prime destination for commuters. CN operates 782 revenue commuter trains weekly with a running trades workforce of 147 employees. Complementing the regular assigned employees are approximately 50 unassigned spare board employees who are utilized in both freight and commuter service. These are employees whose shift one day is on a freight train and on a commuter train the next.

CN operates commuter service on six routes totaling 180 miles of rail lines, from single-track up to four-track main lines. Centralized Traffic Control, CTC, which is the signaling system most people are familiar with, controls 133 of these miles. It's like traffic lights in a city, where red indicates stop, green indicates go, and yellow indicates prepare to stop. CN also operates commuter trains on 47 miles of dark territory, which lacks the flexibility of a signaled system.

From a freight perspective, CN has, for the past few years, been running pilot alertness projects in western Canada. Dr. Martin Moore-Ede, President and CEO of Circadian Technologies, will speak in some detail on this on day two. He has been a large part of some of these pilot projects.

In coming to this session, it was asked what brought CN and GO Transit to the table with concerns about the alertness levels of their operating crews. Greg Percy referred to a serious incident that occurred on November 19, 1997, where an empty commuter train entering Toronto Union Station collided with a loaded train departing in the same direction. There were approximately 1,500 people on board the train. The collision, although a relatively low speed impact, resulted in a number of minor injuries from bruises to one broken limb. This was the catalyst that brought the agencies to the conclusion that the alertness level of crews may be problematic. This ultimately led to the introduction of Dr. Martin Moore-Ede and his Circadian Technologies Group.

There were obstacles that had to be overcome in introducing a study of this nature. Both management and labor exhibited a natural reaction of defensiveness. There was fear of what this study would reveal. Although there was a need for everyone to bare their souls, face reality, and ask what can be done differently to make rail operation safer, there was nervousness over what the data might reveal.

Thus, the undertaking this study required a strong commitment from both labor and management. With the guidance of Circadian Technologies, steps were taken to build a foundation of trust through continued guidance and support. CN utilized open communication sessions and the involvement of local health and safety committees and the BLE and UTU, which are the unions for locomotive engineers and conductors. All parties were very eager to participate in this venture.

The project began with simple objectives. CN wanted to reduce fatigue, improve safety, reduce absenteeism due to sickness, and improve the quality of life and health of its employees. The Circadian group worked with CN for a number of months. They utilized body monitoring systems, observations, logs, interviews of split shift crews, interviews of full shift crews, and interviews of spare board employees. The preliminary study found that most engineers have some sleep deprivation in their schedule and that sleepiness does occur while operating trains. It was also apparent that sickness and absenteeism correlate to cumulative fatigue.

It was found that, over the course of the workweek, there is an element of cumulative fatigue. With 50 percent of CN crews starting work before 6:00 a.m., many of its employees wake up at 3:00 a.m. by alarm. Many of these employees then drive up to fifty miles to get to work. Sixty-nine percent of these individuals have stated through surveys that the present schedule makes them overly tired.

Following study recommendations, as of May 2000, CN has added three new full-service assignments. Its operation relies on a split type with a morning and evening rush. A few trains operate throughout the day on an hourly schedule.

Other recommendations that CN has implemented have decreased the operating miles per job assignment and adjusted both rest days and the total number of days off. The total time on duty per assignment has been decreased, and there has been an attempt to schedule regular time off. The longer shifts have been assigned weekends off.

In looking at whether CN has successfully met its objectives, at face value it appears there have been improvements. Some steps have been taken, but there is still a long way to go. CN is currently conducting a follow-up study of its employees. The feedback from this will better clarify the degree of success.

The issue of alertness of operating employees is influenced by many factors that cannot be controlled on a day-to-day and person-by-person basis. Efforts have been made to modify factors that can be controlled and to provide the education necessary for employees and their families to live the safest and healthiest life possible.

**William Keppen
Consultant
Fatigue & Alertness**

I am going to build a bit on what was discussed earlier. It is really important, as Mark Rosekind briefly mentioned, to understand that many experts are out there in the workplace. Science has an important role to play in this whole process, but the best countermeasure in the world does no good whatsoever if it cannot be made operational. If it cannot be transferred out of the lab or boardroom and applied in the workplace, then it is of no use.

We have worked very hard for the last eight years. Once scientists help figure out what should be done, we must figure out how to make it fit into the railroad workplace. The fact that the workplace is dynamic makes it even more difficult. It looks different in every location and mode. Thus, a countermeasure cannot simply be created and then rolled out across an entire system. This presents a real challenge, but there is no time like the present to get started. I have been a locomotive engineer, a labor representative, and even in management. I'm speaking here from a labor perspective. It is a real challenge, in many cases, to engage labor in this process. As indicated earlier, I did not know much about fatigue when first confronted with the issue. I knew a lot about running trains and railroad, was a third-generation locomotive engineer, but I fell asleep at the controls and was fortunate enough to wake up alive. I decided it was time to learn about being tired and dealing with fatigue.

From a labor perspective, learning about "tired" was the first challenge for me. Many times while struggling to get the industry to deal with fatigue, the question I heard most was not directly from management, but behind the scenes—it was whether there was actually a problem. Clearly, the industry needed to learn about "tired" as well. When the regulators became involved, their question was how to regulate it.

There were some pivotal events in this process. As mentioned, there was the Corona, California, accident, and the NTSB recommendations that went out to labor, management, and the FRA after it. Shortly after those recommendations were issued, the Association of American Railroads, the United Transportation Union, and the Brotherhood of Locomotive Engineers met and formed the Work/Rest Review Task Force. Their first challenge was to pick a name. Many people were still uncomfortable with the word "fatigue," so it was not used. In fact, it probably took a year or two until the members would finally talk about and use the word "fatigue."

Beyond that, the Fatigue In Transportation Symposium held in 1995 was pivotal. Some of the attendees were there. It was multi-modal and there was a lot of enthusiasm, but interest waned after that. However, then FRA got involved, at least on the freight side, when the North American Rail Alertness Partnership was formed in 1997. Thus, there was a bit of a progression.

Finally, because we kept bumping up against this collective bargaining fence, the National Carriers Conference Committee, which represents the Class 1 railroads, the United Transportation Union, and the Brotherhood of Locomotive Engineers entered into the Workplace Guidelines and Principles Agreement. This allowed collective bargaining issues to be brought to the table. It also made it easier to deal with those issues as countermeasures were planned and implemented. Countermeasures cannot be implemented in most operations without making some changes in the collective agreement.

So there started to be a coming together on the issues. It is an ongoing process that will never be completely finished. Labor and management were the first partners, and then government entered in 1997. They were partnering with other people before that, but the collaborative efforts of FRA with labor and management did not begin until 1997.

From the perspective of both transit and trucking, there are other partners out there to interact with, such as the public and other modes of transportation. Even going to the airport seems to involve three modes of transportation. Shippers and receivers also have a role to play. The speaker's exposure to three full days of hours-of-service hearings in the trucking industry showed that shippers and receivers do affect the way people work and, therefore, perhaps their level of alertness or fatigue.

Once the issues begin to be defined, it becomes apparent that there are many things that can be agreed upon, while there will likely also be a few things that cannot be agreed on, at least not immediately. It is all right to have some disagreements and work through those things as the program evolves. There is no need to step back from the whole program simply because one issue cannot be resolved quickly. Both groups identify education as a key program component. This will be discussed further later in this address.

The Task Force, formed in 1992, finally did issue some working conclusions regarding those who are operating trains. They have not stepped back from these, but they have examined the data that drove these recommendations. Unfortunately, or fortunately, depending on one's perspectives, it was data from only one railroad, and it was from only a small part of the railroad. Because there were so few accidents, the database was expanded by looking at incidents that resulted in injury or a serious rules violation. Since this provided a sufficient database, there was

then an attempt to see if there was any correlation between incidents and time on shift. Three things jumped out, at least with that initial cut of data.

Intuitively, many people conclude that the rate of accidents and incidents is going to be much higher for those working nighttime hours. However, data indicated that it was actually dependent upon how much time a person or a crew was on shift. If they were on shift longer than nine hours going into those early morning hours, then there was an increase in incidents.

The two other recommendations or working conclusions involved 5 consecutive shifts for 10 hours or more and 6 or more consecutive permissive starts in a 7-day period. A permissive start involves working up to 12 hours. These seem to be fatiguing schedules and, as it turns out, they are. However, as engineers worked and shift data was examined, these conclusions were not borne out across the board. Five million locomotive engineer starts were looked at, which is not a small cut of data.

The North American Rail Alertness Partnership came up with some key components. This partnership grew out of the Work/Rest Review Task Force, but also involved regulators. They are key players because their decision on whether to regulate or not often depends on their understanding of the industry, its operation, and what the participants are doing to deal with these issues.

The first key is education and training. Employee training and scheduling practices are two separate things. A schedule for trains, buses, planes, taxicabs, etc. can be set up and the service is going to run more or less according to that schedule. However, even if there is an attempt to match up employees with those operations, if somebody drops out on a given day, then everyone falls off schedule.

Thus, these are two separate, but important, issues. When emergency response goes to a train accident or a washout, there are some that are short-term and some that are long-term. This goes beyond just train-operating employees to shift workers or people who are working extended shifts.

If the science side is understood and some of that knowledge is applied to setting schedules, there are many things that can be done, such as setting up breaks, to make those operations a great deal safer.

Another key component is alertness strategies which are things that can be done in the workplace to promote alertness. Examples are a nap or a break. If people are going to work a 12-hour or 16-hour shift, a way must be devised to get them some mid-shift relief.

A third key is the evaluation of policies and procedures. Railroads, trains, planes, trucks, etc., are run with many policies or operations that were created before a sensitivity to fatigue and alertness issues evolved. These policies need to be examined closely and, like the collective agreements, improved.

Yet another key component is rest environments. Away-from-home-terminal rest facilities are a critical element of a safe operation. Employees must not be lodged in a cheap motel with 2x3 foot rooms where a flushed toilet eight rooms away wakes the employee up. In addition, there is a rest environment at home. People had to be convinced to focus on both rest environments because there are many things that happen at home that are beyond the control of the employer. By bringing the family into the process, a better rest environment and a better opportunity to sleep at home can be built.

The work environment is another key. There is equipment, but issues, such as what can be done to promote alertness in a dispatching facility, have to receive attention also. A number of these issues are currently being researched. How these things are implemented and how their effectiveness is then measured must be examined.

The sixth key is work/rest guidelines and principle agreements. This allowed collective agreements to be put into place in the rail industry. These vary widely, not only from one railroad to another, but from one location to another, because there are always local understandings that modify national or system agreements. The Partnership opened the door and allowed people to sit down and determine how they would do things. However, once again, education and training are high on the list.

The seventh key is assigned work and rest days. A great deal of the Partnership's ongoing initiatives have addressed scheduling where people used to work first-in/first-out, on call, in pool and extra-board service. An employee could come into his/her home terminal and be at the foot of the board. As trains would come through, or as crews were deadheaded, they would move up the list. They would then be subject to call reaching the first out position. This meant that the starting time was highly variable and unpredictable.

If crews cannot be assigned a specific time to go to work, then, at the very least, they should be made aware of what their workdays and what their rest days will be. In some cases, the Partnership has had some far-reaching pilot projects that accomplish both. They give them either a specific starting time or an assigned-window starting time.

The last key component is a.m. markups or scheduling. This is a major issue when examined in the context of human nature and physiology. Because they were tied to pay, past agreements provided that when employees went on leave, they went off at 11:59 p.m. and, when they reported back, it was at 12:01 a.m. If employees have been off for 72 hours or more, then they will be able to live like normal human beings. They can go to bed at night and wake up and be active during the day. So if employees return after three days or three weeks off, they are scheduled and will start for work at 12:01 a.m. Monday morning. Thus, they are likely to report for work tired. The Partnership decided to change this so that when employees return from leave, they will be scheduled for duty in the a.m., sometime around 7:00 or 8:00, when they will have had a good night's sleep.

There are other issues concerning crew relief. For example, there were times when employees had put in twelve hours on the road and then trains got tied up because they had completed their hours-of-service. These employees often wound up fifty miles away from their objective

terminal, and their companies sometimes did not do a good job of getting the cab out. The Partnership has had a number of people involved from all of the U.S. and Canadian Class 1 railroads, regional and short lines. It also has had representatives from passenger and commuter operations, non-operating unions, and operating craft unions.

There are also a number of issues in shift work. Even a regular shift worker who works from 8:00 to 4:00 can have fatigue issues. Something must be done for everyone.

There are two choices for transportation professionals. They can deal with the disease, which is fatigue, or they can wait and deal with the results, which are accidents, property damage, injuries, and death. If they choose not to move forward aggressively, then they should not be surprised if events lead to imposed remedies such as laws, regulations, and litigation.

David Osiecki
Vice President, Safety and Operations
American Trucking Association

I am going to take the association approach to fatigue and alertness issues and efforts since this is what I do. I will attempt to answer some of the questions that have been posed to members of this panel.

The American Trucking Association (ATA) is a membership-based organization. It represents about 3,000 trucking companies across the United States, as well as some in Canada and Mexico. The membership, like the trucking industry itself, is diverse and includes large trucking companies, such as UPS, FedEx, Roadway Express, and the Yellow's, as well as 2-, 3-, 4-, and 5-truck operators. In fact, the biggest challenge in the trucking industry in terms of fatigue and alertness issues is getting to the small trucking companies, because they comprise a large part of our industry. ATA and the trucking industry have had successes with some of the medium and large carriers. However, additional work is needed with the small trucking companies across the country.

The research activities of ATA and its research arm, the ATA Foundation, need to be examined for a couple of reasons. First, the activities show that ATA thinks that partnerships between industry and government in research are a good idea and that it wants to continue to be involved in research activities and partnerships with its regulating agency, the Federal Motor Carrier Safety Administration. Second, the activities convey a sense of the type of research that has been done in the trucking industry.

It is hoped that this presentation can perhaps trigger a thought in those who have a research idea or show someone with an idea similar to those of ATA researchers that there is already some research and data out there, at least in trucking. It will touch on some of the specific industry training and public education activities with which ATA has been involved and some of its regulatory advocacy efforts in the area of fatigue, especially those focused on hours-of-service.

ATA and the Foundation both think it is entirely appropriate to be involved in pro-active research issues in fatigue and alertness, and in a number of other operational areas in trucking. In fact, they plan on continuing to be involved in such research for the foreseeable future, despite having been criticized for working with the government agency that regulates them on research.

These are just some of the areas in which ATA has partnered with the Department of Transportation. There was the landmark Driver Fatigue and Alertness Study, a 6- to 7-year study that was begun in 1989. ATA was actually involved in this area for at least 10 or 11 years. This study looked at eighty drivers on real-revenue, real-scheduled runs, hard wire, fatigue and alertness issues, rest period lengths, length of rest, and more. To a degree, the Department of Transportation and the Federal Motor Carrier Safety Administration are relying on this landmark study to revise the hours-of-service regulations that govern the industry.

In 1995 there was a Fatigue Symposium in Tampa. ATA, AAR, the Department of Transportation, and the Federal Transit Administration were involved in the International Fatigue Symposium in 1997. These type of activities help keep up the momentum and focus on this particular issue.

Cruise control and driver fatigue is an issue many people have overlooked. ATA and DOT looked at it and found that there was no relationship.

The ATA Foundation has been involved in the study of sleep apnea for several years. In fact, a report on the study, which involved the University of Pennsylvania and Dr. Dinges and Dr. Alan Pact, has just been completed. It can be found at the Department of Transportation. I do not know what the report says as I am not part of the ATA Foundation. ATA is interested in this study because we want to examine the prevalence of sleep apnea in the trucking industry and learn what should be done about it.

ATA is involved in research efforts for several reasons. We want to discover what it can tell us, how it can advance the science, and how it can then put this science into operational practice and operational guidelines.

Another study ATA was involved in looked at loading and unloading impacts. In other words, it examined fatigue as it relates to loading or unloading, as well as times of day and similar factors.

Scheduling practices was the focus of yet another recent study. It analyzed the types of schedules that seem to promote fatigue and the types that seem to promote alertness.

An ongoing study, the Fatigue Management Technologies Pilot Test, indicates there are technological interventions being tested in conjunction with different hours-of-service regulations. Essentially, there is technology in the cab that is associated with the driver and is being used in conjunction with both American and Canadian regulations.

These are just some of the research projects in which ATA has been involved. We have been involved in many others that were focused on fatigue and alertness.

ATA has been involved in research so that they can understand the science involved and apply it. This has actually been done in a number of ways. Although it may be a coincidence, the lists that Dr. Mark Rosekind put up earlier show that "Regulations" was not at the top. In fact, Regulations and Policies were at the bottom of both the list of eight and the list of six.

Training and education are critical in this area. ATA recognizes that and continues to promote efforts in training and awareness education at both ATA and, through the Foundation, within the industry.

Both the Alert Driver Video and the Alert Driver Guidebook have been out for about four or five years. These ideas actually came from the railroad industry, not from ATA, and were developed in partnership with the Department of Transportation. The focus is not on the work environment, but instead on the home environment. The choice to focus on lifestyle was made because it is a large part of the alertness issue, especially for carriers.

ATA, again in partnership with the Department of Transportation, developed the Understanding Fatigue and Alert Driving Seminar. Dr. Jerry Krueger, who is in the audience here, is one of the consultants at ATA and the Foundation who teaches that seminar. We have probably not made a huge dent in terms of training and education, as only some 2,000 people in the trucking industry have been trained. There still is a great deal of work to do, but it is a proactive effort with materials like a video and a book.

Whether they are entirely applicable to the transit or the rail mode, or any other mode, there are materials developed that can be stolen from and utilized. ATA has certainly done that and felt no shame about it. An example is ATA's "Instructor's Guide for Educating Drivers and Dispatchers." Companies are finding that you have to educate both drivers and dispatchers and build better relationships between the two.

In terms of training, ATA also has periodic updates via its Safety Management Council, which focuses on the safety directors within its trucking companies. Periodically, in an attempt to hit the alertness issue, as well as a lot of other safety issues, ATA provides updates through magazines, mailings, and meetings. In addition, much training takes place at ATA's safety and annual meetings. In fact, the 2000 Annual Meeting has Fatigue and Alertness Education, with Dr. Mark Rosekind as the presenter, as a top agenda item. That is the type of thing ATA wants to continue to keep in the forefront of the minds of chief executives of trucking companies and their safety directors. This particular meeting is primarily for the chief executives of trucking companies.

In terms of public education, although the efforts of AAA and the National Sleep Foundation are better known, ATA has also been involved. We have been working to educate the general public beyond just truck drivers, trucking companies, and dispatchers within the companies. We have conducted campaigns, such as "Awake at the Wheel," in which we have in partnered with a number of other organizations.

ATA has also been making public service announcements. The best one is the “Circadian Rhythm Blues,” which is a 60-second spot. We have also been producing and distributing brochures. An example is “America's Road Team,” which contains tips from professional drivers. ATA has had some success in the area of education and wants to continue to promote it. Regulatory advocacy is another key issue. Hours-of-service are important, but they are not the solution. One of the things on Dr. Rosekind's list was scientific guidance. ATA has developed a position with scientific guidance built into it. We have used this position to advocate before the Department of Transportation in order to promote reform. There has been an effort to change, but it has been very controversial.

Specific industry programs form another critical issue. Many have questioned the need for them within the trucking industry, but at ATA there is recognition that fatigue is an issue. In fact, ATA was part of the 1995 summit where fatigue was identified as the number one safety issue. ATA has promoted these programs because of this and several other reasons. However, the carriers and the trucking companies themselves have some very obvious concerns. There is a concern for the safety of their drivers on the road and for their health, and lifestyle. There are also public safety concerns. Fatigue is not on the list though as it is not perceived as being a company-based concern. A trucking company is not in the business of moving freight for the fun of it, but to make a living. However, to be profitable, the company has to move freight safely and efficiently. There is, therefore, a need to focus on key safety issues, and fatigue is certainly one of them.

Another key is increasing awareness in society. Many carriers have picked up this program with ATA's help, but a number have picked it up on their own. This upswing has occurred because of the better understanding of research findings and the lack of sleep that affects everyone.

Carrier-specific data is another important issue. This is the “show-me” approach, which looks at what data has shown carriers. Some carriers, though not all of them, found that they do not have an overwhelming fatigue problem as it relates to crashes. But large carriers who have enough crashes for them to evaluate and find some trends, found that fatigue-related crashes tended to occur during the first three hours after the drivers came back from extended off-duty periods, extended weekends, and extended vacations. They obviously had to put some countermeasures in place, and that is what ATA tried to help them with.

Another example involved a large carrier that is a member of ATA. This carrier identified the fact that it was having a number of fatigue-related crashes just as the sun was coming up. A very simple countermeasure that they put into place was to require a rest break of at least thirty minutes at 5:30 a.m. in that particular area of the country. It has seemed to work so far. It was a simple policy change, but it was effective.

In terms of a response, many of the companies have undertaken awareness training. Some also have done training in fatigue countermeasures, such as strategic caffeine usage, strategic napping, and better scheduling. Scheduling has been a real challenge, and there is still a long way to go with it in the trucking industry.

Exercise programs comprise another key issue. It is a tough one though because people are generally set in their ways.

Another critical issue is approach to wellness. In fact, ATA is considering building wellness into its Fatigue Seminar. The health and wellness program was developed by another organization, the National Private Truck Council.

Dispatcher training is yet another important issue. It was mentioned a bit already, and it is critical.

These are some of the things the carriers are doing. From this, they have learned that family life plays a huge role. They also discovered that data indicates there is a problem within the first few hours of the first shift after an extended off-duty period. This means they have to take their off-duty time more seriously and rest and sleep at appropriate times.

Drivers are set in their ways, especially when it comes to exercise and fitness. Some of ATA's carriers have put exercise facilities in their terminals, and ATA has supported the DOT approach of putting exercise facilities in rest stops, but neither of these has been well utilized. It has been a hard lesson, and ATA is unsure of how to change the culture. Shock effect has been seen to have some merit. One of the training tapes that is widely used in the trucking industry is called "Iron Mike and Hobo," and it is a shock tape. It is just like the "Operation: Life Saver" tape which shows that blood and gore have to be shown in order to convey the real impact of a fatigue-related crash to truck drivers. It is only in this way that we can get them to pay attention and change their behavior in some way.

The driver-dispatcher relationship and common-sense countermeasures are both extremely important and cannot be emphasized enough. Management commitment is critical no matter what issue is being discussed, but it is particularly important for safety issues. A quick story will illustrate this. There is a carrier that ATA deals with that is both very safety-conscious and very involved in safety issues. Its president and its safety director are both middle-aged white men with big necks and a small weight problem. They both have sleep apnea and use CPAPs. They have instilled that information, knowledge, and culture within their company and are on the leading edge of the trucking industry in identifying sleep apnea in their company. The message has to be reinforced. This is done by both ATA and the carriers. ATA attempts to help them through its councils, meetings and other similar means. Again, industry-government partnerships are very important. To put it simply, they work. In fact, in the view of many, they are better than regulation.

ATA has taken a proactive approach to industry, but it needs to do a better job of reaching small carriers. In order to do so, ATA has used its state affiliates: the state trucking associations. There are many small carriers in ATA's membership, but the majority of small carriers are found at the state trucking association level. So ATA uses the state associations to promote the fatigue and alertness seminars that it implements.

Industry's participation in research is extremely important, just as are education and training. Not to point the finger at any one particular agency, but while the agency that regulates the

trucking industry has a \$269 million budget for fiscal year 2001, less than one percent of that budget is geared toward education and outreach. This really needs to be changed.

Enforcement and regulations are entirely appropriate and ATA supports many of them. They must be in place. However, outreach, education, and training must be increased. The only way the culture is going to be changed for the next generation is through awareness training, laws, and enforcement.

Jeffrey Moller
Director, Casualty Prevention
Association of American Railroads

I am here on behalf of the President of the Association of American Railroads, Edward Hamberger. He not only cares deeply about fatigue, but he served in a number of capacities with APTA's predecessor organization for about 10 years. He wanted to be here personally, but AAR members are interested in other issues that are being discussed on Capitol Hill this morning, so he had to be there.

This symposium is a wonderful opportunity and it has brought together some important players. Although I won't name names lest some be left out, I will do so in the order that they entered into my experience in the fatigue realm.

For over ten years, Bob Lauby and his colleagues at the National Transportation Safety Board have been calling attention to the need to raise the consciousness level of people with regards to fatigue. They did not help just with the 1995 conference discussed earlier, but were also involved in the process that led to three watershed AAR accidents for which fatigue was given as a cause.

Bill Keppen, who spoke earlier, came to the AAR in 1992. At the time, Congress was holding hearings on rail safety, NTSB was finishing its third fatigue accident report, and the General Accounting Office was writing reports about AAR's scheduling. This was a tough time.

Dr. Rosekind, formerly of NASA-Ames, gave the AAR some wonderful information that it was able to "steal."

Dr. Moore-Ede will speak later at this symposium. This morning, he is demonstrating some of the uncertainties of the transportation industry, as his plane is delayed by fog.

Dr. Pat Sherry, from the University of Denver, wrote a report that will be discussed a bit later. He has been very active in a number of areas, including fatigue in railroads.

Dr. Drew Dawson of the University of South Australia has on his web site a very interesting model that can be downloaded and played with in order to generate results from alternate realities.

There is also a need to acknowledge Administrator Molitoris and her dedicated staff.

Finally, there are various members of the partnership here. George Hucker and Merle Geiger from the Brotherhood of Locomotive Engineers are in attendance. There are also a number of my railroad colleagues here. All of these people are outstanding resources of whom to ask questions.

The AAR is proud that it has taken the science of fatigue and applied it practically in the real world. It has been a tough challenge.

The fact that one size does not fit all is a major theme of the AAR. Even in relatively small transit agencies, there are distinct differences in the locations of its system or its various types of operations. In addition, some systems now span huge geographic areas of the country with different types of traffic, terrain, and weather.

The AAR has learned several important things from its research. Education is the foundation of everything and should not consist of simply dictating procedures to employees and managers. Families must also be included in the education process since spouses and children do have an influence. Often, if the spouses buy into this issue, they will use their secret methods to make things happen. If they do not buy in, then an opposite reaction will tend to occur.

Napping has already been discussed here. As a former rail supervisor, I personally climbed up on locomotives in the middle of the night, kicked in the door like a gestapo agent, and looked for obvious signs of sleep. That was the culture I lived in at the time and people did lose their jobs if they were caught napping. This is not universally the case now, but it still exists in the railroad industry. Yet, there has been a remarkable shift. In the past, if someone saw a policeman off in the weeds somewhere reading the newspaper or sleeping, they would have thought that it was a clear waste of tax dollars. Now, however, the idea that he might have been up for 14 hours already would enter one's mind and the reaction would be different.

Bill Keppen has given a good description of the Work/Rest Task Force research and the five million shifts of data they used. The AAR has created a compendium, "Fatigue Countermeasures." It lists and evaluates all of the activities underway in the industry. It is also available on the Association's web site, www.AAR.org. On the left-hand side of the main page, there is a red button for the Resource Library. Click on this button and the document should easily be found.

To conclude, the AAR is proud of its progress to date, but humbled by the work that remains to be done. It looks forward to working, not only with those in its industry, but also with all attendees.

Darryl Droblich
National Sleep Foundation

I was not originally scheduled to speak, but am taking one minute to talk about a National Sleep Foundation project.

The NSF will be holding a spring scientific workshop that will be looking at data systems. It will look globally for best practices and data systems in transportation, the workplace, and the medical fields. The NSF will also bring in people from all of these different fields to examine the current state of its data systems. Specifically, they will look at how the prevalence of accidents is recorded, how accidents are tracked, and what surveillance measures are utilized. The ultimate goal is to see both how the NSF can improve what it has now, and what needs to be built for the future. The workshop will be looking into private and public industry, both domestic and foreign.

SESSION IV: ACCIDENT INVESTIGATION WORKSHOP

Dr. Anita M. Rothblum
Human Factors Research Scientist
United States Coast Guard R&D Center

I will share with you what the Coast Guard has learned so far from investigating casualties about fatigue. This symposium has extensively discussed fatigue, how it affects human performance, and the fact that it causes accidents. This is all true in the marine industry too, where about twenty-three percent of the casualties appear to be fatigue related.

I will first discuss procedures used by the Coast Guard to investigate for fatigue. I will then demonstrate how the data that is collected from these investigations can be used to put together a fatigue reduction program. Much of the research to be discussed was conducted under the lead of Dr. Marvin McCallum and Ms. Mireille Raby from Battelle. A brief background on investigations and the Coast Guard is necessary, and then we can turn to investigative procedures and the use of casualty data.

The Coast Guard's emphasis on human factors is fairly new. In 1992, we finally realized that the reliability of equipment and the integrity of the hull of the ship were not the only factors that had to be considered when investigating casualties. Instead, there were a lot of human factors that can cause casualties.

It is fairly widely accepted that about eighty percent of casualties are human factor related. A quick literature review found that, depending on the type of marine accident, it seems that anywhere from 75 to 96 percent have human error components to them. It should be realized, however, that there are usually many causes of an accident. In a fatigue-related accident, lots of other things normally went wrong too, but fatigue probably contributed to some of those errors. This is why the Coast Guard is interested in trying to reduce fatigue.

In order to improve the industry, the types of errors that are causing problems need to be known. So the Coast Guard is trying to get better data on human factors-related causes. A big reason why fatigue was chosen as the first area of concern was that three different surveys of marine personnel over the last fifteen years pointed to fatigue as the number one concern in the industry.

Investigating for fatigue is extremely difficult. As Mark Rosekind noted, there is no physical evidence of it. There is no Breathalyzer or blood test at the scene of the accident that can show that someone was fatigued at the time of the casualty. Even if investigators do arrive shortly after the casualty has occurred, a person who was fatigued at the time of the casualty will not be fatigued any longer. The excitement of a casualty event will have increased his/her adrenaline level, so that they will be as alert as they can possibly be.

Fatigue is an insidious thing that modulates performance. The problem is that as a person's fatigue level grows, reaction times slow down, ability to make good judgments starts to fade, and memory starts to worsen.

There is clear delineation between being alert and being fatigued. It is a very gradual thing and depends on the amount of one's debilitation. When an accident does occur, unless the driver happened to fall asleep at the wheel, fatigue itself is generally not the thing that caused it. There are errors that were made, and the problem facing the investigators is determining whether or not fatigue underlay those errors and caused them to be more prevalent.

In the Coast Guard, these investigations do not usually occur when the accident happens, which causes a great deal of difficulty. It may be days, weeks, or even months before an investigation gets off the ground. This is because the regulations for the maritime industry state that a company whose ship has had an accident needs to contact the Coast Guard within forty-eight hours.

Most accidents that occur are not so devastating as to keep a ship from going elsewhere. The ship often simply undergoes a few repairs and sails off. By the time the Coast Guard hears about the accident, the ship is already in the midst of sailing to some other port, which makes it difficult to go on scene and investigate. Investigators cannot easily call up someone on a ship by phone, so they have to wait until those involved in the accident are finally back off the ship and on land in order to contact them. However, it is common for these mariners to be on ships for two to four months at a time.

Thus, maritime has this added problem that, hopefully, does not exist in other transportation industries. When days or weeks do go by before an investigation can start, memories fade and no one can be quite sure what all the facts really are. Plus, it is not always possible to contact all witnesses. In fact, in the project about which I am going to speak, the Coast Guard was unable to get in touch with fifty percent of the people it wanted to contact.

Another factor that makes it difficult to investigate for fatigue is that people are less than totally truthful. Being fatigued is very similar to being under the influence of alcohol in that fatigue impairs judgment. It is one of the first things to go, and it means that the person is unable to properly judge whether he or she is alert or not. People are their own worst judges when it comes to matters like alertness. They are better at seeing whether somebody else is a little fatigued or inebriated than they are at judging themselves. Also, many workers become so used to being fatigued that it simply feels normal to them. They are unable to tell investigators that they are fatigued simply because they legitimately do not realize that they actually are.

Another problem is that the Coast Guard represents the law. Most people who could lose their license due to negligence are not going to own up to everything for which they are responsible. Talking to the police regarding fatigue is something about which many people do not feel comfortable.

Finally, there is a very macho image in the marine world. It is common to hear statements such as, "only a sissy would be fatigued," and, "real mariners can work for three days straight without any rest." These are things that influence people to suggest they are not fatigued when they actually are. So it is challenging to try to perform this kind of investigation, but it is possible. In fact, some very good data can be obtained when it is done aggressively.

The determination of fatigue is really a hypothesis because, again, there is no concrete evidence and an investigator is never one hundred percent certain. But an investigator must take the evidence that is there and make a best estimate as to whether a person was fatigued at the time of the event. Investigators do not determine whether fatigue caused the casualty. What they really do is determine whether the person was fatigued when the errors were made. They make the assumption based on scientific evidence of what fatigue does to people, that fatigue was involved in causing the errors that caused the casualty.

There is a precedent for this, again with alcohol and drugs. A blood test with a reading of 0.10% BAC does not prove that the alcohol caused the casualty. What it does indicate is that the person is legally inebriated. It is then assumed that the alcohol was at fault as well, because of the scientific evidence on how alcohol affects performance.

In looking at how the Coast Guard conducted its investigations, a piece of it came from an earlier study that I did with Sue Hill and Jim Byers from the Idaho National Engineering Laboratory. In that study, there was an examination of how to create a reliable and valid casualty database. It resulted in a list of four steps, and these fit in with the fatigue study that the Coast Guard just did.

The first step in developing a reliable and valid casualty database is to determine the goals of the data being collected. That means what questions does the data collector want answered. If the questions are too vague, the data collected will not give us what we want. If data is collected with no real goal in mind, it tends to result in haphazard information. The collector is then often unable to extract desired answers. Developing the database must be done from the top down with clear goals in mind. Collectors must know what indicators they are looking for and then design the casualty database so that the right data is collected to support it.

For the Coast Guard, the first goal was to determine the incidence of fatigue-related casualties. That is, investigators should be able to investigate a casualty and tell whether fatigue was involved. This would then give us the percentage of casualties in which fatigue is a factor. It is a good figure to have and, as already mentioned, twenty-three percent of the Coast Guard's casualties turned out to have been fatigue-related. That is a big number and it sounds important, but it does not indicate anything about how to go about solving the problem. Therefore, the second thing the Coast Guard wanted to do was identify operational factors. These are the changeable factors that seem to drive the fatigue in the industry.

This second step is to determine the specific data that is required. Once the investigators know what the questions are, they can get the right data to answer them. If the Coast Guard just wanted to determine whether fatigue was a problem, it had to think about how to find out whether someone is fatigued. There are causes, there are symptoms, and there are effects of fatigue. Coast Guard tried first to collect data that would help understand whether any of this information seemed pertinent in a particular case. Secondly, the Coast Guard wanted to make the data as objective as possible. It did not send the Investigating Officers (IOs) out into the field without instructions on their data-gathering procedures. The Coast Guard wanted to be as specific as possible about what kinds of factors the IOs had to examine, so it formulated a detailed set of questions to be asked during the investigations.

The third step is to match the investigators and the procedures so that investigators have the skills needed to collect the right data. They must be able to do it in a reliable and valid way. The Coast Guard knew that its IOs did not have a human factors background. Since they did not know a great deal about fatigue, the Coast Guard designed its procedures so that it would require minimal skill to get good data and, in addition, provided training to the IOs. An entire day of training was devoted to this process at each of the Marine Safety offices. A large part of it was background on human factors and fatigue. It taught what fatigue is, how it affects people and why the Coast Guard is interested. There was then specific training on the data collection forms. This training went over every element on the form, why it was being collected, and how it all fit in. Lastly, a couple of casualties were staged so they had a chance to see how to use these procedures in a more realistic setting.

Finally, it cannot be expected that someone who has taken a 1-day training course will become an expert. Thus, the Coast Guard had two human factors experts, Dr. McCallum and Ms. Raby, review each and every casualty form to determine whether enough of the data had been collected. They also checked to see if they agreed with the IO's investigative methods and conclusions. If they had any questions, they talked directly to that IO. So the IOs got individual mentoring as they went along, with feedback on things that they did well and things that they needed to do better or differently.

The fourth step in developing a solid casualty database is the need to provide feedback. There is nothing that de-motivates an investigator more than to have put in effort only to find out that all the data was simply ignored. The Coast Guard found that out a few years ago from its investigators when they said that they were not receiving any reports on the results of their labor. It is very important to keep the motivation level of investigators up, since it is a hard job that does not allow for taking short cuts in order to collect the data. Investigators must know that their data is important, that their data is being used, and that their output is being used as input to some other safety system.

In the case of the Coast Guard, it conducted a 6-month study. It was not long-term, so much of the feedback of that nature could not be given to the investigators. However, three newsletters were sent out to the involved offices letting the IOs know of changes that were being made to the forms, giving the IOs answers to some of their questions, and listing the number of cases that each of the offices had completed. This was in addition to the direct feedback the IOs received from the experts who reviewed their casualty reports.

These four steps are useful for any kind of database building. To be a little more specific about the Coast Guard's fatigue investigation, it developed a 3-step procedure, which may differ somewhat from what others elect to do. It started with a criticality screening. The Coast Guard receives about 5,000 vessel casualty and personnel injury reports every year, but has only about 160 full-time investigators. That was way too many cases to allow for detailed studies. As a result, the Coast Guard tried to screen out the cases that did not seem severe. By doing this, the IOs were able to dedicate more time to more critical cases. The criticality screening looked for those cases that had significant damage, injury, or risk to the crew.

The second screening was a quick human factors check that looked for direct human factors input to the casualty. The Coast Guard defined “human factors” for its investigators as a bad decision made, a bad action taken, or inaction. Inaction was when someone should have taken an action but did not. If any of these things contributed directly to either the casualty’s occurrence or severity, then the casualty was classified as human factors related.

The Coast Guard was not looking at latent factors. It was not looking at the things that happened off the ship or two or three weeks beforehand that may have contributed to the casualty. It was not looking at factors like poor maintenance or a bad policy decision from company headquarters. The Coast Guard did not feel that its investigators could go back, trace these things, and determine their fatigue content or relevance. Instead, the investigators were looking at the events that occurred then and there on the ship, probably within a few hours of the accident. For accidents that passed the human factors screening, an attempt was made to conduct a complete fatigue investigation.

In terms of actual questions, they were based on a model that shows the causes, symptoms, and effects of fatigue. In addition, an entire list of contributing factors was compiled. What the Coast Guard was interested in was whether the person being investigated had gotten enough sleep. They also checked as to whether that sleep came in the right part of the circadian phase. Another contributing factor that was checked was the amount of stress in the life of each person and whether it was job-related or personal stress. Physical and environmental stress was also investigated. These types of stress are very important on seagoing vessels because it is very fatiguing just trying to stand up, never mind trying to work, in storms and rough seas when the ship is rolling from side to side.

More specific factors were also looked at, such as the number of days on duty at the time of the incident, that is, how many days the person had actually been on the ship at the time the incident took place. Other questions involved the number of days off the person had in the last month, the number of hours on duty without more than a half-hour break at the time of the incident, the time of the last break, and the time of the last meal.

There were many similar pieces and 3-day work/sleep schedules were obtained from them. Starting from the time of the incident, the IOs worked back three days and discovered when the person slept, worked, took recreational or personal time, and ate. The IOs then had the person rate things such as workloads during work periods for that day, their quality of sleep, and the fatigue level for each of those three days. Thus, very specific information was obtained.

The IOs next asked about fatigue symptoms. If a person is very fatigued, some of these symptoms will begin to become evident. There are physical symptoms, like clumsiness, sore muscles, and mental symptoms, like forgetfulness, simple arithmetic errors, or lessened motivation. The mariners were asked whether they had experienced any of these things.

This last part did not work out for the Coast Guard. There are certain types of human errors that tend to happen more often when a person is fatigued. Actually, to be more precise, fatigue tends to cause this type of error to happen. The Coast Guard tried to get specific error information in order to look at the effects of fatigue. Unfortunately, this required a more detailed knowledge of

human factors than the IOs had. However, although it did not go as hoped, it was felt that the contributing factors and fatigue symptoms were handled well.

The question became whether fatigue was a factor. In the initial look, investigators had gone through the whole list of factors. They had had training, and had a couple of experts watching, and evaluating their work. In this way, if the investigator thought it was fatigue-related, then the Coast Guard could confirm that it was. If the investigators said it was not, then the Coast Guard agreed that it probably was not. However, the Coast Guard also considered the mariner. It was decided that if the mariner thought fatigue was a factor, then we listened to that also, even if the IO was not sure that that was true. So the first cut at this was to say that if either the investigator or the mariner considered fatigue a factor, it was accepted as a factor.

Next, the Coast Guard looked at casualties and found that there was not a complete overlap between what mariners thought and what the IOs thought. Usually, if the mariner thought fatigue was a factor, the IO also thought fatigue was a factor, but about fifty percent of the time when the IOs thought fatigue was a factor, the mariner disagreed.

This discrepancy arose partly because people are generally not aware of their own fatigue or do not want to tell authorities that they are fatigued. In some cases, there may have been an IO who was a little too motivated to find fatigue where there was none or a mariner who was a little too anxious to deny that his operations caused fatigue. This caused the Coast Guard concern about the possibility of over- and under-reporting. In response, we tried to find a more objective way of determining whether an incident was caused by fatigue.

The Coast Guard took all the incidents on which it had information, both those that were fatigue-related and those that were not according to the IO and the mariner, looked at all the data that had been collected, and did a multiple regression analysis. This found that, with about eighty percent accuracy, just three factors could be used to determine whether fatigue seemed to be present.

A “Fatigue Index Score” was used in some of the analyses. It showed that if just the number of fatigue symptoms, the number of hours worked in the 24 hours prior to the casualty, and the number of hours slept in the 24 hours prior to the casualty were put into the Coast Guard’s formula, it could be determined with eighty percent accuracy whether fatigue seemed to be a factor.

If the score was greater than fifty, then the Coast Guard found it was fatigue, while a score of fifty or less meant it was not. This was a more objective index and the Coast Guard actually is still using it today. Unfortunately, the Coast Guard decided they do not have enough time to do a full fatigue investigation, so they are using the Fatigue Index Score to investigate for incidence data.

Next, the Coast Guard made a comparison between the fatigue index scores and what it had received from the IOs' and the mariners' thoughts. It found that the results of each were very similar. In the maritime industry, sixteen percent of vessel incidents, which includes incidents like collisions and groundings, and one-third of personnel injuries are fatigue related. Thus, the

combined incidence rate of fatigue to all marine incidents is twenty-three percent. Fatigue causes generalized results among people, and can cause errors in almost anything they do. Therefore, it is not a surprise that the Coast Guard found fatigue in almost every type of incident. Fatigue-related incidents were found in collisions, allisions (when a moving vessel hits something that is not moving like a dock or a bridge), groundings, and sinkings. The same was true in personal injury cases. It did not matter what kind of personal injury the Coast Guard looked at, fatigue would loom up as having contributed to that incident. Fatigue contributed to slips, amputations, and all sorts of injuries.

This kind of casualty data can be used to support fatigue reduction programs of other agencies. Essentially, the Coast Guard was trying to compare its fatigue-related incidents to those from other causes in order to determine what caused the fatigue-related ones. Finding operational factors that cause fatigue-related accidents provides an input as to areas which can be improved.

The Coast Guard found four major areas that seemed to underlie its fatigue-related incidents. These were time of day, insufficient sleep, poor sleep quality, and long work hours. Human beings have been genetically engineered to be up, alert, and working during daylight hours and asleep at night.

If errors made over the course of the day or how quickly a person can fall asleep at different times of the day are examined, a function will be found that shows that from about 9:00 a.m. through about 12:00 noon or 1:00 p.m., people are very alert. However, after 1:00 p.m. there is a post-lunch dip. People are real alert again in the late afternoon and early evening, but around 11:00 p.m. alertness takes a nosedive. This shows up in performance, mental ability, and accidents, and also in the accidents the Coast Guard investigated. It found that forty-one percent of its fatigue-related accidents happened between the early morning hours of 4:00 a.m. and 8:00 a.m. The reason we looked at that is because maritime crews operate on watch schedules. They are usually on a four-on/eight-off schedule, which means that one group works the midnight to 4:00 a.m. shift and another group works the 4:00 a.m. to 8:00 a.m. So the Coast Guard looked at 4-hour periods.

It was the early morning watch group that had the most trouble. This meant that the Coast Guard had mariners who were expected to be alert and working during the early morning hours that were not adapted to their work schedule. Thus, we had to find out just what it was that was kept them from adapting to the schedule. We found that they do not adapt because their schedule kept changing. The mariners, therefore, never got a chance to adapt, and maybe that is a problem with those in transit as well.

There is a need to find out what it is that keeps people from adapting to schedules, because people can adapt to a nighttime schedule and be a lot more alert. The research can be supported through a change in the way agencies operate. This would be a great thing, and, in fact, there has been some research conducted that looked at changes in schedules and other things that would help people become better adapted to their work schedules. Mark Rosekind mentioned that light is one of the things that cues in the biological clock. People can be in control when they have light available to them, and that can help resynchronize their clock to their work schedule. So time of day is one important area that is correlated with accidents in the marine

industry. It could also be an important factor in the transit industry.

The Coast Guard also discussed sleep quality and lack of sleep. An experiment was conducted with people who were well rested. They came to the laboratory and were allowed to sleep for only a certain amount of time for just one night. The next day the researchers observed their performance and general level of alertness. For people who got between 5 and 8 hours of sleep, there was a gradual decline in performance as the number of hours of sleep decreased. In general, however, these people were still doing alright the next day. On the other hand, the performance of those who got 4 hours of sleep or less was much worse than that of the group which got 5 hours or more. This showed that just one night's sleep of 4 hours or less was sufficient to greatly reduce a person's ability to perform the next day.

The Coast Guard decided to look at less than four hours of sleep in its data because we were interested in that particular part of the function. We wanted to discover how many people, on the basis of that one night's sleep, would be expected not to be particularly alert the next day. The actual result was that in fatigue-related incidents, 18 percent had gotten four or fewer hours of sleep during the 24 hours prior to the incident.

What was found to be even more important than sleep duration was sleep quality. As mentioned, the Coast Guard asked its staff to rate the quality of their sleep on a five-point scale for each of the 3 days prior to the incident. It found that almost one-third of those involved in a fatigue-related casualty said that they had had poor quality of sleep during the 24 hours prior to the incident. That is eight times larger than what was found in incidents where no fatigue was apparent. Poor sleep quality was not just a one-time problem. When the sleep ratings for the last three days prior to the incident were averaged, it was found that at least one-quarter of those questioned said that they had had poor sleep quality for all three nights.

This is a chronic problem and not just a matter of mariners merely missing a good night of sleep once in a while. It is also reflected in the fatigue ratings, because Coast Guard asked the mariners to rate their level of fatigue or alertness for the three days prior to the incident. Sixty percent of the mariners who were in a fatigue-related incident admitted to having had a high fatigue level on the day of the incident. When the average fatigue rating for the three days prior was calculated, it was found that forty-six percent of mariners showed high levels of fatigue for all three days. Therefore, it appears that fatigue is a chronic problem in the maritime industry and needs to be addressed.

In terms of trying to develop a fatigue-reduction program, the Coast Guard must understand why its industry and operations are causing poor sleep quality, high fatigue levels, and such few hours of sleep within a day's time. It must determine why this happens in order to determine what it can do to fix it.

Finally, the Coast Guard looked at working conditions associated with fatigue-related incidents. It identified a trend that showed that there was more work going on in the group that had fatigue-related incidents than in the group that had incidents caused by other means.

First, the fatigued mariners had worked about twice the number of consecutive days as non-fatigued mariners. A second comparison showed that the fatigued group had about half the

number of days off as the non-fatigued group. The most dramatic comparison concerned the number of hours worked. We looked at the number of hours on duty prior to the incident, which is the number of hours on duty without more than a thirty-minute break. The mariners who were involved in fatigue-related incidents had worked, on average, nine continuous hours prior to the casualty. They might have had 20- or 30-minute breaks at some point, but that was all. On the other hand, the other mariners were only on duty 3.3 hours, on average, when their incidents occurred, and it was not as fatiguing.

Their hours worked are too long. If the number of hours worked the day before the incident, two days before the incident, and three days before the incident are looked at, we find that fatigued people worked two to almost three times as many hours as the mariners who had incidents from other causes.

These work hour comparisons are important because they reflect overwork in the industry. However, what gets people nervous is that the legal work hour limits permitted by the Oil Pollution Act of 1990 is 15 hours in 24, 24 hours in 48, and 36 hours in 72. People are therefore working what they are legally allowed, but government regulation may be a little too lenient. Research indicates that overly long work hours cause fatigue in the maritime industry, and it is possible that it is necessary to decrease work hours in order to decrease fatigue. Work hours may not be the only factor. If these mariners are allowed better and longer-duration sleep, then they will have the energy resources necessary to deal with these long work schedules. Regardless, something must be changed.

So that is how fatigue-related data can be used to help get a handle on what is happening in an industry that is promoting fatigue.

In summary, fatigue increases the probability of making errors and having accidents. It can be difficult to investigate, but it is worth while to do so. If objective data collection methods using specific protocols can be found, then good, reliable, usable fatigue-investigation data can be obtained. This data can then be used to help support fatigue reduction programs. It can help track the incidence of fatigue-related casualties because, once the program is underway, the level of fatigue-related accidents will be being collected. Even more importantly, the detailed data can help identify what it is about the operation that may be driving fatigue. This, in turn, indicates where action is needed in order to start reducing fatigue problems.

Stephen Klejst
Assistant General Manager for Safety and Training
New Jersey Transit

As anyone who has examined fatigue or alertness as a possible cause of an accident knows, it is very important to examine all aspects of it, whether it be a personal injury, a motor vehicle accident, a train accident, or a derailment. It is often surprising to see the data and information that can be collected by looking at fatigue or alertness as a possible cause.

Just because an incident takes place between the hours of 4:00 a.m. and 8:00 a.m. and, as Dr. Rothblum just pointed out, over 40 percent of marine accidents take place during that time period, does not mean that it is automatically a fatigue-related incident. Therefore, it is important to ask the right questions and collect the right data.

It may not be always a matter of someone simply falling asleep. An example is a maintenance employee that might be slightly fatigued. The alertness has been diminished because they have not gotten enough rest. Although they may not be falling asleep, they may have to perform a procedure that requires proper sequencing, and make an error because alertness has been decreased by the lack of sleep.

So it is not simply a matter of an operator falling asleep and causing a collision, or someone operating a motor vehicle veering over the median and getting involved in a collision. It could be a personal injury that at first does not appear to be fatigue related, but in actuality is very much so.

In 1996 an incident took place early in the morning that involved an overnight split shift assignment. It resulted in three fatalities, two crewmembers and a passenger, and had all the makings of a fatigue-related accident. Fortunately for New Jersey Transit, even though I had never had any formal training in fatigue investigation, the NTSB provided assistance. Their investigators were highly skilled and trained in investigations of that type. They helped determine that it was not a fatigue-related incident. It was a medical-related incident, but if it had been only scrutinized on the surface without the benefit of experience on the part of the NTSB investigators, it might have been incorrectly categorized as fatigue-related. This would have overlooked what turned out to be the medical standard which has changed within the industry. So it is important to investigate all these incidents accurately and correctly.

A good deal of the information presented at this symposium can be overwhelming if it is a person's first exposure to fatigue and alertness issues. When I attended my first session in 1996, after hearing all the different presentations on the science and physiology of fatigue, I was confused about where to start. Here, the attendees have received good information on the Coast Guard's approach to accident investigation from the human performance standpoint. However, one of the goals of this conference is to not only present information, but also to allow the attendees to leave with the ability to do something quickly with the information. The goal is to have their agency or property benefit as a result of them being here today.

So my objective is to help the attendees through facilitated development of an accident investigation tool. That is a fancy way of saying that it is your turn to work.

As a starting point, the four categories that Dr. Rothblum went over in her presentation will be used. These categories are time of day, sleep duration, sleep quality, and work schedule issues. All but one property as represented here today actually examines alertness and fatigue as a possible cause, so the question of what the attendees can do when they go back needs to be examined. If you do have an incident, you must know how to ask the right questions and what questions must be ask in order to determine whether or not fatigue and/or alertness had some

impact.

One of the first questions you might ask as investigators is the length of time the operator has worked. As a follow-up, individuals involved in the incident should be asked about the amount of rest they had prior to starting their shift. This should focus on not only the previous 24 hours, but the previous 48 and 72 hours, as well. In fact, when New Jersey Transit conducts its investigations on train accidents, it goes back over a 30-day work history. Access to that level of information could help you make a determination as to the possible contribution fatigue may have had in an incident.

Another question investigators might ask is whether there was a shift change. And if there was a shift change, they should inquire as to whether it went forward or backwards, because that is a very important distinction. Each direction has a specific impact on a person's ability to tolerate shift changes. Going forward has an impact that could be very detrimental as compared to dropping back.

Another point of inquiry is when within the work history did the incident take place. It is also important to consider as a human performance issue the person's familiarity with the job from a training standpoint, although it is perhaps not directly related to fatigue. Their familiarity with that particular location or run might also be a very important issue. There is a difference between a bus operator who may not have been over a particular route in some time and crashed while looking for a particular turn and someone who was simply on autopilot and missed a spot or had to make a quick turn. Incidents therefore may not always be fatigue related. Instead, they may be traditional human performance issues. However, investigators still must ask appropriate questions in order to either support or refute the possibility that it was an alertness/fatigue-related incident.

Other areas one might focus upon are the level of attentiveness, environmental issues, and the possible contribution of drugs and alcohol. For the most part, either through regulatory requirement or through company policy, drug and alcohol testing is a requirement for New Jersey Transit. However, for those attendees who are in a situation where that is not required, it is something that their properties might want to consider. It allows for the use of drugs and alcohol in an incident to either be ruled out or confirmed.

Different people have different definitions of alertness versus fatigue. An audience such as the one at this symposium, which includes individuals who have had some exposure to it, may be looking at fatigue and alertness from different perspectives. To a lay person, fatigue and alertness may mean the same thing, or it may be something completely different. It all depends on what they have been exposed to in terms of definitions.

However, it would still be good to ask someone involved in an incident about that person's level of alertness. Yet, as mentioned earlier, the investigator may not get accurate information in an answer to this question. They might say that they were alert even though they had rotated shifts for the past thirty days, had averaged four hours of sleep a night, and had to drive two hours each way to go to and from work.

Everything has to be put into its proper perspective, but if investigators have access to a person's work history and can take a look at the amount of sleep versus the number of days worked versus the number of days off, then they can obtain an answer that either supports or runs contrary to the person's answer to the question. Asking the question is not a bad idea at all.

Another important question an investigator might ask involves sleep quality and its level over the couple of days before the incident. Fragmented sleep or sleep that is affected by a sleep disorder is not efficient. Under such circumstances, sleeping for 10 hours may not result in a productive sleep. In such cases, the investigator should work to pinpoint the exact quality of sleep and the frequency of interruptions.

The issue of commuting to and from the job location might also be investigated. An hours-of-service regulation can prohibit people from working more than twelve hours, which is the case in the rail industry. There could, however, be an extension of that time through a break, which is the split shift arrangement. A person may have driven two to two-and-a-half hours to get to the job site and another two to two-and-a-half hours to get home. If he/she is then brought back with an eight-hour call, he/she does not have much time to be at home to take any kind of rest, even though he/she has been off duty.

If there is a fatigue education program at the agency, an investigator might want to find out if the person involved attended the program and, if so, if that person followed what was learned. This might also be good secondary information to study to determine if such programs are having any positive effects on behavior.

Another good question might be whether the person woke up tired. Some people wake up refreshed and feel like they can conquer the world, while others have had ten hours of rest and still feel as tired as when they went to bed.

It is important to remember that there is no one question that enables an investigator to definitively ascertain whether fatigue was an issue in an incident. Asking the appropriate questions and taking a hard look at the data to find out what possible impact fatigue really had is what is going to enable them to make an informed decision as to whether they are looking at a fatigue issue or some other human performance issue that might involve retraining and re-education.

Another question the investigators might ask would involve the length of time the person had been up at the time of the incident. This could include time of rising in the morning if it was a daylight incident, or time of last non-nap sleep if it was a nighttime incident. As stated in earlier presentations, the timing of a person's rest is very productive. People who work at night and try to get some rest during the day or the afternoon may experience a significant negative impact on their ability to perform at a level comparable to people who sleep the traditional evening hours.

Another possible point of inquiry is whether the person was released from duty. The investigator could look into whether there was a break in duty between the time of the event and the time the person had gone on duty that day. Again, this could be due to a split shift assignment, a release, or some other reason. So the investigator should try to gather information both on the total time on duty and any break time that may have been taken.

As a follow-up, the investigator can ask whether the person napped while on break. If the organization has a napping policy, this again may be a good way of determining whether or not people are actually taking advantage of it. It can help determine if provided rest facilities are being used, or perhaps, it might indicate that a rest facility is needed.

Without going too far into the physiology, it is known that stress causes the body to expend more energy. Investigators must assess whether they are dealing with someone who is not in an active decision-making position or actively doing a job, such as a maintenance or operations worker. This will help them assess whether physical activity or stress was possibly a contributing factor. Stress does play a very important role. Anyone who has ever spent a couple of hours behind a bus operator in midtown Manhattan knows there is a lot of stress there, and that the work schedules of those drivers are much different than those of people who work split shift assignments. Different job environments present different tasks and activities every day, which have different impacts on workers' alertness levels.

Another point of inquiry concerns issues in the person's home life as the home life absolutely cannot be separated from the business world. While investigators may hope that employees would be very forthright and share such information, it can be difficult to get them to do so. If there is a positive relationship between a first-line supervisor and the employee involved, they may be a little more inclined to do so. In any case, it is certainly another question that is worthwhile to ask. In the worst case, the investigator will simply get no information, but they could also get some very useful information.

Another question an investigator might ask is whether the person was on any medication at the time of the incident and, if so, whether the medication affected his/her performance. Just because the label on the box says non-drowsy formula, it may not exactly be non-drowsy, given the level of attentiveness that an operator, a maintenance person, or someone in a dispatching center must have in order to safely carry out their job responsibilities. The impact of both over-the-counter and prescription medication on alertness will be discussed later in this symposium.

However, again, while investigators would like to think that employees would be forthright and provide this information, sometimes people are not very willing to do so. Regardless, it would still be a good line of questioning to pursue. The idea is for the investigators to try to pull out information from the individual, or individuals, that will help guide them into making the determination of whether fatigue was a factor. Some of it will come out very easily, some of it will be inaccurate, and some of it, in some of the more sensitive areas, will never be revealed at all. They have to at least be able to ask the right questions to try to make as accurate a determination as possible, though.

The investigation can start off with a couple of basic questions, even if they are only about some of the scheduling issues, which are pretty straightforward. They will be able to get most of the scheduling and work history data on their own, without having to ask the employee, because this information can be collected from payroll or other types of records. When the investigation proceeds to questions about sleep, then investigators must rely on the employee for information. Hopefully, however, they can still draw some conclusions from the level of information that the employees share.

When you return to your properties, even if you are only able to use some of the basic information presented here, such as work hours and time of day analysis, it may still take them much further in dealing with alertness and fatigue issues than they are currently able to go. For example, while many properties collect data on each incident, how many have looked at their aggregate data to plot frequency distributions for the different time periods and locations of their incidents? Do they analyze any of the existing data they have? If an investigator has the ability to go back over past records, they should take a look at frequency distributions. The length of the period examined, which could be 6 months or a year, would depend upon the number of incidents the property has had.

As Dr. Rothblum noted, a significant number of incidents happened in the early morning hours between 4:00 a.m. and 8:00 a.m. If investigators wanted to target their energies, employees who work during that time period seem a good place, as opposed to those who work middays. Again, until investigators actually collect the right data and start looking at it, they may not be able to do justice to the whole process.

Another investigative technique that could be utilized is direct observation of employees, such as by supervisors in the course of their normal duties. This could result in discovering things such as an employee nodding off or being inattentive or an alarm going off with no reaction to it. If so, this certainly would give the investigator some useful information.

After an incident takes place, adrenalin starts to flow in the person involved so functionality is essentially regained. Therefore, an investigator may not be able to make a realistic determination as to whether or not the person was tired before the incident. However, it is something that can be noted through normal basic supervisory observations, and it certainly is something to be recorded. Observations may not always be of someone falling asleep. They could instead be situations in which a maintenance person walked by a train and did not observe a brake shoe hanging off because of being less than fully alert. The worker may not be sleeping, but certainly did not have the alertness to pick up an obvious defect. Observations like that would certainly indicate there might be an alertness problem with a given work force.

An investigator might ask a person involved in an incident whether he had consumed any beverages containing caffeine either before or during his tour of duty. While it has been shown that the strategic use of caffeine does improve alertness, if it is overused, it does not have the same effect as when it is used correctly or strategically. If it is found that caffeine is not being utilized properly, perhaps an educational awareness program could be instituted. If the topic has been covered, the responses to this question might again be useful in assessing the impact of the

educational program.

Another point of inquiry might be whether the person uses an alarm clock. Some think that needing an alarm clock to get up is a clear indication that a person is not getting enough sleep. Again, however, it may be tough to get accurate answers to that question. There was an interesting study that indicated there was a sleep debt among Long Island Railroad customers. Thus, the actual makeup of a person's commute might be investigated, as well.

Another question we could ask concerns exactly what happened. Depending on the severity of the incident, it might be something the agency wants to investigate thoroughly. While the accuracy of the information can be improved by a seasoned investigation, it is something a staff of any level of expertise should pursue. It will provide some good information, particularly if it is a major incident. An investigator would like to have at least a good explanation of what happened because it will help develop corrective actions.

Investigators may also want to note the physical characteristics of the person involved in the incident. Overweight individuals with larger necks are more prone to sleep disorders, and sleep apnea is more of a male dominant trait. In its strategic planning, each agency must decide whether they want to be involved in this area. They must look at whether they have the ability to do so from a staffing standpoint. They must also decide if this would result in information that would add any real value to the investigation in comparison to more quantitative data that can be gathered from more traditional records.

As properties start doing this type of investigation, their investigators should look at the possible contribution of fatigue through information that can be more easily gathered given the size of the property's staff. They should then proceed to the next level when they have developed a little more expertise and the other employees of the property have reached a comfort level with the fact that no one will be disciplined or terminated because someone comes forward and admits they have a sleep disorder or something related to one.

The list of possible questions compiled here may be more than the operating indoor safety departments of those here can currently deal with. However, these departments might at least take a look at the list and start working with some of the questions in order to start the process. With a good start now, perhaps in five years they will be dealing with issues such as people being forthright with properties and their investigators about whatever type of sleep disorder they might have.

SESSION V: SCHEDULING WORKSHOP

Dr. Drew Dawson
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In Australia, a group of fatigue researchers, including the speaker, have been working primarily with the rail industry. The project has been going on for the last five years and has resulted in some interesting outcomes and models. These outcomes may be valuable, or instructive at least, for the American rail industry, which is facing many of the same problems as the Australian rail industry.

It has occurred to the researchers over the last couple of years that there is a need to identify the drivers of fatigue within an organizational setting. The primary driver of fatigue in most transportation industries is greed, and lack of accountability is not far behind.

That is probably controversial, but greed is not limited to management. There is greed exhibited by employees, as well. This is commonly referred to as “the conspiracy of greed.” That is, everyone will maximize his/her short-term profits, and because he/she is not accountable, either directly or organizationally, for the longer-term costs of that, he/she will then make indirect cost transfers, either within the organization or to the community and taxpayer as a whole.

It has been a very interesting perspective to put forward, and it has been seen as somewhat neo-Nazi in the United States. If properties are looking for a quick fix and the ultimate cost effective fatigue management method, then all they need to do is get their employees and prop a couple of matchsticks under their lids. That is about all they are going to need to do. As Gordon Gecko said in “Wall Street,” it is all about money and the rest is conversation. On the other hand, properties might instead ask themselves the question of why does greed emerge as a significant driver, and what are the cultural values that underlie it?

At the end of 1999, a series of public lectures at the University of South Australia was run entitled “Great Villains of the 20th Century.” Each lecturer was asked to pick a great villain of the 20th Century, and the Politics Department picked the usual suspects, such as Adolf Hitler, Joe Stalin, Margaret Thatcher, Ronald Reagan, etc. However, the speaker decided to be a little counter cyclical. Due to his perspective and his interest in sleep and fatigue research, he decided to identify the person who had done the most to contribute toward the greed and unaccountability that drive so many organizations.

He decided, coming to the U.S. particularly, that Thomas Edison was probably the greatest culprit in terms of driving this greed, although he obviously was not the only person who has driven it. Around the turn of the century, Edison said, “[m]ost people overeat one hundred percent. Most people oversleep one hundred percent because they like it. That extra one hundred percent makes them unhealthy and inefficient. The person who sleeps eight to ten hours a day is never fully asleep and never fully awake. They only have different degrees of doze throughout the twenty-four hours.”

That quote encapsulates the cultural value that is seen, particularly in Anglo cultures, with respect to what economists refer to as the fallacy of composition. That means that if X amount of training is good, then two times that X amount of training is even better. Thus, it is often believed that if someone works for eight hours and produces a certain amount, then if he/she works for 16 hours, preferably for less pay, he/she will produce twice as much for the organization.

When a company manufactures widgets, this doubling of production may actually be the case, but as the complexity of the skills required increases, this relationship tends to break down. That is, there is no longer a linear relationship between work and efficiency.

What is quite interesting, as was seen in the stuff that Mark Rosekind presented, is that as the tasks and the symbolic manipulation that is done in an organization become increasingly reliant on intellectual and cognitive skills, the susceptibility of that system to the fallacy of composition increases exponentially.

The culture that surrounds this has actually been quite endemic across the Twentieth Century. The cult of cost compression, as it is called in Australia, has resulted, in many cases, in the sort of outcomes where increasing short-term efficiencies are achieved, but they lead to longer-term inefficiencies and, in many cases, increased costs above and beyond any productivity savings.

There is an interesting cultural factor at work here. When the fatigue researchers talk to individuals in different workplaces or ask students to do a projective case, they give them a little case history. The only thing that varies in the story about the individuals in the case histories is how much sleep they actually get. One individual in the vignette only sleeps four hours a night, while the other one sleeps ten hours a night and needs his sleep. The researchers then ask the students or the workers to project or indicate to them the personality of the individual in the vignette, their likelihood of success, and a whole range of other such things. What is really interesting, culturally, is that this research indicates that people who sleep more are perceived as lazy, inefficient, and unproductive. However, all the research that has been done indicates that this perception is absolutely incorrect.

Another thing that is quite interesting, particularly in the Anglo cultures that have been characterized by a decade of cost compression mentality, is that people increasingly undervalue the potential of sleep. CEOs and organization managers worship long hours of work and approve more of workers who are there from 8:00 a.m. until 8:00 p.m. than workers who work less time per day. Yet, these long-working people are often primarily getting in face time. They get in before the boss arrives and remain until after he/she leaves in order to look good and get a promotion. Yet, they are actually having a seven-and-a-half hour lunch for most of the day, or are standing in the corridor talking to people rather than working all that time. Productivity, efficiency and effectiveness in an organization do not correspond in any simple way with the number of hours that can be wrung out of individuals in that workplace.

One of the great culprits in the rise of fatigue, Edison, was responsible for inventing the light bulb, and therefore stealing darkness and sleep from people. The fatigue researchers found that, over the last eighty or ninety years, there have been a number of surveys done across most of the

European- or Western-developed countries. In 1910, according to some of the surveys that were done then, the average sleep length was somewhere in the order of eight-and-a-half to nine-and-a-half hours. In 1913, there was general widespread introduction of tungsten electric illumination around most of the developed world, and by 1990, the average sleep length had fallen by one to one-and-a-half hours. From Thomas Edison's perspective, that is a large potential increase in efficiency, as there is another couple of hours available for people to work during the day. But while there are undoubtedly some productive benefits, particularly direct, measurable ones, associated with the decrease in sleep, there may be some consequences too.

Humans spent a billion years evolving to the point where they needed eight-and-a-half to nine hours of sleep, and the cost compression culture has only existed for one hundred years. It is going to take another four-and-a-half million years to actually adapt to it.

The speaker's brother-in-law is a coffee importer and roaster, and he and the speaker found a couple of interesting graphs recently. The first showed the decline in sleep across the last eighty years of periodic surveys. The other one showed the increase in caffeine consumption in milligrams per head per day across the U.S. What is quite interesting is that people have gone from an average of around 100 to around 450 to 500 milligrams of caffeine per head per day. That is not particularly profound, and, of course, correlation is not causation, but the point is that the decline in sleep, and the massive reductions in sleep that some individuals are undergoing, does not translate automatically into productivity gains and an improved bottom line.

In many cases there is a delayed cost that can be several times the productivity gain. So if that is looked at, thought through, and deconstructed, most people who think about fatigue in terms of the transportation industry will realize that they have been pondering only the short-term immediate effects.

It is important to go through a literature review with respect to changes in performance, the ability of people to cope, and a whole range of things under the influence of fatigue. In particular, it is necessary to look at some of the studies the fatigue researchers did a couple of years ago that examined the relationship between fatigue and alcohol. In categorizing how fatigue affects people, it can be seen to do so in four broad clusters of their life.

Most of the research to date, however, has focused primarily on neuro-behavioral performance effects. That is, it has used the cognitive psychology model that says the brain is like a CPU and started its investigations from that perspective. In this view, if a person were fully awake and rested, then he/she would have a Pentium III Windows machine operating. If he/she were tired, then he/she would be back to about a 286 and Version 1 of Microsoft Word, at most. So, in a sense, slower processing in a range of areas and increased rates to most types of things start to be seen as a person's fatigue level increases. As a background to that, fatigue researchers had an interest in the relationship between fatigue and alcohol. What is quite interesting is that the effects of fatigue and alcohol, when combined, can be somewhat ambiguous.

I used to work in an electricity production facility in the middle of a desert in Australia. During one fatigue training session I was teaching, I put up some graphs that showed the effects of fatigue on four choice, serial-reaction, time-processing responses. At the end of this talk, the

union delegate got up and wanted to know just how serious a problem fatigue was. In particular, he wanted to know if it was better or worse than being drunk. That was interesting because the researchers had heard a lot of anecdotal stories from people comparing driving home after a sequence of night shifts to being half-drunk at the wheel.

When I was invited to brief one of the ministers for transport in Australia, the minister asked how serious a problem fatigue is. I replied that the effects of fatigue could be thought of as similar to the effects of alcohol. The minister found this to be a very contentious statement and wanted to know if it could be proved. I replied that if given research money, I could do just that.

At that point, researchers had actually embarked on a set of projects as part of work with the rail industry. In connection with this work, they decided to explore the relationship between alcohol intoxication and fatigue, not because it was great science, but because it could provide the community and policymakers with an easily interpreted index of the relative risks associated with fatigue. That is, as a community, people do not accept other people operating in workplaces under the influence of alcohol. So, the researchers decided to use alcohol as a positive control, to use scientific terms, in order to give people an understanding of the relative effects of fatigue.

The researchers, then undertook a series of studies in which they decided to look at people, using the same sort of performance tests they had used in the fatigue area under an alcohol condition, a placebo condition, and a sustained wakefulness condition. In order to get the word out, they put ads up at Australian unemployment offices and universities.

The study was quite simple. It looked at people under the influence of alcohol and under the influence of fatigue and compared them so that the researchers could obtain a relative comparison of the effects. They then used a range of laboratory-based tasks. The fact that the study only looked at laboratory-based tasks is an important point to remember when analyzing the results. What happens with laboratory-based tasks under the influence of fatigue, and alcohol for that matter is not necessarily the same as what happens out on the road, either for a driver operator or a road transporter. It must be kept in mind that the researchers here are only talking about people in a lab, and that they are primarily students and unemployed people.

What the researchers did was use a number of tasks to decompose the types of skills that are typically used in the transport sector. The first of these was an unpredictable tracking task. That meant the subject basically had to follow a target around the screen. It corresponded to the sort of actions that are typically found in things like operating machinery or driving a car.

The researchers then asked what were the relative effects of fatigue and alcohol. To answer this, they formulated a performance score for each individual for each task, found the average score for each individual, and kept track of the intoxication level. In the unpredictable tracking task, the performance score basically measured how long each individual kept on target. Then everybody was compared against himself or herself, and the percentage decline in performance relative to the performance at full alertness was measured. A traditional relationship was found with increasing alcohol intoxication correlating to about a 20 percent decline in performance on that tracking task.

The 28 to 30 hours for which the subjects were tested for the effects of fatigue were also plotted against performance. That may seem a long time to be awake, but that level of wakefulness, at least in Australia, occurs in approximately 50 percent of night shift workers on the first night of their shifts. This is because they follow the logic that, since it is difficult to sleep during the day, they will instead get up early, get all their stuff done, and then go to work. It is very hard to bank sleep because that does not work. Then, by the end of the night they will be really tired and will be able to sleep during the day. It is a very common strategy and, as mentioned, about half of the shift workers working nights in Australia use it.

The researchers next extracted the .05 and .1 percent blood alcohol equivalent impairments. They found that between the hours of about 3:00 a.m. and 5:00 a.m., performance in unpredictable tracking was equivalent to a blood alcohol concentration amount slightly greater than .05 percent, which is the legally prescribed limit in Australia and Europe. On the other hand, between 5:00 a.m. and 7:00 a.m., that performance declined to a blood alcohol equivalency of about .1 percent. That is twice Australia's legally prescribed limit, and equal to that of the U.S., except in the 21 states which wanted more highway funding and moved to the .08 percent level.

For unpredictable tracking, there is a period toward the end of the darkness phase where performance declined. Performance started to return to normal again after that, in what is referred to in Australia at least, as the sun-up effect. That is, performance lowered to its lowest level just before sunrise, and then started upward again. If they had extended this protocol, it probably would not have returned to the levels it was the day before but, instead, would have started to decline down in a downward sloping S-curve. That is, the circadian time of day and prior wakefulness would have combined to produce a non-linear relationship between time awake and fatigue levels.

The second task the researchers looked at was a vigilance task that is commonly used in mining, manufacturing, and a lot of other workplace environments. In this particular vigilance task, the subjects faced a control panel on a computer screen and held their finger on the home key. Two types of signals, the correct and the incorrect, were then displayed to them. When the correct signal was displayed, one of the lights flashed, and the job of the subjects was to take their fingers off the home key and punch the key corresponding to where the light was. The light did not stay on for a very long time. In fact, it had gone off before the subjects could get to the corresponding key, so they could actually go to the wrong key without too much problem. When the incorrect signal was displayed, two lights came on.

Anyone who has ever operated machinery or worked when tired knows that sometimes decisions are made to do something, the persons realize they should actually not do it, but then do it anyway. It's as if there is a disjunction between the brain and the body. This type of hyper-reflexive or hyper-reactive responses are another thing which fatigue affects. So the researchers decided to measure the subjects when under the influence of both alcohol and fatigue.

Again, the results were pretty similar. There was a declining performance under the influence of alcohol. After extracting the .05 and .1 percent equivalencies, the researchers found that from

7:00 a.m. to 9:00 a.m. there was a quite profound level of performance impairment. It was well beyond what would be seen at the legally prescribed limit in Europe or Australia. Again there was a corresponding rebound in performance as the sun came up. We saw the same pattern of maintenance of performance, primarily across the habitual wake period, followed by rapid degradation of performance as the subjects started to move into the normal habitual sleep period.

The third study that should be looked at in the context of this address is the logical reasoning task. This is because over the last few years the researchers have become increasingly interested in how higher functions operate rather than looking at Task Level One complexity performance.

The logical reasoning task was a bit of a doozy for most subjects. Initially, they got two letters, A and B, in a particular order on the screen. This is referred to as the battery of grammatical reasoning task. In addition to this presentation of the stimulus A/B or B/A, they then saw a grammatical sentence that said that A precedes B, B precedes A, or A is not preceded by B. They did 64 of these over approximately a 3-minute period. By 4:00 a.m., working it all out was a reasonably challenging cognitive task. Again, this measured the same thing as the earlier, simpler tasks. That is, when the subjects held their fingers on the home key and responded to the correct and incorrect signals, the researchers were trying to measure how long it took them to think about it and then respond.

Researchers compared the effects of alcohol and fatigue and found essentially the same performance relationship yet again. Performance maintained until about the .045- or .05-level, and then rapidly declined about 15 percent. From about 6:00 a.m. to 9:00 a.m., performance was well below that associated with a .1 percent blood alcohol equivalency impairment.

Over the past couple of years, researchers have completed a number of studies that have been published and are easily attainable. Their net conclusion was that the more cognitively complex the task was, the more susceptible the task was to the effects of fatigue. In other words, tasks that required the brain to work a great deal were much more susceptible to fatigue than tasks that did not require much thought. This conclusion was hardly surprising. Depending on the task measured, somewhere between 20 to 25 hours of wakefulness, starting from about 8:00 a.m. produced performance decrements equivalent to a blood alcohol concentration of between approximately .05 and .1 percent.

The question that organizations have to ask themselves is very simple. If moderate levels of fatigue produce performance decrements equivalent to or greater than those at levels of alcohol intoxication deemed unacceptable when driving or working, why is it that most organizations not only permit it, but also give additional payment for it? In many organizations today, the approach to fatigue is exactly the same as what used to be called danger money. That is, something is dangerous, so the organization will pay the employee more to do it, and that employee then sells the health and safety risk to the organization.

This is an important point to understand because it forces transportation professionals to deconstruct how they manage hours-of-service. They treat it as a labor-relations exercise rather than a health and safety one. Although I will further discuss the politics required to make this change, the take-home message is that, in order to achieve an effective fatigue management

system, managers must eliminate lawyers and labor-relations people as the dominant control forces in this negotiation. As long as they manage it as a labor-relations process, their organizations will continue to consider safety a negotiable issue with respect to hours of work. That is because the history of lawyers and labor-relations negotiations is one of horse-trading work and pay.

In Australia, we have spent the last five years fundamentally repositioning hours-of-service as a health and safety issue. This repositioning has had implications for the labor-relations people in that they no longer, at least in the progressive Australian organizations, have control over that process. This loss in power has been an important fundamental political shift in the fight to achieve good policy and implementation practice regarding the issue of fatigue.

The studies presented earlier focused primarily on the effects of fatigue on relatively trivial or simple tasks. What the research literature is now starting to move toward is an understanding of how fatigue not only affects the process of time and how many down periods there are, but how it affects the larger cognitive environment in which people operate.

One of the areas of increasing interest is the effect of fatigue on situational awareness. In the safety science area this is sometimes referred to as the ability to handle the decisions base. That is, what are people aware of in their environment that factors into how they choose to act or make decisions?

For example, truck drivers often tell anecdotal stories about when they get really tired while driving. When this happens, they put their heads on their shoulders, look through the wheel, and keep the white line coming up the front of the bonnet. Because fatigue reduces their situational awareness, they tend to focus on the most relevant information. It is actually a very good strategy, as it exhibits survival adaptive functions. The important point to understand though is that it is a bit like juggling. In other words, how many balls can be kept in the air at once mentally? Also, how does the inability to keep all of the balls in the air at one time, which is referred to in cognitive science as the relational complexity of the task, affect performance?

Researchers have found that the more tired a person gets, the less balls that person can juggle. For example, they did some studies of physicians. It was actually a bit difficult to do because all the risk managers in Australia were lawyers. They would not let the researchers do the studies because, if the researchers actually found the hypothesized results, that would make the risk managers liable. This is actually not an uncommon strategy in many organizations in the U. S. That is, the absence of evidence is seen as evidence of the absence of effect. This logical paradox is actually exploited unmercifully by the unscrupulous.

What researchers actually ended up doing was moving trainee physicians into a simulated environment, giving them a complex patient, and presenting them with vignette scenarios. They then asked the trainees to give them a differential diagnosis and a management plan for each particular patient, which is a standard task for medical graduates.

What was very interesting was that, when the trainees were tired, there was a massive degradation in the quality of their differential diagnoses. In other words, what they usually did

when fatigued was base their diagnoses on what their last patient had when they showed the same symptoms. Researchers realized that the length of the differential diagnosis fell by about half when the trainees were fatigued. They also realized that the trainees tended to engage in probabilistic gambling in terms of the outcome when tired. The trainees tended to make degraded mistakes, such as relying too heavily on prior diagnoses and making the quickest diagnosis possible.

It is important to understand that the effects of fatigue are not limited to just reaction time and falling asleep at the wheel. They can actually be much more profound than that both at higher levels of thought organization and at higher levels of organizational policy.

When researchers tell people that they respond more slowly to a 4-choice serial reaction time when tired, they are often cynical and ask how much longer does it actually take? Well instead of taking 220 milliseconds, it takes 250. If those times were tapped out, nobody could actually hear the difference, but the difference is very important in practice. This will be explored further.

Two of the areas that are starting to see more of the impact of fatigue at an organizational level are the issues of motivation and compliance. This is particularly true for those organizations that are starting to move into the safety science or the reason model of crew resource management. These areas are two of the first to degrade under the effects of quite moderate levels of fatigue, which is really important.

As an example, researchers did a study of Kimberly-Clarke, the company that makes diapers, and found that the organization had both high levels of fatigue and back injuries. They then found that everyone had been through good training on manual handling, but when people were tired, they could not be bothered to do things that they were supposed to do.

In a sense, an important way of understanding how fatigue can affect people and their organizations is to look at why people actually commit rule violations while performing higher-level functions within their workplaces. They have been trained, they know exactly what to do, and they have been provided with all the necessary materials, but they still do it incorrectly. Therefore, one of the first effects of fatigue in many organizations is the higher-level diffuse structure, which is this intentional disregard of proper procedure due to tiredness. It is definitely something every organization should think about at length.

In terms of developing understanding of the effects of fatigue within organizations, managers should use a broad brushstroke. In many cases, they will see rule violations, compliance failure, or poor motivation within an organization, which reflects a high fatigue level.

At the moment, a number of organizations are obsessed with the effects of fatigue on operators, particularly in the rail industry. However, after visiting a few American railroads over the past year, I realized that the biggest fatigue problem was not with the drivers, but with the managers, who were working 16 hours a day. They were cutting corners, exhibiting poor motivation and compliance levels, and managing in a reactive crisis mode. These managers did not work nights or, at least, they were not scheduled for nights, but most of them got up at 3:00 a.m. to get all their E-mail done before they had to be at work.

In many cases, higher-order functions within an organization are also incredibly susceptible to the effects of fatigue. For example, what happens to managers' strategic planning, logical reasoning, and problem-solving skills when they are tired? How caring and sharing are they when fatigued? They are much more apt to tell an employee to either get the job done when they are tired or get a new one. So researchers are now starting to look at the effects of fatigue in terms of its impact on quality of communication, and the quality of working life, to use the Australian expression.

Many organizations have undersized so their management workloads have reached the point where the fatigue level, not in the traditional sense of working night work but in the sense of workload versus time opportunity, is high enough to cause poor decision-making and poor strategic reasoning. That is far more costly in the long-term than any number of accidents by drivers, which are relatively infrequent and relatively inexpensive. A couple of years ago, for example, an Australian transnational, in order to save \$10,000 on hotel expenses, flew everyone to a negotiation to buy the Escondida copper mine. However, as a net consequence, they negotiated the worst deal in history and blew \$2 billion in one day.

This sort of poor, diffused, cost-consequence decisions are increasingly important. So managers should not just think about the drivers, but also about themselves. They should also evaluate their relationships with employees and their families for potential symptoms of where and how fatigue may impact them.

Now is the time to shift the focus to alertness and fatigue management beyond the Year 2000. That is, where should managers be arguing for their organizations to head in the next three to five years to make sure that they have the right operational and cultural values in place, in order for fatigue management to be implemented in a sensible, cost-effective, and successful manner?

As H. L. Mencken said many years ago, for every complex problem, there is a simple solution. Unfortunately, this simple solution is usually wrong. If someone thinks that an organization can solve the fatigue management problem over a 6-month period, that person is wrong. Fatigue management requires a continual improvement process. It must become a mainstream, regular activity of the organization. It cannot simply be handled by throwing everyone a few pamphlets and sending them to a 2-hour class. If this is done, then management should not be too surprised if their employees do not actually change a great deal.

It is understandable for many organizations to feel the need to cover up by being able to point out that they have an education program. That is fine, but they should not expect this sort of simplistic solution and one-off approach to actually lead to any cost benefits. The research literature is full of errors of one-off fatigue management projects that promised millions in cost recoveries, cost savings, and potential benefits, and produced nothing. The only reason it is not is that fatigue researchers do not tend to write up their failures. If the literature is systematically examined to see how many people have actually shown clear benefits from fatigue management programs, very few will be found. In fact, if thoroughly scrutinized, there might not be any found. However, I will try to present some data contrary to this.

What is there for an organization to understand from a regulated perspective? There are a number of rules that dictate when people are allowed to work, and there is the separate question about what is a safe work schedule. What arises in organizations, then, is an incongruity between what is legal and what is illegal and what is safe and what is unsafe. This is a dilemma for the regulators and the organizations. Hours-of-service regulations that have grown through the labor-relations process in most countries have a very poor congruence between what is legal and what is safe.

For example, there are shifts that should be permitted but are not, and there are many shifts that should not be allowed and are. Thus, there is a high degree of legal unsafe practices and illegal safe practices. A big reason for this is that most transportation regulations are based on duration of shift or duration of break and does not take into account time-of-day factors that research shows are actually far more important than duration. The fundamental failure is an inability to integrate scientific knowledge. This happens largely because negotiations on the matter are a horse-trading exercise.

Hours-of-service regulations in the road transport sector were introduced in the late 30s in both the U. S. and Australia. The logic behind them was quite simple. They were intended to limit hours of driving so that trucks could not travel more than trains. It was a level playing field argument and had no relationship to safety. The whole cultural process of viewing it as a negotiable, competitive issue meant that very few good decisions based on the underlying scientific evidence have been made. Overall, an organization wants to maximize those activities that are illegal and unsafe or legal and safe and minimize those activities they should be able to do and cannot or that they should not do but can. To try to sum this up, if an organization can get everything in the right boxes, at the end of the day it may have a successful fatigue management system.

This is easy to say, but how should organizations actually do it? The first thing that they must do is shift from a labor relations focus to one that clearly identifies fatigue management as a health and safety issue, and assigns responsibility and accountability for it as such. It clearly has implications for the labor-relations people within each organization, but as long as they dominate those negotiations, the organization will not end up with fatigue management. Instead, it will end up with many debates about scheduling and very little discussion about fatigue management. The importance of this as a political process within the organization cannot be emphasized enough. The extent to which CEOs can be persuaded to endorse this shift in focus will, in a large part, actually determine the outcome.

A shift away from the situation where the government acts as a policeman, catching organizations that are doing the wrong thing, is also needed. Instead, the responsibility of organizations is to demonstrate that it is doing the right thing must be emphasized. The experience of organizations in Australia over the last couple of years has been absolutely definitive with respect to this. In fact, a recent inquiry by the Australian government came out and actually declared that prescriptive models are clearly and demonstrably non-viable ways of achieving a good relationship between safety and permissibility of hours-of-service.

What it has recommended is that, while we must leave some minimum standards in, particularly for the unscrupulous industries, the government has directed the National Occupational Health and Safety Commission and the legislatures in each of the states to create a model of safety case approaches to hours-of-service. That is, if an organization does not like the hours-of-service legislation for its particular operating circumstances, that is fine, but it then has a responsibility to develop and show the regulator a safety case to demonstrate how it will manage fatigue.

Again, the experience in New Zealand, Australia, Canada, and parts of Europe is that the shift away from prescriptive legislation, which has the focus on the government as police, has been a spectacular failure. Instead, it has managed to create enormous bureaucracies of inspectors who run around investigating logbooks. As they say in Australia, the question is when a policeman stops a truck driver, is which logbook does that policeman look? This is where the government as police has been spectacularly unsuccessful. It has been expensive, ineffective, and typically very responsive to localized lobbying efforts.

On the other hand, the problems can be addressed by a shift away from prescriptive models to ones where organizations put together a case and show the government how they plan to manage fatigue. The role of government in these models is to determine what the requirements are and what issues the organizations need to address in their presentations.

The beauty is that all the money that the government wasted on inspectors would actually be saved. In public or civil government service, it is known that the idea of saving money and using fewer people is antithetical to the career goals of government workers. Instead it is desirable for them to maximize the number of people who work for them for budgetary reasons. Nevertheless, the Australian government is starting to experiment with this, and all of its major transport modalities have made the decision to move away from prescriptive models to ones focused primarily on safety cases.

Another issue that has not been pushed quite as hard in Australia, but is permeating at least the aviation and rail industries there, is the issue of shifting from an emphasis on fatigue management to an emphasis on targeting the risks associated with fatigue. It is a subtle difference, but it is a very important one. When looking at fatigue from a risk management perspective, the main issue becomes identifying the risks associated with fatigue.

Within an organization, if one looks at it from a risk management perspective, it is important to understand not just how tired someone is, but how tired is too tired to do that task. After all, the level of fatigue that would be acceptable for someone operating a photocopier is quite different from that which would be acceptable for somebody landing a jumbo jet at JFK in a snowstorm. What is the worst thing that can happen to a tired person who is operating the photocopier? Will that person make two copies instead of one, or thirteen instead of twenty, or something similar to that? Or if it gets really severe, will that person's head fall down on the platen and cause a bit of a bang on the head. Other than that, the consequences of it are not particularly important.

In a sense, the government does not want to set guidelines for managing fatigue that create a new prescriptive model which may become increasingly inflexible. Many operators have a reasonable fear that alertness or fatigue regulation will result in many new rules that will further restrict their capacity to operate in a safe manner and increase the number of safe things that are illegal.

So three issues have begun permeating the industry in Australia. These are the need to shift from a labor-relations perspective to a health and safety perspective, the need to shift towards organizational responsibility and away from government as police, and the need to accept a risk management perspective rather than a fatigue management perspective.

It is now time to focus on what the Australian rail industry has been doing from that political perspective. We must focus on the three fundamental changes and the work that it has been doing in terms of shift work and fatigue.

The group of speakers at the Center for Sleep Research has done this precise work. The group is a university-based independent resource and a research unit for the tripartite group of government, industry, and unions. Its management board consists of labor, academic, government regulator, and participation divisions, and the emphasis has always been to work collaboratively and develop synergies by working across industries rather than at the organizational level. What the members get involved in is the development of schedules for policy and fatigue management programs. There is a web address, which I will give you later that carries much of what the group provides.

Because most work on fatigue around the world has been developed by taxpayer-funded money, the group has a commitment that such money or activities should not be charged again. In many cases, the members have taken an active role in promoting public domain dissemination of materials. People should not have to buy materials which were developed with government funds. Therefore, much of what I will discuss today was developed primarily in order to get information and management strategies into the public domain.

The Rail Consortium is a political organization that was developed in 1995. It consists primarily of organizations in the freight industry and came about as a result of a labor agreement focusing on the increasing emphasis on deregulation of hours-of-service in the Australian railway sector. While deregulation produced many efficiencies, my group was not convinced that all of these efficiencies were coming without a cost. Again, from the group's perspective, that view of cost was very broad. It encapsulated social and environmental costs as well as economic cost. Therefore, the group focused on the requirement on its agenda to establish cost benefit analyses across the three dimensions that were consistent with the triple bottom line accounting movement.

The other thing that was important was that the consortium was created for two reasons. The first reason was to provide public domain information for all of the members of the consortium and reduce the cost to individual players. The group went to industry and the government and told them that good systematic research costs a great deal of money. Yet in the ten years prior to that, there was much duplication of effort and much loss of knowledge when an individual pilot

project was done. There was no attempt to harness the synergies of the potential collaboration across the industry.

The second reason was that, by doing it on a capitation model, that is by sharing the cost across the industry, it was possible to reduce the cost for individual organizations. For example, consortium membership in Australia, at the moment, is about \$50,000 a year, which produces most of the things that I will show over the next 10 to 15 minutes. The idea was, that by working collaboratively and sharing information, it was possible for members to learn from others, to distribute that information in a public domain, and to achieve significant industry-wide synergies. The consortium is a very interesting model. It is uncertain how general this is among cultures, but it has certainly been the case that this consortium, which originally developed in rail and has now merged in aviation and road transport, is a fundamental principle underlying the gathering of industry, unions, management, and, most importantly, end users around the table in Australia.

The other thing that is important is that the consortium has designed its research projects collaboratively rather than traditionally, where other researchers and consultants answer a brief and then tell the researcher what research they want done. The researcher is not allowed to research issues in which he has the most interest. Instead, the researcher is forced to choose between competing options that may not necessarily answer that researcher's needs. Therefore, the consortium tried to engage end user groups, industry, management, and regulators and have them all sit down.

When the consortium first got together, it took it nearly a year to design the research program and to ask the questions that the industry felt were important and would lead to management programs which could be implemented.

One of the major difficulties the consortium identified in the past was that, while many organizations completed research, they did not have a great deal of success implementing it. In many cases, this was because management and industry regulators had not been involved in the project design. Instead, they basically bought projects presented to them off the shelf.

The aims of Phase One of this study, which started six years ago and is slated for at least another two, were some very simple goals that resulted from those discussions. The first goal was the development of shift work training and education materials and methodologies that could be applied consistently across the industry. The consortium also identified that most research on fatigue is being done in labs and most of that is taking place in military environments with Air Force personnel and astronauts. These researchers are people who eat, sleep, and breathe their job, and they also unquestionably obey their superiors.

Unfortunately, in the rail and rail transport industries, not only are its people drivers, they are also mothers and fathers, brothers and sisters, and coaches of football teams. They participate in all sorts of social activities. The reality is that much of the research that has been done was conducted in over-controlled environments that do not necessarily reflect what happens in real life. Pilots and astronauts do not have to pick between watching Monday Night Football and going to sleep. They get told to go to sleep and they do it when told. They do not have the

discretion that most people face when they are actually out in the work force.

While the research has been valuable and has revealed much about the physiology of fatigue, it has not reported what people in the real world, leading real lives as non-participants or subjects or experimentees, do in practice. Thus, consortium members wanted to ensure that they could develop technologies that could actually be taken out into the field and measure what real train and truck drivers and pilots do. It was also postulated that an additional outcome could be the development of a fatigue management software system or fatigue management tool. There are a number of these available around the world now, and the consortium has just one of many possible approaches.

This is an attempt to summarize a great deal of activity, but it is instructive to look at what the consortium members learned from training and education. They did a benchmarking exercise that used as much of the training and education programs that have been delivered, both within Australia and around the world. However, it was limited to English-speaking countries because the members spoke only English.

What consortium members discovered very quickly was that most of the training and education programs fell into the handy hints category. That is, they were comprised of making a video, handing out some pamphlets, and nothing more. When they tried to deconstruct the texts, what they found in the organizations was very interesting. Typically, the pamphlets would have some light, fluffy text and cartoons. It basically sent the message to employees that the issue was a joke.

In many cases, that was the subtext which management actually believed. It was a subconscious attempt to discount the importance or value of the fatigue issue. It was seen as fluffy, lifestyle management stuff and not a training issue that needed to be integrated within the organization. The members also talked with people who had been given pamphlets and videos, and they were deeply cynical about the issue.

The other thing that was really important as a response was that consortium members realized that, where there had been successful training and education programs, there was something that clearly demarcated the training and education programs from the handy hints model. That is, they had made the assumption that good fatigue management and good shift work coping strategies are a competency. Being a good shift worker was a skill in much the same way as driving a train or operating a piece of machinery. It needed to be managed in exactly the same way that any other organizational competency was approached.

Therefore, successful programs and the subsequent program that consortium members developed were based on the initial philosophical assumption that being a good shift worker and managing fatigue is a skill that can be learned and assessed.

The idea was that the members shifted away from a handy hints model to one that clearly emphasized the importance of competency. This reached interesting levels in organizations in the U.S. and Australia, such as Kimberly-Clarke which had developed the approach that, in order to be a shift worker, an employee had to demonstrate competency. In other words, no employees

could become shift workers until they could show management they had the coping strategies and skills to do it well. This was a very fundamental revision of the policy of most organizations because, in most new-hire situations, the job was simply originally presented as shift work. This shift in training and education to a competency-based approach was important.

Another type of program was passive training and education, where management had someone come in and talk to the workers. When it was an expert, consortium members found that there were a number of problems. Having a Ph.D. did not impress most train drivers. In fact, in many cases it caused exactly the opposite response. On the other hand, management felt that when they told drivers that a professor was coming in to give the talk, the drivers would automatically respond positively. They felt that since the professor had told them to do something, the drivers would decide to do just that.

The reality was that adult learning models did not work well. The education programs that were most effective were those delivered by people with high street credibility. If someone worked with train drivers, they should get train drivers and teach them to teach instead of outsourcing the work to a young consultant. The drivers would ask if the consultant had ever worked shift work, and the consultant could say is that, while he had not, he knew a great deal about it. At that point, the drivers would stop listening or caring.

The lesson that members learned was to get in people with high street credibility, which is not a difficult thing to determine. One easy way is to ask end users who had high street credibility. The programs for members had typically been developed by older driver trainers or people who had had a great deal of experience working on the road, doing shift work, and managing fatigue. Employees listened to these people.

Another thing that turned out to be important was that sitting passively and listening did not actually result in either high levels of retention or significant behavioral change.

The programs that consortium members evaluated showed that, when there were small work groups focused on developing competencies and engaged in training programs, there was better acquisition of skills and a greater likelihood of behavioral change. Not everybody changed, since they could not be made to think, but the results were definitely better.

The groups also had to be small. Management needed to divide employees into work groups. The model that consortium members developed was based on the Dupont Safety System Workbook Model, which is a self-paced workbook that elicits whether people can actually answer questions and demonstrate deep learning rather than simply regurgitate surface information. This model is fabulous and most people in the safety science area have found it be quite useful. That approach does not have to be used, but the key elements were small groups and active participation.

Consortium members also learned that most of the knowledge about managing shift work in an individual location was actually inherent within the work group. However, because issues related to fatigue and shift work were often considered the illegitimate narrative or dialogue within the organization, members had to bring an expert in to tell the groups.

On the one hand, many older shift workers had a great deal of experience and could help younger workers. On the other hand, it was not safe to assume that everybody who has 20 years of seniority has 20 years experience. Many of them have had the same one-year experience twenty times.

Another thing is that, when the programs were delivered, they had to be tailored. Consortium members found amazing material that presented general information. It even had pretty covers with pictures of trains and train drivers. The drivers pointed out, though, that the locomotives illustrated were not the same as the locomotives they used.

In a sense, materials that the members developed in the Australian program and provided as a workbook to each of the individual participants were developed collectively. However, the case studies, the exercises, and the graphics within the workbooks could actually be substituted for by images from that particular organizational area or region. Having the face of the local train scheduler or dispatcher made it very real and concrete for these individuals.

The reality is that about 80 percent of the information is actually common across environments; so only about 20 percent of it actually needs to be tailored. However, the tailoring gives a sense of a high degree of ownership to individuals. It was also found to be important that the training be done in a non-patronizing way. After all, the idea was that an expert with a Ph.D. was coming in to tell everybody how it was going to produce the opposite outcome to what was expected. Management must not patronize staff.

Another thing that the consortium members cannot emphasize enough is the process of engaging the end users in the design and implementation of the process. This is management by walking and talking, and it is somewhat novel.

The studies done in Phase One were laboratory-based studies, and the results have already been discussed. The other thing members did was use a field-based approach, which attempted to validate laboratory tools that had been developed to see if they could be used in the field and actually produce useful outcomes.

Members tried to develop a universal methodology so that when they conducted studies looking at effects of different operating environments or different schedules, they had a common base methodology that could be used to compare and contrast results from different organizations working in different environments.

The initial consortium membership consisted of seven rail organizations, including the union. All contributed an equal amount to the process and the government then matched their contributions dollar-for-dollar. Again, it cannot be emphasized enough how important that matching funds model was and, since each organization had paid to join the consortium and all were involved in the process, the degree of implementation was accelerated.

The members had a high degree of buy-in and ownership and, because they paid their money, they were able to actually control the development and outcome of the program. They did 14 studies in five different states in which they collected data for at least 14 days. They measured a whole range of factors in these volunteers, including health questionnaires, work/sleep diaries,

and family interviews. They even measured the melatonin rhythms of the subjects. If it moved, they measured it, basically. The idea was to test different methodologies to see what worked and if they were viable for use in the field. The one that will be discussed now reflects what the members did when collecting work/sleep data.

What consortium members tried to do was develop a work and sleep methodology in the field. One thing that was quite important was that ectographs, even though they have been around for a while and have been used a great deal, have never been validated. It was not known whether they would actually work with shift workers. Catherine Reed, who did her Ph.D. at their lab, spent a lot of time working on the validation of these technologies. Although it was with some reservations and some modifications, in the end, they were found to be acceptable for use in the field. However, many of the algorithms that were inherent in the software packages that were being flown users did not necessarily predict sleep in shift workers because they were developed for people sleeping at night, usually with sleep disorders. Therefore, there were some issues about how much the results could be generalized.

What members did then was follow 253 people in 14 depots for at least 14 days each. They collected around 4,000 or 5,000 nights of work and sleep data. From this data, they calculated distribution of work across the 24 hours of the day in the depots, and found that it was pretty evenly distributed. This data primarily consisted of freight, and much freight in Australia is transported at night. On the other hand, the distribution of sleep, irrespective of the distribution of work, was primarily at night.

That was nothing that members did not already know, but it was fundamentally important in terms of implementation policies for drivers to understand that the tools that were being developed for them reflected data collected from them. So despite the fact that people worked around the clock, about 75 percent still typically did most of their sleeping at traditional hours.

In the Australian study, the strategy of most drivers when they faced three or four nights of work in a row was to accumulate a sleep debt during that period, and then pay it back on their nights off. The Can-Alert study and several subsequent studies in North America have shown approximately the same results. What consortium members did then, and it did not show up particularly well, was to see if they could disaggregate the data in order to develop an approach that would allow them to understand, from the information available in the rail industry, how much sleep people got.

The current fatigue modeling software falls into two categories. One category of model requires the user to know when people sleep and work. The other category of model recognizes that, while that information would be nice to have, it is not necessarily available or obtainable for day-to-day operations within an organization.

The members took the data that they had from the rail industry, which consisted of time each employee started work and the time each finished work. From there, they wanted to determine what they could work out from when breaks started and how long they lasted. From that data, they developed a contour map of color surfaces that corresponded to the proportion of time spent asleep. The white on the map corresponded to a high probability of going to sleep. So, for example, if a worker were to have a break starting at 9:00 p.m. and the break was seven hours

long, the map indicated that most of that time would be spent sleeping.

By disaggregating the data this way, so they were using time of break onset and length of break, the members wanted to know if they could work out how much sleep an employee got and, if so, if they could link that amount to performance in the workplace. The results of this part of the study were, as already stated, that engineers have timed the majority of their sleep at night, irrespective of when they work, and that the amount of timing of sleep is highly consistent, given a certain length of break at a certain time of day.

This information was then used to develop a management tool. The rail consortium made the fundamental decision that, if they wanted fatigue management, they needed accountable management systems to enable them, from a regulator perspective, to look at how the system was managed and, from an organizational perspective, see how it actually worked.

The fatigue modeling had to meet the following underlying criterion—it had to manage the risks associated with fatigue. Therefore, it had to be based on a risk management model. In Australia, this was a standardized risk model that is also used widely in the U. S. The idea was to lock fatigue management into a generalized mainstream methodology of risk management. In Australia, this is called IS4360, and is currently being formulated to be the ISO risk management standard for release and dissemination in 2002.

It is not a fatigue-specific risk methodology. It is simple and straightforward, but what differentiates it from the more traditional risk methodologies is that it has a compulsory requirement of consultation with the employees on the ground in the area where the analysis is taking place. Previous and traditional risk management strategies basically required an expert to come in and assess things and did not actually involve having them talk to the people on the ground.

The basis of how to do this risk assessment can be summarized very quickly. There are two dimensions that are used in the analysis of risk. The first is the likelihood of an incident, or how frequently there is likely to be a fatigue-related incident in the area. This is done using either a qualitative or quantitative approach. The likelihood is rated on a scale from one to five, with one being almost never and five being quite frequently. There are gradations, and assessors can get technical and use something like ten decimal points, but the principle is very simple. The idea is to simply indicate whether there is a low likelihood or a high likelihood of an event, which would be a fatigue-related event in this case.

The second dimension is a look at the consequence of a fatigue-related event. As mentioned, if a worker falls asleep on the photocopier and bangs his head, there is not a very expensive outcome. On the other hand, if a worker stacks a 747-400 at Chicago airport, the airline is looking at a several billion dollar mess. Therefore, there must be a rating of the consequences of fatigue-related incidents in the work environment which has to be based on how much it will cost the organization. It is the organization's choice whether to take a broad view or a narrow economic view of cost.

As a result of that dimensional analysis, risk is then categorized on a 4-point scale. That is, it is low, moderate, high, or extreme. This is determined by a combination of the likelihood score and the consequence score. Therefore, the assessor should allocate a score of likelihood from one to five, allocate a consequence score from 1 to 5, and then look up the risk categorization in the table. It is just a standardized methodology that means that different parts of the organization going through the process end up with a good understanding of both the relative and absolute risk categorizations. The members simply used that standardized methodology with respect to fatigue.

When members carry out this risk assessment for the tasks within the work environment, activities that would be typically characterized as low risk are office work, training, and management.

Moderate risk was the classification for activities such as switching and locomotive provisioning. Provisioning basically means putting water into the locomotive and checking on water and petrol, and it is a highly physically active activity. The worst that could happen is that such a worker could fall off the train, but compared to a derailment, that is usually a fairly minor consequence.

On the other hand, an example of a high-risk activity was seen a dual driver in protected territory. In Australia, there are single driver environments as well as dual driver environments. That may or may not be the case in America. An example of an extreme risk activity is a single driver with low track experience working in a dark territory where there are hazardous chemicals. That is kind of extreme, but the principle to understand is that there are varying degrees of risk for activities that individuals will undertake within the work place.

I remember a meeting with the unions that was kind of interesting because I had to try to explain, from a risk management perspective, that if there were a single driver instead of double drivers, it would be of less consequence because only one person would die. Risk management methodologies are entirely amoral, which needs to be considered by people when they try to engage workers in the consultation process. There are logical perversities somewhat associated with it but, nevertheless, the principle is sound and reasonable.

On the basis of that approach, the members then developed a software-based system that took into account the length of shifts and breaks and the time of day at which they occurred. Using that information, the system then calculated the amount of sleep statistically that an individual operator would be likely to get, given that break. For example, if a worker gets a break from 12:00 a.m. to 8:00 a.m., he is likely to sleep reasonably well. On the other hand, if his break is from 12:00 p.m. to 8:00 p.m., he probably will not get anywhere as near as much sleep. The data that I discussed earlier enabled members to calculate the statistical probability of sleep in a given time off and then assign a relative fatigue level associated with that.

In addition the individual shift, members also looked at prior work history over the previous 7 days. The idea was that it is not just an isolated shift the employee is working now that is important, but also what he worked yesterday and the day before and the week before, because

he did not necessarily pay back his sleep debt just because he had 1 or 2 days off.

The model also had to take into account biological limits to recovery. People cannot bank sleep and they cannot pay back a night of sleep debt in one hit. When the members first implemented this approach, they put it in a prototype spreadsheet version, because railways are highly technical tribes. Members had realized very quickly in the rail industry that if something was on a spreadsheet, it was considered true, and if it had a color transparency and a trend line through it, then it was gospel.

So, in part, this was a fairly subversive methodology, as it was put in a spreadsheet simply because spreadsheets were real to people in the rail industry. There was a sense of trying to create an import or attempting to manipulate the system by using what constituted truth for people within the rail industry.

What happened then was that the software was used to calculate fatigue scores. Essentially, any calculation of a fatigue score did not have real meaning, as there were no ISU units for fatigue. A person using the model would come up with a fatigue score, and by triangulating it against things that are known about fatigue, the model would output a fatigue score of 40, 60, 80, 100, or 120.

The consortium members did a series of elevation studies, with the idea being that fatigue scores associated with a Monday-to-Friday workweek consisting of days that lasted from 9:00 a.m. to 5:00 p.m., with weekends off, typically produced fatigue scores of around 40. A 60-hour week of 12-hour days typically produced fatigue scores of around 80-85. A .05 to .1 percent blood alcohol concentration is in the range of 80 to 100. A schedule with seven night shifts in a row, which is still commonly used in Australia, typically showed scores of around 120.

The software then took fatigue levels and the risk levels assigned to the tasks that people were doing and checked them for internal consistency. That is, they checked whether, based on the members' risk assessments, they had allocated people on a schedule in a way that is logical and rational.

Now, the advantages of this technique were kind of interesting. It enabled members to analyze, both prospectively and retrospectively, a work sequence with respect to their own internal risk assessment criteria. It enabled them to manage risk, not just fatigue, and it provided transparent accountability. That is, it provided a numerical output, reporting, and all of the things that held people.

Lastly, members have found that this technique can be linked to KPIs. For the last couple of years in Australia, this approach has been used to start linking risk management models and fatigue modeling to KPIs within the industry. So, as part of this approach, members took these modeling techniques and applied them. For example, it became a compulsory reporting requirement for each of the consortium members that whenever there was an incident, they automatically calculated the fatigue levels and the risk assessment of those individuals at the

time of the incident. That data was then pooled as part of a national database so members could start to build statistical models to find out how tired is too tired. They also used the information for reports to the regulator concerning people who were seeking exemptions from the hours-of-service.

The regulator ruled that as long as a modeling-based approach on risk management can show him that, prospectively, the organization would not be violating its own rules, and that, retrospectively, it has been able to achieve the compliance level that was negotiated, that constituted the basis of an adequate fatigue management system.

The advantage of this approach is very simple. The lawyers and barristers of the members have advised them that the system is lawyer-proof, in the sense that it demonstrates clearly a due diligence-based approach. That is, since it is the culmination of the fatigue training and education research and risk management assessments, and less than 10 percent of the workplaces are doing it at the moment, it must, by definition, be best practice. On this basis, if someone is looking for a strategy that allows him to cover himself, it is pretty successful.

This discussion will end with a brief explanation of what the members have been doing in the second phase of the study. Essentially, they have extended Phase One of the study, again in consultation with the industry. The studies that were discussed earlier, which showed the relationship between fatigue and alcohol, were very controversial in Australia when they were released. They made many people nervous, particularly in the policy and regulation area. The question that arose about this, and the consortium members put it forward, was how much do lead-based studies actually link pushing buttons to what people do in the real world?

Another thing that the members did was an evaluation of fatigue training and education, which they just finished, and which we discussed earlier. The members also dealt with the implementation of dynamic rostering, but that is another issue and does need not to be discussed here.

How the consortium members managed the validation was that they had some anecdotal evidence from the industry that the conception of risk was associated with falling asleep at the wheel and having a derailment or something similar to that. On the other hand, many drivers said that, as with alcohol, they were impaired before they passed out. In a sense, the parallel with fatigue was quite reasonable. A person could have cognitive impairment before he actually fell asleep on the job. The question then was how did that cognitive impairment associated with fatigue impact the driver's task of driving?

In the study that the consortium members had been doing over the last year-and-a-half, they put people into train simulators. This took them out of their normal schedule while still having them work the piece of track they would normally work. It put them in the simulator under both low and high fatigue conditions and also under an alcohol condition. This used the exact same paradigm as Phase One, only with a more real-world task. The outcome measures they used in these studies were more indirect measures of driver performance. That is, they used measures such as fuel usage, brake wear and tear, inter-train forces, risk behavior, which is measured through things such as speed violations and that sort of information.

It is instructive to look at some of the preliminary and initial analysis from this study. The protocol was quite simple, since the subjects simply did a training run in the simulator. They had all learned on the simulator, and they had all worked the track for years. Nevertheless, the members brought them in and trained them. They would then do a run that typically went from 10:00 a.m. to 4:00 p.m. That same piece of track could also be run between 11:00 a.m. and 7:00 a.m. These times were chosen because they corresponded to the times that coal trains in Queensland were typically scheduled. In addition, the train simulated was quite long, followed an interesting piece of track, and had a 2,000-horsepower GM locomotive.

The members recently came to the realization that, while the simulator gives much feedback on how well the driver is doing, the cabs of actual trains do no such thing. There is not even a fuel gauge in Australian cabs, so operators do not have feedback even on fuel consumption.

At the end of each 2-hour training period, the drivers completed Dave Dinges' PVT, or psychomotor vigilance task, to get some evidence of how tired they were. They were given a breathalyzer test when they were in the alcohol condition.

One thing that is very important to remember when looking at how people actually drive is that train driving is not what most people in research think it is. That is, it is a horizontal elevator. The driver gets in and pulls the lever and the train then goes. I have spent over 2,000 hours in cabs with train drivers, and have come to appreciate that driving is actually a highly skilled activity.

So, the consortium members tried to degrade or decompose the tracks into the elements that were meaningful from a training sense. In terms of how the tracks driven in the simulator were categorized, there were upgrades and downgrades, with each usually having two levels, and also level track. In terms of inter-train forces, or buff and draft forces, there were cresting behaviors when the train went over the top of a hill, and troughing behaviors when the train went down to the bottom of the hill. These inter-train forces were on trains that were somewhere between 500 meters and a kilometer long. The trains used for the simulation were long coal trains loaded with coal, and intertrain forces could potentially produce quite significant impacts on them.

The members decomposed the tracks in order to do the risk assessment because the effects of fatigue on driving performance were not exactly the same when it was decomposed into different bits. In terms of a qualitative assessment, the members had driver trainers view the individuals going along the track and rate them on a number of dimensions. Importantly, these trainers were kept unaware of the different conditions of the drivers.

These assessments found that the effect of fatigue on level driving situations, where the task was effectively to manipulate the throttle to maintain steady speed, increased speed variability. In upgrade situation where the task was to maintain velocity using the open throttle, there was a significant increase in penalty brake applications and, of particular importance, significant lack of planning for crests. Because of this lack of planning in the cresting behavior of drivers, the fatigue effect produced significant increases in intertrain forces, corresponding increases in buff and draft forces, and potential coupler damage. Downgrade activity was typically affected slightly differently. There were heavy brake reductions in response to fatigue, as well as

increases in the number and duration of speed violations.

What was quite interesting was that there were not really many speed violations. The biggest ones were on downgrade tracks, which was an obvious result. One implication of this was that, when drivers are faced with a long uphill track, speed violations due to fatigue are not really going to be an issue. So uphill grades were not, in terms of the likelihood of fatigue-related mistakes, a high-risk environment. On the other hand, there was an increase in intertrain forces on trough behaviors, and that was typically related to poor planning behavior. These were the high cognitive functions alluded to earlier.

To wrap up, there must be a short discussion about where this project is going. The members are starting to do a decon analysis, and have actually produced some data on fuel utilization. They are also developing some actual costing models. They want to create a costing model for drivers so they can determine the organizational costs associated with fatigue. The principle behind this is that they want to be able to determine exactly how much money the organizations should invest. An interesting political fact that the members have developed over the last two years is the use of a capital expenditure model to justify expenditure on fatigue-related management programs. These models determine the payback period for each organization, which could be something like two or three years. This then lets the organization know how much it should spend on fatigue management. It is viewed as a capital expenditure program in the same way as buying another piece of equipment or an asset with the organization.

ALERTNESS 2000:
TOOLS FOR MANAGING FATIGUE IN TRANSIT

Day Two

October 27, 2000

**Doubletree Hotel
Arlington, Virginia**

PROCEEDINGS

Chairperson Hiram J. Walker
Associate Administrator for Program Management
Federal Transit Administration

This next session will be on over-the-counter medicine. In the last year, the FTA has sent over 5,000 letters on this subject to its grantees and clients around the country. The effect of over-the-counter medicine is a real issue, and it is one that the FTA is very concerned about.

SESSION VI: MEDICAL WORKSHOP

Dr. Gary Kay
Clinical Neuropsychologist
Washington Neuropsychological Institute

Neuropsychology is a field involved in the assessment of brain function. It evaluates the impact that various diseases and medications have on brain functioning. In terms of medication, it looks at whether there are positive effects, in terms of helping takers by improving their memories or other such things, or negative effects that interfere with brain functioning.

I have been involved in looking at the impact of over-the-counter antihistamines, which are particularly prevalent and widely used. The fact that pharmaceutical companies developed alternative, non-sedating antihistamines provided the opportunity to do this work. In doing this research, my fellow researchers and I always used the older, first-generation sedating antihistamines as the positive control. This gave us the opportunity to examine exactly the impact of these very widely used medications.

I do much of my work in aviation medicine. In fact, I developed the Cog-Screen test, which is what gave me the opportunity to do a great deal of this research while I was under contract to the Federal Aviation Administration. The Cog-Screen test is used to evaluate pilots to determine their fitness for duty when they have had an injury and want to return to flight status. Nowadays, it is being used by the airlines to actually hire pilots. It plays a major part of the selection of pilots both in the Air Force and in the major airline industry.

Although this would be more difficult to collect in the United States, a French researcher wanted to get a snapshot of medication use by aviators for a given day. He gave out about 1,000 questionnaires and got 852 replies, which was a pretty good response rate. The questionnaires asked respondents if they were currently taking any medication, if they were currently taking anything over-the-counter, even herbal products or vitamins, and whether they were currently taking any kind of prescribed medication. It turned out that about one-quarter of pilots had taken something on the day of the examination. The researcher broke it down by whatever kind of pilots they were, such as civil flying, civil aviation, transport, fighters, and helicopters, and the range for all of the categories was between 20 and 28 percent. The actual average for all of the categories combined was 27 percent.

Eighteen percent of them had taken analgesics, which, in the U. S., are primarily over-the-counter medications and often have a sedating effect. Eighteen percent, again, had taken nutraceutical medication, which consists of things like vitamins and St. John's wort and can be quite active. Fifteen percent had taken something for cholesterol control, 11 percent had taken antihypertensive medication, 8 percent had taken an antibiotic, and 8 percent had taken antihistamines. A look at these statistics on pilot use of prescription versus self-medication showed that there was quite a bit of use of self-medication.

The most common reasons for missed work, according to employees, are things like headaches, for which they take over-the-counter analgesics, or even prescribed analgesics, poor sleep the previous night, which Mark Rosekind will discuss further later, doctor or clinical appointments, and drowsiness. These are the most common reasons for people suffering work time loss. People are confused about the medication they are taking and they are not given much guidance. In fact, the recommendations the NTSB provided in January stated that there must be better guidance given to pilots so that problems like this can be avoided.

On a British Air nighttime flight from Pittsburgh to London, the first officer had a bad headache, and he took what is, over in the UK, an over-the-counter medication. He became incapacitated and left the captain to handle the flight by himself after they reached cruise altitude. It is surprising that the captain actually went ahead and continued with the flight, because he had trouble with the landing once he got to London. He came in the wrong direction on the runway. The good news was that British Airways claimed that the passengers' safety was not compromised. That is always really good to know.

Antihistamines are medications used to treat allergy and cold type symptoms. Allergies are an incredibly prevalent disorder and anywhere from 19-38 percent of people in the United States suffer from them seasonally. Thus, approximately 19 million employed adults suffer from allergies and make 58 million office visits a year. People with allergies have reported several interesting things. First, when they had their allergies, they were less efficient. Also, out of those sufferers that had taken antihistamines, half of them had experienced drowsiness. One-third of allergy-sufferers did not know the difference between sedating and non-sedating antihistamines, and half who reported that they had taken non-sedating antihistamines had actually taken sedating ones. So people had actually taken medication they did not realize was going to cause impairment.

In an employee survey that was done across 40 U. S. Fortune 100 corporations, 42 percent of employees reported that they took diphenhydramine, Benadryl, when they had their allergy symptoms. Meanwhile, only 20 percent of employees took prescribed medication. That is pretty consistent with data from 1998, which indicated that 57 percent of allergy sufferers took an over-the-counter (OTC) medication for control of their symptoms.

In 1998, “over-the counter” was synonymous with sedating, as there were no non-sedating, over-the-counter antihistamines in the United States. These older antihistamines are very potent drugs and block the histamine receptors in the brain. The histamine system is part of what is needed to stay awake and alert. These antihistamines are so effective at blocking these receptors that, when only 4 milligrams of chlorpheniramine is taken, which is the amount found in Chlortrimeton, essentially 77 percent of the histamine sites in the brain are blocked.

These medications carry a warning that states they may cause drowsiness and that care is necessary when operating a car or dangerous machinery under their influence. This is the standard FDA-required precautionary statement that is found on over-the-counter medications that cause sedation. It is written in microprint and nobody over the age of forty can see it, but a bigger problem than even its size is its believability. Most people take the over-the-counter stuff first, and if that does not control their symptoms, then they will go to the doctor and get the

“really strong” stuff. However, that is not quite the case when it comes to these types of medications.

These drugs contain diphenhydramine and are packaged as Unisom or Sominex or Benadryl, which confuses consumers greatly. They hear and read lots of ads for over-the-counter medications and there are no warnings in these advertisements. Yet, when prescription drugs are advertised, the makers have to tell the consumers about any possible problems or side effects. Chlorpheniramine is Chlortrimeton, or, as many people know it, Contac. Tylenol PM contains this same kind of medication. Actually, a dose of Tylenol PM contains 50 percent more of it than Sominex.

The second generation of antihistamines was designed to be just as effective at blocking the histamine receptor site, but without entering the brain. After all, when people are suffering from a runny nose, an itchy throat, and itchy eyes, it is not due to a brain disease. Instead, it is something that is going on peripherally. If the drug is kept out of the brain, then there is no sedation, and the patient's symptoms are still being alleviated. This was done by making the drug less lipophilic, that is, less able to cross into the brain. This was pretty successful, as PET-scan studies have shown that second-generation drugs like Seldane, which has actually been taken off the market for cardiotoxicity, only bind 17 percent of the receptors rather than the 77 percent that the first-generation antihistamines bound.

For the drugs in this second-generation category that do not cause sedation, there is no precautionary warning. However, only two such drugs are available. There were four, but two have been taken off the market because if they were taken in combination with grapefruit juice, antibiotic, erythromycin, or anti-fungal drugs, the metabolism in them was actually stopped. Studies at Georgetown showed that they could extend the intervals of some heart signals and cause a fatal arrhythmia. People actually died from that, so these drugs were pulled from the market.

Currently, there is fexofenadine, which is sold as Allegra, and loratadine, which is sold as Claritin. There are two other second-generation drugs that are less sedating than the old first-generation drugs, but they still carry precautionary statements because their sedation rate is about double that of a placebo. Fexofenadine has about a 14 percent blockage rate, while loratadine is comparable to a placebo.

Medication-caused sedation goes well beyond drowsiness or sleepiness. To somebody who does pharmacology research, it means the slowing down of brain functioning. That slowing down might show up as feeling sleepy or drowsy, but it might also show up as brain activity slowing down, difficulty staying awake, or impairment in the ability to perform activities like driving, operating a train, or operating a bus. To evaluate sedation, researchers use self-report measures. That is, they ask users how they feel. They also use physiological measures so that they do not have to ask the users directly how they feel. Instead, they can take a direct look at brain activity and use performance measures to see how well the subjects drive and think.

For studies utilizing self-reporting, researchers can choose among various diaries for the subjects to use. My team and I have partnered with a company called In Vivo Data that actually uses a

Palm Pilot, which is a great way to do it. With this method, they can have somebody take a medication every couple of hours. After that, the Palm Pilot prompts the subjects to indicate how sleepy they feel on a scale from one to ten, or they can mark it on a visual analogue scale. One recent study compared two popular medications and found that, while in the first two hours there were no differences, the amount of sedation grew with the day for one of the drugs but not for the other. This continued on for seven days of testing.

Researchers have had, basically 100 percent compliance with this diary, whereas with the prior paper-and-pencil diaries, they had many problems with compliance. They also use mood inventories and visual analogue scales in their research. With the Stanford Sleepiness Scale, the subjects rate themselves from one to seven on how sleepy they feel, with one being fully wide awake and alert. With the mood scale, the researchers put up words and ask the subjects to indicate if they feel that particular mood state. With the visual analogue scale, they give the subjects a drug and the subjects indicate on their scale the change from the baseline. For example, when they give them diphenhydramine, which is the drug found in Benadryl, Sominex, and Unisom, they find a change from the baseline of about one-quarter in terms of increased fatigue and decreased motivation to work. In addition, their appraisal of their work is that it has deteriorated in quality.

Self-reporting is very subjective. However, even more concerning is the fact that when the researchers gave 33 people a 50-milligram dose of diphenhydramine, which is a large dose, only one out of every three subjects in these placebo-controlled, randomized, controlled studies, actually reported any change in their Stanford Sleepiness Scale. That is, only one out of three reported sleepiness, and the other two-thirds said they felt perfectly fine. It was then recommended to the researchers that they go back and look at the data for the two-thirds who did not feel sleepy and see if they were actually okay. So, they tested their brain functioning, using the Cog-Screen test, and it turned out that their performance was actually impaired. They were not sleepy, but they were impaired in their ability to perform cognitive tests, to think, and to respond.

People who are not sleepy when taking a drug like Claritin or a placebo are, in fact, not impaired. However, people who are taking Benadryl and do not feel sleepy may still be impaired. In fact, they may be significantly impaired in areas that are very important to public safety. The scary part is that, if people do not have awareness that they are sedated, then they are not going to modify their behavior. They are going to get behind the wheel of their car, operate a train, or actually fly an airplane while less than fully functional. This fact helps explain a lot of the tragedies with which transportation professionals are familiar.

There is another way to look at sedation, which is to use physiological measures. Researchers have used many different approaches, such as EEG and evoke potentials. They have also done some functional brain imaging and some sleep studies through the Georgetown Sleep Center. In one study, they gave the subjects an evening dose of a very common over-the-counter antihistamine called chlorpheniramine. It is found in Chlortrimeton and Contac and is in all kinds of combination tablets. They gave people either an 8- or a 12-milligram tablet at 10:00 p.m., as they were curious about the hangover effect the following day.

In this study, the researchers looked at sleep latency, functional brain imaging, and self-reported sleepiness. In terms of self-reported sleepiness, when the subjects took the 8-milligram dose of chlorpheniramine, they did not feel sleepy the next day. However, when they took the 12-milligram they felt pretty awful the next day, as if they had only gotten a couple of hours sleep the night before.

For the multiple sleep latency tests, the researchers put electrodes on the subject's head, took them to a comfortable room, had them lie down on the bed, and told them to try to fall asleep. They repeated this every two hours, and recorded the average number of minutes it took for them to fall asleep. It should have always taken more than ten minutes, and it did for the placebos, but for both the group that took eight milligrams and the group that took twelve milligrams of chlorpheniramine it was down to six minutes, which is similar to a patient with sleep apnea.

In terms of brain imaging, the MRI at Georgetown has a special head coil that measures the activity in different regions of the brain during mental activities. The subjects perform tests and the activation levels in the different regions are measured. Normally, on no medication when a test is repeated a week later, there is activation seen, but only a fraction as much as there was originally. This is because the brain is more efficient once it has learned how to do something. However, the research done here was a different story. These subjects came in during the training phase on no medication, and then repeated the test after three consecutive nights of taking twelve milligrams of chlorpheniramine. The results showed that there was six times more brain activation after taking the medication. The brain was working overtime simply to do the same activity.

One last way to look at sedation is through performance testing. Many people find driving interesting, so it is often used. One of the driving studies is actually an on-the-road study, but simulators are used as well. There is even a virtual-reality driving simulator, which has proven very effective in looking at medications that might cause dizziness, such as antibiotics. Since a driver experiencing dizziness does not want to turn his head and therefore will often not look to see if somebody is in a crosswalk, it is a lot safer to test those types of medications in a simulator.

An example of performance testing is the work of some Dutch researchers that conducted on-the-road studies of weaving. This type of work is not done in the U. S., but it is done over in the Netherlands. They were very careful in their research, and used a Volvo. They had people drive 50 kilometers out, get off the highway overpass, turn around, and come back 50 kilometers in the other direction. At all times, an instructor-driver sat next to the person who had taken the drugs.

They tested alcohol, drugs in combination, and sleep deprivation. They looked at Seldane and Claritin, which are non-sedating antihistamines, and then triprolidine, which is a lesser sedating, over-the-counter antihistamine that is found in Actifed and is equivalent to a .05 blood alcohol level. That does not seem too bad, but the increase in weaving was pretty significant. In 2000, University of Iowa researchers used a driving simulator to look at accident avoidance and found that people taking diphenhydramine in 50-milligram doses were about on par with a .09 blood alcohol level. Comparatively, the triprolidine is not so bad. In fact, NASA astronauts used to be

allowed to take Actifed, as it was less sedating than other medications. Now, however, they do not take any sedating antihistamines on their flights.

Children's performance in school learning simulations has also been used to look at the impact of sedating antihistamines. They were taught to perform computer simulation learning tasks, and then were randomly given things like Claritin syrup, 25 milligrams of Benadryl syrup, or a placebo. The results were no surprise. For placebo-takers, those without allergies outperformed those with allergies, which indicates that allergy-sufferers should aggressively take care of their allergies. However, the main conclusion was that the sedating antihistamines caused significantly worse performances than the allergies themselves did. Thus, antihistamines simply add to the problem rather than solve it.

Looking at productivity loss for employees that are taking sedating antihistamines is also useful. The MIT School of Business is currently looking at the effects on worker productivity of various prescription and non-prescription drugs. Many of these drugs cost a great deal and employer programs are paying for many of these medications.

One study looked at insurance claims processors and found that they completed, at baseline, 200 claims correct per day. Those who took a non-sedating antihistamine continued after they started taking the medication to get 200 claims correct per day. However, those who took a sedating antihistamine dropped down to only 172 per day. This is a 12 to 14 percent deterioration in productivity, which is going to cost the employer a fair amount. Employers always complain that they want to restrict their formularies and make people take the cheaper over-the-counter drugs so that they do not have to pay much for it. However, if this is done, they will end up paying for it many times over anyway in lost productivity.

The speaker conducted a study when Claritin, that is, loratadine, was a new drug. The manufacturer of the drug funded it and had come to him because he had done a study of Seldane in the military when it first came out. They wanted him to use the same kind of protocol in this study as he had for Seldane. Ninety-eight healthy subjects participated in the project and were randomly given either 10 milligrams of loratadine, diphenhydramine 50, which was then dropped down to 25 QID, or a placebo. None of the subjects knew which medication they had received.

The study focused on several mental abilities. The first was vigilance, or the ability to sustain attention during a boring mental activity, which is obviously very important for traffic safety. In fact, NTSB promotes it in their literature as the most important safety issue. The second was divided attention, which is the ability to perform simultaneous mental activities, such as talking on a cell phone and driving at the same time. The last mental ability was working memory, which is the ability to hold onto recent, larger chunks of information. For example, how well is a person able to remember a 10-digit telephone number that he just got from directory assistance. This information surpasses normal working memory capacity, and he has to hold it in the frontal lobe. These three mental abilities are especially vulnerable to the effects of sedation and fatigue. They are also critically relevant to daily life and very important in transportation.

The Cog-Screen test, which is a totally computer-administered test, was used to study these

abilities. In the version used, the person took the whole test with a light pen, while looking up at the screen. There was no keyboard to deal with at all and they did not have to know anything about computers to take this test. In addition, a whole roomful of people was able to take the test at the same time. The first part of the test involved following instructions. It was comprised of different exercises, and each had different rules. For example, the subjects could be asked to memorize a checkerboard pattern and then, after a short period, match the pattern to one of two given choices. Or they might have to look at a box and then match it to a box with the same color as its border. They might also be told to match it to the color of an arrow or even the direction of an arrow. Basically, they received a sign that told them how to do the match and they had to try to follow it. However, the sign quickly shifted from one instruction to the next. The study found that the ability to do this deteriorated dramatically with either sleep deprivation or sedating medication.

The next part of the test looked at divided attention. One exercise involved remembering what number had been in a box prior to its change to the next number. For example, the number 1 might be in the box and then be replaced by a 2. The subject would then be asked what number was there before the two. At the same time, the subject undertook another exercise that involved keeping a little blue box in the center of the screen. This exercise measured weaving. Again, the study found that with sedating antihistamines there was deterioration and poor functioning across all the dimensions. However, there were no differences found between the results for non-sedating medications and the results for the placebos.

The results of the tests for vigilance are easy to explain. There was no difference in the results for Loratadine, Claritin, and the placebos. However, the results for diphenhydramine indicated that a user suffered four times the number of lapses of attention as the placebo-taker. The question to be addressed then is whether this deterioration in mental abilities causes any kind of increased accidents and injuries. Group Health Cooperative looked at about 3,400 traumatic work-related injuries, which are things like burns, fractures, and dislocations. They found that the thing that increased a worker's odds of suffering one of these kinds of injuries the most was taking sedating antihistamines, which are the most prevalently taken over-the-counter drug.

If the autopsies of pilots who died from crashes are looked at, the two top drugs found in these pilots for the last eight years have been the sedating antihistamines diphenhydramine and chlorpheniramine. NTSB research into accidents has found the same things. After looking at the Greyhound accident discussed on the first day of this symposium, NTSB led off its recommendations for 2000, which included several new ones, with that illustration.

The fact that 35 states plus the District of Columbia have made it illegal to drive while under the influence of any sedating medication, whether it be over-the-counter or prescription, is also compelling evidence. If a person's driving is impaired by an over-the-counter medication, even though that person has no alcohol in his system, he can be treated the same as if he was driving drunk.

Returning to NTSB, their recommendations are very important. However, they must provide a list of medications that are approved and safe to take before driving or operating vehicles and expressly prohibit the use of drugs not on such lists. They must also educate pilots and vehicle

operators on the effects of medications and point them to sources of such information on an ongoing basis. There is also a need for them to conduct toxicological testing following fatal passenger car accidents in order to evaluate the role of prescription and over-the-counter medications in this kind of crashes, as that data is currently uncollected.

One thing that can be done as a short-term solution is to change the labeling. In Europe, a prominent triangle is put on the front of bottles and boxes of pills to indicate that the medication is known to impair driving. Europeans have quickly come to realize that it means that it impairs driving.

So, the overall conclusion is to avoid sedating medications. This is pretty obvious, especially where a non-sedating alternative is available, which is certainly the case with antihistamines. Over-the-counter does not mean safe or safer. Management must not rely simply on self-reporting when they are determining if a medication is non-sedating, and they must be especially careful with the use of sedating antihistamines in individuals whose activities demand vigilance, skilled coordination, divided attention, or working memory.

**Dr. Mark Rosekind
President/Chief Scientist
Alertness Solutions**

It often seems a miracle that anybody ever gets a good night of sleep in the transportation industry, considering the operational disruptions that occur in such workers' circadian patterns. There are approximately 88 different sleep disorders. It is a miracle that anybody actually wakes up feeling refreshed, alert, and ready to go. Sleeping really is an art. Today we will cover sleep disorders, with an emphasis on screening, diagnosis, and operations programs.

The number one question on the subject is how prevalent are disorders? If they were just an exception, then no one would even bother worrying about them. However, a report from one of the leading medical journals in the United States on the prevalence of sleep disorders shows that they are far from being an exception. In any given year, about one-third of the adult population will actually report a sleep disturbance. However, a new National Sleep Foundation poll has suggested that this could actually be as high as 67 percent depending on how the question is asked. The way the question is asked is very important. There is a real distinction between the occasional bad night or having to sleep during the day once in a while due to work-related issues and chronic sleep disorders. Scientists are interested in the physiological, physical, and psychological things that create the latter.

Not only are sleep disorders highly prevalent, they also range widely. There used to be 82 different disorders, but the number is now about 88. Scientists are finding new ones all the time. There is a wide range of causes; some of them are physical and some of them are psychological, in that they are related to environmental aspects and/or a whole range of other things.

What is most important is that sleepers usually have no idea that they have a disorder. In fact, there is a big discrepancy between what people report and what is really happening

physiologically. Affected people may have a complaint about something physical, but they have no clue it is related to a sleeping disorder. Thus, their reports may not be the best way to indicate that they have a sleeping problem. There is actually an international classification system to characterize all the different sleep disorders that exist. It is put out by an organization that used to be called the American Sleep Disorders Association and is now a new group. Since it is international, it is essentially used worldwide.

The sleep disorder heard about most often in transportation is sleep apnea, but the most prevalent one is actually insomnia. The one most joked about, which means that it too is well known, is narcolepsy. However, because there are 88 different disorders that have been identified, it is actually much more complex than most people typically appreciate. A few examples of these disorders can give a good idea of just how widely they range.

Periodic limb movement is a disorder where the anterior tibialis muscle in the right and/or left leg twitches. Thus, when the sufferer goes to sleep at night, the leg twitches. It is a problem because every time the legs twitch, it wakes the person up and there can be leg twitches three or four hundred times per night. So even if sufferers have a great quantity of sleep, in the morning they do not feel refreshed because they had 400 awakenings during the night. Again, what is interesting is that the person might wake up in the morning and feel wiped out, and never realize that he has been kicking his legs.

In a similar vein to snoring and sleep apnea, which will be discussed shortly, the person who typically makes the diagnosis in this case is the kickee, not the kicker. The kickee is the bed partner who is usually on the receiving end of all those kicks.

Narcolepsy is extremely rare, which is interesting, as it has received a lot of attention. There are, at most, 100,000 people in the United States that have it, yet much research has been done on it. Narcolepsy is a disorder where sufferers complain about being excessively sleepy all the time, which is why there are so many jokes about it. Even when they get ten hours of sleep, they are still tired. Since they are tired all the time, they do things like nod off in the middle of a conversation, fall into their food, and fall asleep during sexual activity. They are unable to engage in activities such as driving or seeing a movie.

Narcolepsy is sometimes joked about because sufferers also have cataplexy where, if they get excited, they have a muscle paralysis, just like as if they were in REM sleep. So instead of having REM sleep in the middle of the night, people with narcolepsy have it during wakefulness. If they are told a joke, they can experience paralysis while they are walking and talking and have a partial or a complete collapse to the ground. Although narcolepsy is rare, it is the first thing that people with a sleep problem often think of, especially if they are unfamiliar with apnea. It is very straightforward to diagnosis it at sleep clinics.

The most prevalent sleep problem that people complain about is actually insomnia. For a variety of reasons, nearly everybody has experienced problems with getting to sleep, staying asleep, or waking up too early. Again, there can be both physical causes, such as alcohol, or different psychological disorders that can create insomnia.

Advanced sleep phase syndrome and delayed sleep phase syndrome are two more disorders. These are problems with the normal sleep phase, which is when a person goes to bed and then wakes up. In an advanced sleep phase, it is the same pattern, but is earlier. People on an advanced sleep phase like to go to bed at about 8:00 p.m. and are unable to sleep past 4:00 a.m. Their sleep phase is essentially advanced earlier. This is a problem because if they try and stay up until midnight, they fall asleep in places other than bed, and they cannot sleep in the morning.

The reverse of this is delayed sleep phase syndrome. It is basically the normal phase, again, but it is now shifted later. Sufferers want to go to bed at 4:00 a.m. every morning and sleep until noon. So they still get eight hours of sleep, but it is delayed. The problem is that, while they are great party animals, when they have to get up in the morning for something, they are totally out of it. It is the classic college syndrome. It starts in high school and is perfected in college where there is no schedule. The good news is that these two syndromes can actually be diagnosed and treated.

Another group of disorders are the parasomnias, which include sleepwalking, sleep talking, head banging, and night terrors. These are typically found in kids, as between 10 and 15 percent of all kids have them, but they happen in adults as well. They are phenomena that typically occur in non-REM three and four, which are the deepest sleep categories. These behaviors can actually be seen occurring during sleep and are part of an arousal from the deepest sleep. Essentially, the sufferer is trying to go into REM sleep in which the brain is more active. There is a spectrum with parasomnias. Everyone has a little movement, but it then progresses through sleep talking and sleepwalking and ends at night terrors where children and adults sit up glassy-eyed, scream loudly, and then lay back down.

What is interesting is that they are typically not dangerous. They are generally simply treated with tender, loving care, although concerns about safety sometimes lead to medication use. However, they are really people just trying to transition from deep sleep into really active REM sleep. In adults, parasomnias are more often related to some kind of psychological stress as opposed to what is typically seen in kids. Most people do not know they do these things because they happen in non-REM three and four, and there is typically no recall of them in the morning.

Almost everybody who has known a sleep talker thinks that they have had great conversations with that person in the middle of the night. However, this cannot usually happen, because the talker is in deep sleep, and non-REM three and four kinds of behaviors are very simple things. So if such discussions took place, the other person was actually awake. They may not remember it in the morning, but they were probably awake.

This is just like sleepwalking, as sleepwalking is typically non-purposeful. The sleeper is essentially limited to walking. After all, what can a person do when asleep? He can probably get his clothes on, but it would be very tough to drive a car. So typically, the sleepwalker's activities are very low effort. Like the other parasomnias, it happens fairly often with kids, but adults can do it too.

Sleep apnea is another disorder that must be discussed. When the word apnea is

deconstructed, the “a” is *not* and the “pnea” is *breathing*. So, sleep apnea is when a person cannot sleep and breathe at the same time. Sufferers of sleep apnea go to bed, go to sleep, and then stop breathing. There are two things to be concerned about when a person has an apnea. One is for how long the breathing generally stops and the other is how often it happens.

While falling asleep, everyone has brief 10- to 15-second pauses between sleep stages. However, with sleep apnea, a person remains in these pauses for up to a couple of minutes. That is a long time for no oxygen to be reaching the brain or the body. Typically, all of the systems in the brain stem that are sensitive to this problem wake the person up. Once this happens, all the machinery that helps the person breathe wakes up too, and breathing begins again. The snoring associated with apnea is the sound of the sleeper waking up. Since the machinery in the brain wakes up, the breathing starts again. The person is awake when the breathing starts, but then falls asleep again and stops.

By definition, a sufferer needs to have five apneas per hour, but a severe case involves many more than this. In fact, one physician who is a friend of mine has a patient that had 861 apneas in one night.

It is obviously a good thing that these people wake up to breathe, because if they did not they would have a sudden death during sleep. Most people with apnea typically make it through the night. However, every time there is a sudden “cardiac death” during sleep, I have to wonder, since there are so many undiagnosed or misdiagnosed cases of sleep apnea. If a person does wake up 861 times during the night to breathe, that person will feel very tired in the morning. The number one complaint of people with sleep apnea is excessive sleepiness. They feel tired all the time.

This is another disorder where it is usually the spouse or the bed partner who realizes there is a problem. In fact, an article came out in the past year on spousal arousal, which is when people with apnea wake up their spouses enough that it causes a sleep disturbance in them too. In such cases, if the person with apnea is treated, then the spouse or the bed partner is treated as well, and both of them should improve.

There are all kinds of other physical symptoms associated with apnea besides disturbed sleep. It puts tremendous strain on the heart and lungs, so if people have high blood pressure, they can have valve and other heart problems. In addition, excessive sleepiness leads to certain types of performance risks when the sufferer is awake. This is important because when it comes to fatigue, most transportation experts talk about shift schedules, working through the night, or flipping days versus nights. However, workers could already be predisposed to sleepiness due to a preexisting sleep disorder. Then, while all of the other issues are adding to the problem, they are not the actual root cause.

Currently, the best epidemiological studies suggest that about 24 percent of the male population and about 9 percent of the female population is afflicted with sleep apnea. So, 24 percent of male transportation employees and 9 percent of female transportation employees probably have some form of sleep apnea. Thus it is fairly prevalent. As recently as a couple of years ago, essentially everybody thought sleep apnea was found only in middle-aged fat men who snored.

Now, it is known that this does not hold true. Instead, it can be found in all body types. However, it is still more prevalent in some body types than others. For example, 30 percent of people with 17- to 17½-inch necks have sleep apnea.

On the first day of this symposium, Dave Osiecki mentioned that the American Trucking Association is trying to look at sleep apnea in truckers. Part of the reason for this is that two sleep disorders researchers at Stanford, Hilda Manton and Ricardo Steus, went to a truck stop, screened some drivers, and found that over 70 percent of them had sleep apnea. This raises the question of whether there might actually be higher numbers within certain populations. The researchers have been looking at whether it is due to the sedentary lifestyle of drivers.

However, the DOT study that Dave referred to, which was conducted at the University of Pennsylvania, suggests that the numbers in a well controlled study are actually closer to the 24 or 25 percent level found elsewhere. So it is still unknown whether particular operational groups have different percentages of apnea sufferers. For now it seems it can be counted on that there are, at least about 24 or 25 percent of males and about 9 percent of females in every group of workers who have sleep apnea.

There is some good data that shows that people with sleep apnea have a two to seven times increased risk of having an accident while driving. There was also a recent study by Nelson Powell and some other researchers at Stanford that looked at mild to moderate apnea and found that it was associated with a performance that equaled a blood alcohol concentration level between .05 and .08. So, clearly, there are certain well-documented driving risks associated with apnea. Basically that means there is a safety risk associated with it. So this is one of the disorders that management would want to know the extent of in its employee population.

Sleep disorders medicine is actually still pretty new. Some years ago, when I was still at Stanford, a colleague, Robert Woods Johnson, and I decided to do a survey of all the medical schools in the country in order to find out how much physicians were learning about sleep disorders during their four years of medical school. They looked at what the students were learning about sleep, sleep disorders, sleeping pills, disorder diagnoses, and evaluation techniques. Unfortunately, the range was essentially zero. In four years of schooling, these students spent just under an hour, on average, learning about these issues. So when someone with a sleep problem goes to a health care provider that has not had specialized training, he may or may not know exactly what to do. However, there is an organization called the American Academy of Sleep Medicine. It used to be called the American Sleep Disorders Association. It accredits facilities, clinics, and individuals with a board certification to do sleep disorders medical work. Their web site provides a listing of all the clinics in the United States and Canada that are accredited.

Many local hospitals say that they have a sleep disorders clinic. However, patients need to do their homework and find out if the AASM has accredited the doctor for sleep disorders or if the doctor is actually an expert in some other area. If someone is going to seek help for a sleep disorder, it is very important that he go to an accredited facility. If a person does go to a clinic, the doctors will monitor him overnight and very often through the next day as well. During this time, they will measure pretty much everything physically possible. They will put monitors on

the patient's head to look at brain activity, eye movement, muscle activity, heart rate, and whether breathing is from the nose or the mouth. They will also put monitors across the patient's chest and abdomen, as well as little ones on the legs to see they twitch. They might also put things in places that should not be described publicly. Basically, anything that can be measured while a person is awake can be measured while he is asleep. In a thorough sleep disorders clinic evaluation, they can choose to look at a full range of things, depending on what they are trying to rule out. The exam is called a nocturnal polysomnogram, or NPSG, and it is a full physiological monitoring.

Over the last ten years or so, people have decided that they want to take all of this monitoring into the home. So there is now a whole range of different monitors that are used to conduct this kind of evaluation in the home. These basically fall into a couple of categories. The first is where the examiners try to do the same kind of things that are done in the sleep clinics. In other words, these monitors try to measure all the things that are measured in an NPSG. The other category is where examiners simply look at something specific, like sleep apnea, and get rid of the extra stuff. They go right for the heart of things, like tests of the oxygen level in the patient's blood, which is really simple and is useful in looking for apnea. They essentially try to do their monitoring in as straightforward a manner as possible.

There is an ongoing debate in the sleep disorders field about which is the better route. In fact, while the AASM has come out with criteria for home monitoring, in terms of what is good and what is bad and there is a debate about those too.

No matter what clinic patients visits, examiners are going to give them questionnaires about whether they snore and other like subject matters. There are all kinds of these questionnaires out there but, as Gary Kay pointed out, examiners should never simply rely on self-report because it is not an accurate predictor of whether people actually have a sleep disorder. So if that appears to be all that the clinic is interested in, it is best to find a different place. These then are the kinds of things people need to know about when they go to a sleep clinic.

Most insurance companies, though not all of them, will typically pay for an evaluation. Sleep disorders clinics can range from about \$1,000 to about \$1,800, depending on the clinic and how thorough the evaluation is. Home monitoring is starting to be covered as well, but it is a little bit more expensive, and it is not always clear which companies will cover it.

There are many ways to measure sleep. One that is widely used is time-lapse photography. When a person goes to bed with his head on the pillow and wakes up in the morning with his head still on the pillow, it is only due to luck since time-lapse photography shows that people move throughout the entire night.

When management is deciding what to do about sleep disorders on its property, it needs to think about education, policies, and methods. First of all, management typically frames this issue from the positive side and talks about healthy sleep rather than sleep disorders. Healthy sleep comprises everything from good sleep habits, which everybody should have, to the identification of disorders.

When it comes to education, management must think about the basics. Employees should know about sleep and circadian rhythms. They should also be told about the different sleep disorders that exist and given a few examples. If management only gives employees information as part of the education process, it must make sure they also have resources. Management should find out through the human resources department whether the property's insurance covers sleep disorders and where the local clinics are. If there is a corporate or organizational program already designed for this, then management must make sure employees know about it and that they do not simply go out on their own.

A major reason that all of these actions must be taken is that sleep disorders are now largely underground. If appropriate policies are not in place, many employees will do things like go out of state and use a different name to find out if they have sleep apnea. So if the property does not have a policy, it may cause some of the seeking of treatment to go underground. If it does have a program, it should tell employees about it in order to allow them to be open about seeking help.

In terms of policies, there are several areas management should think about. Human resources is one. It is very straightforward and was discussed earlier. Liability is another one of these areas. Sleep disorders are a medical health concern but there are also liability issues. Confidentiality is another important area. It should be part of any medical program. Operations is a last important area. For example, once treated, should the employee be allowed to drive again immediately, or should be kept off until a certain level of treatment and compliance has been reached? The operational issues must be identified and thought through when a program like this is actually set up.

In terms of methods, which can also be thought of as the program objective, management can either just give people information on sleep disorders or include the information in an educational program that also recommends that any employee who thinks he has some disorder to see someone and do something about it. Management has to decide whether to use screening programs or programs that produce a diagnosis. A screening program identifies employees who seem to have a disorder and has them go to a sleep clinic. On the other hand, a program designed to produce a diagnosis definitively identifies employees who have a sleep disorder and also attempts to identify the actual disorder.

If management decides to use home monitoring and is not familiar with what kind of methods are appropriate, then it must make sure it is partnering with an accredited clinic. The clinic can help management decide whether various different procedures should be done in the home or in the clinic.

A critical element for management is figuring out what treatment is appropriate. Sleep apnea alone can be treated with weight loss, tongue-retaining devices, CPAP machines which help the sufferer breathe at night, or different kinds of surgeries, including somnoplasty. Management must understand the range of treatments for a wide range of disorders. At the same time, management must be concerned about employee compliance with ordered treatments. So there must be appropriate follow-up measures built into the process.

The most important thing is for management to decide what kind of a program it wants and what the objectives of that program are. It has to decide if it wants to simply give employees information, if it wants to screen employees, or if it wants to actually help make diagnoses. These are all very different, so management must decide which is most appropriate as part of whatever comprehensive program it decides on for dealing with alertness issues.

SESSION VII: EDUCATION

**Dr. Dennis Holland
Director Of Alertness
Union Pacific Railroad**

Union Pacific believes that education is extremely important to any alertness or fatigue management program. Today, I will look at how Union Pacific targets different populations within its workforce, what the contents of the programs are, and how it distributes the programs among its employees. Since Union Pacific has over 53,000 employees, it can be very difficult to get the message out to all of the people, especially since they are spread out across the United States.

The focus is to reach the employees on three different levels. First, Union Pacific wants to send out a general message on the importance of fatigue and alertness not only in the workplace, but in society as well. Second, we want to target specific populations based on craft, shift work, position, geographical location, etc. Third, we have individual concerns—we want to look at whether any of our employees either have sleep disorders or have had trouble adjusting to shift work. If so, we want to figure out what can be done for them on an individual basis. The educational process is trans-theoretical and based on stages of change. Union Pacific uses a lot of different methods since different adults learn in different ways.

Training based on the stages of change is new to the Union Pacific program. For example, some people are precontemplators. They do not know yet that they need to change, so management needs to get the word out to them. However, we need to communicate with them and provide their education differently than we do with contemplators, who are people that are thinking of change, already changing, or trying to maintain change.

Union Pacific's philosophy is that education has to be the foundation for all of its activities. This philosophy was developed with its partners and its consultants at Alertness Solutions when it first began its program about three-and-a-half years ago.

In terms of targeted populations, it is important that senior managers and managers hear a bit of a different message than some of the employees in the field. What Union Pacific wants to do is explain to them not only the health benefits for them and their employees, but also the cost benefits. These cost benefits may range from increased productivity and reduction in absenteeism to their own personal ability to make decisions, their own personal health, and things of that nature.

One of Union Pacific's educational tools is a brochure on the myths and the concerns that tend to frighten managers. For example, many managers fear that all their employees are going to sleep on duty and no work will ever get done if a napping policy is instituted. This is the type of things that have to be overcome. So Union Pacific has tried very hard to tailor its message to the audience.

Union Pacific's operating employees are the erratic shift workers of the railroad industry. They are known as crews on demand and can be called to work on a 24-hour basis, 7 days a week. So they need a different education than that managers receive. They have different issues and difficulties than non-operating employees, who may work long hours, but still work only daylight or standard shifts in a shop or a clerical operation. In terms of staff personnel, while they do not have these same fatigue or shift work problems, they do bring all of the societal fatigue problems to the work site. Union Pacific wants everyone in the company to understand these issues so those that are not directly affected by these fatigue issues can be supportive of the employees who do work shifts and who are facing them.

The other population that Union Pacific wants to target is family and significant others. It has found that families are very crucial. First of all, society as a whole is very sleep-deprived. Second, families can be very supportive of both the process of ingraining new behaviors in employees and of employees in their shift work. There is a moral obligation for Union Pacific to take what it knows about the problem of fatigue in society and give the information not only to families of employees and significant others, but to the community as well. For example, I have been involved in a project working with adolescents on their sleep problems. I have also worked at a local high school using the teachers and students as consultants to help Union Pacific develop both an educational film and booklets for high school teachers in their health classes.

The content of the programs at Union Pacific is designed to have very practical application. It should help people understand not only the problems of fatigue, but also how they can practically apply that understanding to some of the basic issues that result from shift work.

Union Pacific has begun to modify its education program lately. We are moving from more academic content in its brochures and videos to more practical content that better suits employees and their families. We currently also have a project designed to raise awareness of sleep disorders. And we have put out communication tools and a new educational video in anticipation of a sleep disorder screening project.

The content of Union Pacific's education program is very broad. However, a brief mention of some of the different items should be useful. For example, there is a family video that explains the issues and shows families how they can take part. There is also a special brochure that was produced in cooperation with the employee assistance program. It contains an educational program for people recovering from addiction and explains how fatigue can actually contribute to relapse.

As explained earlier, Union Pacific has special education directed toward managers. For the crew callers, the people who call the erratic shift workers, it has a special little brochure and etiquette checklist. They describe how to interact with the people they are waking up in the middle of the night and how to act courteously toward people who are fatigued.

Union Pacific's drowsy driver video and brochure are important tools, not only for employees who drive other employees, but also for contractors who drive employees to the trains. It is also directed towards the entire family, since drowsy driving is a significant problem in society as a whole.

Since Union Pacific has 53,000 employees spread out over the western portion of the United States, it is very difficult to get all of this information out to all employees. The fact that people are working around the clock, seven days a week makes it even tougher. And not everyone learns readily in the old classroom style. Union Pacific has found that people learn in a variety of ways, so we want to keep these messages about fatigue in front of them. Union Pacific has a number of things designed to do just that. We have videos and brochures that it keeps very short, and the videos are tailored with specific messages. We also have an ITV system, which consists of little television screens in crew rooms and offices across the country. This system consists of slides with different messages about either communications or fatigue and sleep awareness.

In addition, we have a BTV system, which can be used to reach a number of centers around the country and have discussions via satellite. This allows interaction with safety captains around the country. We can show them a specific topic, let them ask questions, and then distribute videos of the broadcast.

Union Pacific's distribution centers are little plastic holders that are placed throughout the system and contain different brochures and informational messages. Formal classroom training is held every two years, and all new employees receive specialized fatigue training upon starting.

Union Pacific also has a health services field staff who are sent into the field to talk with employees, conduct focus groups with the employees' families, and provide special interaction for employees' significant others. Educational material is mailed to employees' homes and work sites as well as a number of surveys, including a general health monitor that looks at the general health of employees and a variety of other surveys that include educational material.

In closing, I want to make a reiteration of what Union Pacific does in terms of fatigue education. We have a trans-theoretical change model. We try to reach all employees as well as their families and significant others, and we want to reach into the community as well. We try to keep the content very practical and relevant to the employees. Lastly, we use multiple distribution methods.

William Keppen
Consultant
Fatigue and Alertness

Denny Holland has done a great job and they have a great program at Union Pacific. Dr. Mark Rosekind should be recognized for his role in that. He and NASA-Ames also played a very significant and pivotal role in the education programs that were originally established for Burlington Northern/Santa Fe employees. Once again, the Work/Rest Review Task Force is where the national collaborative effort started, with the assistance of experts like Dr. Rosekind, Dr. Moore-Ede, and numerous others. It quickly became apparent to the members of the task force that education had to be at the base of these programs and pilot projects.

NARAP, the North American Rail Alertness Partnership, is an outgrowth of the Work/Rest Review Task Force. The railroads and operating unions put together this collaborative effort that

involved locomotive engineers, conductors, and management teams. The initial effort was designed to push information both down and up. This was a wise decision because if senior management had not bought into the program, then it would have been dead and there would have been no reason to spend any money. So, getting senior management onboard was the first thing that had to take place.

BNSF originally sent a group of six management and rank-and-file employees to NASA-Ames to participate in their fatigue management training program. Eventually, about sixty employees were trained there. It was a great program, but it was aerospace-oriented and did not quite fit the railroad model of transportation. The scientific aspects were applicable, but there was a need for programs that suited different operations and employee populations.

For example, if a program is moved out of the locomotive cab into the shop, a different educational module is needed. Again, the technical information may apply, but the operational and work environments are much different. In each environment, management needs to look at what workers are doing, to see if they are shifted or non-shifted, and if they are working regular or extended hours.

So, in order to see what was going on with its population of workers, BNSF utilized a team of management and rank-and-file employees to look at all of these issues. In effect, it translated the training materials and program from planes to trains. The members thought that, since they had captured the best scientific knowledge out there, they would simply have Dr. Rosekind approve the product. However, he felt he could not approve it because he did not understand the industry. He did however offer to correct any scientific information that had been translated incorrectly.

That product formed the basis for the BNSF Fatigue 101 training module. Utilizing the force of 60 people who had been trained at NASA-Ames and the train's educational module, management trained 18,000 operating employees across the BNSF system. It was quite a challenge because the goal was to get it done in a year and the employees were working all hours of the day. It was not possible to simply schedule a time and have all of the employees in a certain area show up for it. Generally, at any given point one-third of the employee population is out of town and another one-third is resting after having performed service on over-the-road trains. So management needed a group of trainers that was large enough to hit the target populations.

The training has been largely successful. It has not reached 100 percent of the employees because there are people on extended leaves and things like that, but it has worked out pretty well for the initial 101 training. Beyond that, management has targeted specific factors that it could promote in its fatigue and alertness management programs. These factors included things like diet and sleep disorders.

Management implemented pilot programs for which it had developed specific training materials, such as its napping pilot. It changed the operating rule that if an employee slept on the job, he would get fired. Employees can now sleep in accordance with the policy that has been outlined and, in fact, management encourages them to do so. Management had training and promotional

materials that went along with the program, and it went out and piloted the materials at several locations on the system.

The napping program scared the heck out of people at first. Everybody, from the senior vice presidents down to the union local chairman, expressed concern about employees napping on the job. In any case, because of the promotional materials and the targeted nature of the training, the program ended up being a huge success. BNSF now has a napping policy across the system for all operating employees, and it is currently extending it to non-operating crafts.

Alan Lindsey and Merle Geiger are going to discuss some of the other details of the program next. Following their presentations, there should be time for interaction with the audience so we can find out what different audience members are doing with their people and operations.

Alan Lindsey
Director Of Safety And Rules
Burlington Northern/Santa Fe

Education is a driver of change. Everyone at this symposium understands the importance of education for their employees, but what is frequently on properties is how to use education with management leaders, labor leaders and Federal Government agencies to bring about change. When BNSF has done it well, it has been successful, but it has also had some failures.

I will focus just on the issue of napping. We will look at both how the educational process led BNSF into napping and how what is now normal in the railroad industry was not normal when BNSF first started it.

The BNSF educational journey started with the Work/Rest Task Force that William Keppen and Jeffrey Moller mentioned earlier in this symposium. Indeed, BNSF and UP were two of the original railroads that wanted to participate in it in 1992. From this task force, BNSF was able to get a great deal of data. In fact, the first points of education are probably getting data and making decisions driven by data instead of anecdotal information.

While knowing the truth will eventually result in benefits, at first it causes misery. So while the BNSF team knew that there was a fatigue problem, it did not really know what was causing it or what the basic issues were. In many ways, the team came to believe that there were things it could do to change the situation. That was the first piece of education for the members. The next big step in fatigue education for me personally took place at the joint symposium NASA-Ames and the NTSB held at Tyson's Corner in 1995. That was the first time I had heard any information on napping and the impact that it could have.

With that information in hand, the speaker and some other team members went to NASA-Ames and participated in Dr. Rosekind's program where napping was discussed again. At the same time, Dr. Moore-Ede was implementing a program for BNSF in Winslow, Arizona. So the team talked to Dr. Moore-Ede and asked that it be able to put in a napping policy on its Arizona division, just to see what it was like.

Being true railroaders, and thus control freaks, the team did not take all of Dr. Moore-Ede's advice. For example, it wanted to make sure that it could manage the situation and count people napping. So, against his advice, it ruled that employees had to call the dispatcher every time they were going to take a nap. This way, an accurate count could be kept. However, the program was a miserable failure, as nobody reported taking a nap.

In response, I flew to Arizona, sat down with the BLE and UTU people, and asked them why the program had failed. They were very honest and open, and it turned out that the big problem was that fellow employees made fun of those who wanted to nap. If an employee called up the dispatcher and said he wanted to take a nap, the railroaders, other crews, and dispatchers would all make fun of him.

The team regrouped and thought about the situation. The speaker flew back to Ames and talked to Dr. Rosekind and his staff about what should be done. It was decided the first thing that should be done was to have Dr. Rosekind come and give a presentation to BNSF senior management team and its senior vice president. In this presentation, he talked about the napping project that he had been involved in with the overseas pilots.

One of the things Drew Dawson mentioned is very true. If somebody with a Ph.D. who works for the space industry comes in and talks to senior management, they are going to believe what that person says. BNSF senior management came out of Dr. Rosekind's presentation and decided that a napping program was needed. It was then decided to set up pilot programs in the Southern California and Illinois divisions.

As a little aside from education, when trying to do things at a property, it is very important where the process is started. What the SI did was very simple. I had worked for the railroad for twenty years at that point, so I looked at division superintendents and rated them based on how friendly I was with them. I then went to those with whom I was most friendly with and asked for their help. They all agreed, and that is how the program started.

Next, William Keppen and I went to each of those divisions and had meetings with the local chairmen and local management. Depending on the request of the division superintendent, sometimes we both met with that person and sometimes only one of us attended the meeting.

The next level of management below division superintendents got very excited about all of this and thought that it was the end of the world. They felt that there was no way they could have napping out there. They wanted to know what they were supposed to do when they got on a locomotive and found someone sleeping. The division superintendents told them they should congratulate that person and praise him for following the policy. That was a huge cultural change for the railroad. It also proved to labor that management was willing to do some unconventional things, which was important.

By this time, senior management was really excited in a positive way, and they wanted to know

if the napping policy could be implemented across the railroad within a month. That was too much, too soon, so instead the team set up a 6-month project and went out to each division. The team sat down with the local chairman and local officers of each division and had about a 4-hour meeting with them during which they talked about why they wanted the chairmen and officers to support this policy. The team did not just put pressure on the local management and order them to do it. Instead they allowed them to make their own modifications to the policy.

So initially, BNSF actually had 22 different napping policies within a general framework. This framework was that no nap could be more than 45 minutes, including the time it took to fall asleep, the train had to be stopped, and one person had to stay awake. Within that framework, each division was allowed to develop its own napping policies. By mid-1997, BNSF had napping policies in all of its divisions.

In April 1998, BNSF finally came together with one napping policy for the entire system. This is a true success story. At the same time BNSF was doing this, they were having conversations with Union Pacific, which started down the same path and then went system wide. Union Pacific and Burlington Northern Santa Fe both operated under the general code of operating rules.

BNSF went to the General Code of Operating Rules Committee and, as of April 2000, it now has a napping policy for all roads that deal with the general code of operating rules, which are all roads west of the Mississippi River. In fact, most of the short lines in the United States now have a napping policy because of this.

BNSF feels like it has changed an industry and that it was because of first partnerships. It brought labor in, which was very important. Indeed, the fact there are not many labor people at the symposium seems a mistake. It is necessary to really reach out to them because a lot of the issues that have to be dealt with are agreement issues. These types of policies cannot be successfully implemented unless labor is at the table.

Merle Geiger
General Chairman
Brotherhood Of Locomotive Engineers

It has indeed taken a real partnership to accomplish BNSF current policies, and that partnership has required a major education for those people who have to rewrite the agreements in order to address the fatigue issues in the rail industry. Everything that William Keppen mentioned in his second address that was recommended by the national group is in some fashion tied to a collective bargaining agreement.

I represent locomotive engineers on the former Burlington Northern, a territory that encompasses Seattle, Washington; Chicago, Illinois; Kansas City, Missouri; Denver, Colorado; and all places in between. I represent about 3,200 engineers on that property, and about 70 percent are in unassigned freight service, which is the reverse of most people in the transit industry. Many of these engineers protect service 24 hours a day, seven days a week, and most do not have rest

days.

The manner in which unassigned service employees work has remained essentially unchanged for about one hundred years. In that time, there have been only a few minor modifications. One such modification was a change in the hours of service from 16 hours per day to 14, which occurred about thirty years ago. It was later reduced to 12 hours per day, which is what it is today. A U. S. Department of Transportation hours-of-service comparison that I saw is very interesting. Commercial aviation has a monthly maximum of 120 hours; motor carriers, which are bus and truck carriers, have a monthly maximum of 260 hours; the U. S. Coast Guard, in port, has a maximum of 270 hours; U. S. Coast Guard commercial ships have a maximum of 360 hours; and locomotive engineers have a monthly maximum of 432 hours.

This reality and some very unfortunate accidents are what ultimately got both BNSF labor and management to realize that if they themselves did not address the issue of fatigue in the rail industry, then the Federal Government was going to step in and regulate the issue. Since both were fearful that this would result in something that neither wanted, they decided it was time to try to formulate a plan that would address this very serious safety issue. It definitely took a partnership between labor and management to address this issue properly. However, on freight carriers, the two groups have had a longstanding adversarial relationship. Unfortunately, many key employees in both rail management and rail labor were very comfortable with that historic relationship and, in fact, did not even want to change it.

To further compound the problem, many in management and labor were also very comfortable with the employee utilization system that, again, had basically remained unchanged for one hundred years. Some employees on both sides deemed that change was unnecessary and were actually adamantly opposed to it. However, there were others on both sides that realized that change was necessary and were ready to move forward.

The experience of BNSF indicates that Dr. Rosekind was directly on point when he stated that the two major obstacles to change are history and economics. As already discussed, the fact that the employee utilization system had been in place for one hundred years made change difficult. Management was also obviously concerned about any increased costs associated with change. One of these concerns centered around the idea that giving rest days to employees who historically had not had any would require more employees to do the same amount of work.

Certain people in management were fearful that any agreement intended to rectify fatigue issues would increase their budgets and, ultimately, probably cost them their jobs. However, it is not right to simply bash management because, unfortunately, labor had a lot more obstructionists than management did. Many on the labor side had concerns and strong objections to change. Many were comfortable with the way that they worked and were very concerned that required rest days were going to result in reduced earnings.

An episode from my life gives an idea of some of the problems on the labor side. I am a third generation engineer, which explains why the morning after I was elected local chairman in Portland, Oregon, in 1986, my father and three of his cronies from Pool Service came by his house on a visit. They came in for some coffee, sat down, and said that, while they were thrilled

that I was now their local chairman, I had to understand that I was not going to alter the way that they worked in Pool Service or I would be replaced with somebody else.

So, my own father told me that, if I changed the way that he and his colleagues worked, he would help remove me. Pool Service expected to double the road four days a week and triple the road three days a week. That is how they wanted to work, and that is how some of them still want to work. However, in the end, I did get it changed. It took ten years, and it did not actually happen until the year after my father had retired, but I did get that changed.

BNSF has been a leader in the rail industry in addressing the fatigue issue. Although they have been at it for several years, they know that they are still just at the beginning of the endeavor. There is a long way to go, but the railroad is starting to see changes for the better. The whole process has been a learning experience for both management and labor. Although some of the attempted projects did not work well for all of the employees on both sides, each of them has been a very valuable learning tool. As mentioned already at this symposium, one size does not fit all in the rail industry, and it is going to take a great deal of work to address the fatigue issue.

BNSF did find wins for both sides in some of its projects. For example, engineers who had never had rest days before now had them without any loss in earnings, which had been their main fear. They now had designated periods off, during which they could make plans with their families and, more importantly, rest. In fact, management found that employees with assigned rest days actually remained available for service to a much higher degree. For example, in a couple of BNSF projects, layoffs dropped from 30 percent daily to less than 2 percent. This meant that management could finally plan its workforce, which was something that they had wanted to do for years. And its fears of needing additional employees never materialized.

Improvements come in baby steps and it is very easy to become frustrated with the process. In fact, some of my colleagues have dropped out of the process due to the frustration level. However, this endeavor is too important to both sides for either of them to allow that to happen.

The rail industry as a whole must deal with the reality that major changes are necessary to address fatigue. Labor and management cannot continue to hang on to the old ways of managing and utilizing their operating forces just because it falls within their comfort zones. Instead, both must continue to look at new ideas. At times it may be necessary to move cautiously, but forward movement is continuously needed.

In the effort to address fatigue, the first thing both management and labor must educate themselves on is the obvious need for change and how these changes provide a safer and more efficient operation to both sides.

Questions For The Panel

Question 1: What types of policy changes are seen as beneficial to the industry?

Alan Lindsey, Director Of Safety And Rules, Burlington Northern/Santa Fe. The first thing that management must do is form a committee with labor that will review the current policies and agreements that impact fatigue. It must also realize that this is going to be a tremendously drawn-out process. In fact, it will likely take at least a year before the two sides trust each other enough to even start getting into the issues. Still, the very first step should be just having the two sides at the same table. The Federal agencies should also be invited into the discussions. The committee needs to look at which of its current policies are hindering forward movement, which is something that BNSF found very beneficial. Inevitably, management will come up with a list of certain policies and labor will come up with a list of different policies. The two will then have to argue it out as to whether each is actually a hindrance or not. This process has to be data driven. In fact, the BNSF committee has found that obtaining data agreeable to both sides has helped it more than anything else.

William Keppen, Consultant, Fatigue and Alertness. My organization has been involved with a great deal of collective bargaining agreements, and it is apparent that, at times, senior management or even middle management is a little bit less reluctant to put some of its policies under review. In order to build on this trust relationship, when policies come into question, the management team should, at the very least, agree to look at labor's concerns since the policies derive from collective agreements. Hopefully, this will happen one day soon. FAR has been offering to grant waivers on hours of service for several years. This has scared the heck out of many people, particularly in labor. Certainly, the public advocacy groups and safety groups have been really concerned about existing hours of service and anytime waivers were mentioned, they have raised a red flag. However, management would not be looking at changes in the hours of service if they were currently adequate. BNSF currently has an informal policy between labor and management that it is verboten to even talk about joining together and asking for any waivers on hours of service. This is true for all cases, even when it would be done in order to try a pilot project. However, doing it for such a project may not be that bad if it done is in a controlled environment and it is measured. Either way, it is one area that BNSF has not yet gone into.

Question 2: What kinds of tools could be useful to ensure that employees do not misuse additional time off? For example, what would be useful in preventing them from getting other jobs?

Dr. Dennis Holland, Director Of Alertness, Union Pacific Railroad. Education is one of the most important tools there is, which is why the Union Pacific comprehensive education program includes senior management supportive staff, families, and employees. Management looks at it as a dual responsibility. First, the company has an obligation to both provide the proper education to its employees so that they can understand the issues and to advocate for them. But once they have been educated, employees have certain responsibilities, too. Once families have been brought into the process and it is presented in a health and quality of life framework, it changes from an economic issue into a very important health and environmental issue. That is one of the reasons I advocate for the community. Union Pacific operates in many small

communities, and the high school students that we are teaching good sleep habits to today will be its employees in the future. So again, Union Pacific comes at this from a variety of aspects and includes all of the populations involved. Once there is fundamental understanding of what is needed, fewer aspects and populations will be ignored. Bad practices will not be completely eliminated overnight, but the more that fatigue is framed as a health and quality of life issue, and the more that a dual responsibility is accepted by both the company and the employee, the more success a property will have in dealing with the issue of fatigue.

Alan Lindsey, Director Of Safety And Rules, Burlington Northern/Santa Fe. One of the biggest concerns voiced when BNSF went to assigned days off was that people would get second jobs. However, I have not heard of that happening at all. Instead, according to company surveys, there has been an increase in planned family activities. I am not positive that I would know if an employee got a second job, but I have heard no reports of such behavior.

William Keppen, Consultant, Fatigue and Alertness. BNSF also saw an increase in the amount of sleep reported by employees, which was a primary objective.

Question 3: Did any of the properties increase the number of its people in order to protect its service?

Merle Geiger, General Chairman, Brotherhood Of Locomotive Engineers. The workers BNSF has addressed to assigned days off at this stage are its extra board employees who comprise about 30 percent of the workforce. In those arenas, BNSF has actually compressed the workweek. So while the workers have less time off between shifts, that missing time is taken and put into an increased amount of rest days. So, BNSF did not increase the number of its people to protect its service. It kept the same level of employees, but their time off was taken, compressed, and given back to them as rest days.

Question 4: Are there any policies that restrict people from moonlighting? Is doing so legal?

Alan Lindsey, Director Of Safety and Rules, Burlington Northern/Santa Fe. BNSF used to have such a policy, but it does not anymore.

William Keppen, Consultant, Fatigue and Alertness. Although the speaker is unsure about the general code, BNSF did, at one time, actually have a rule that required any employee that took a second job to have a conversation about it with his/her supervisor, whether it was appropriate or not. However, as Alan Lindsey said, it is now gone.

Question 5: If an employer had a good program to address sleep disorders, would sufferers come forward?

Merle Geiger, General Chairman, Brotherhood Of Locomotive Engineers. The fact that there are many employees with closet sleep disorders is a major concern for labor. However, they have not yet come to grips with how to address these employees without removing them from the workforce for 4 to 6 months without pay. Until this issue can be addressed, these people will remain in the closet.

Dr. Dennis Holland, Director Of Alertness, Union Pacific Railroad. Union Pacific is going to have a sleep disorders screening process pilot program with Dr. Moore-Ede. This required a lot of work up front. In fact, I spent an entire year leveraging my relationship with labor organizations, reinforcing that the program will be confidential, that it is being done for the health of the employees, and that no one will lose their job because of it. All of this was further reinforced through communications with the families of employees. In addition, a great deal of information was given to employees on sleep disorder screens. The result was that a number of employees came forward and said that they thought that either they or a family member had a sleep disorder. They wanted to know what they were supposed to do about it and were very straightforward. Management meanwhile made sure that both strict confidentiality and the idea that no employee would ever lose even a day's work were the bottom line in the program. When Dr. Moore-Ede came to Union Pacific to talk about the potential pilot, he met with some of the union leadership. As it turned out, not only were they very receptive to it, they also talked at length about how they had discovered their own sleep apnea issues. They spoke very freely about their problems and encouraged their co-workers to do something about it. So the bottom line for management is to spend a great deal of time with its employees and to make it very clear to them that it is important and it is confidential.

Question 6: What if an employee is diagnosed with sleep apnea and does not follow the prescribed treatment?

Alan Lindsey, Director Of Safety and Rules, Burlington Northern/Santa Fe. If BNSF finds that an employee who has been diagnosed with sleep apnea is not following the treatment, that employee, from a liability standpoint, is in a real bind. In many ways, we would rather not even know that an employee has gone to a doctor and is receiving treatment. However, as Merle Geiger said, BNSF is really struggling with how to do this. In fact, there have been a few occasions recently when management was made aware of the situation and had to take action. Management would prefer that the employees go to their private physicians, because of doctor-patient privilege. However, employees normally go to a sleep clinic since it is covered in most of their insurance policies. So there are a couple of smaller policies that BNSF needs to work on, since we are in a very awkward position when we know that there is an employee with a sleep disorder who is not getting treatment.

Dr. Martin Moore-Ede, President, Circadian Technologies, Inc. As will be discussed in more detail in the next session, 20 percent compliance relates to properties that do not have a special case management. In other words, if a property does not give a lot of support to its employees beyond the clinical diagnosis, such as helping them with equipment and equipment use problems, then it will get a very low compliance rate. However, in the experience of Circadian Technologies, the compliance rate can be brought up to 95 percent. This can be achieved over a 6-month period and last for the long term. Any company that knows that an employee with sleep apnea is not being treated has a duty to pull that person from service. There are no alternatives—it must be done. Managing confidentiality is always an issue, but the property has to do something about such a situation once it knows of it. There are ways of managing the whole issue, which will be discussed in the next session.

SESSION VIII: PULLING IT ALL TOGETHER

Dr. Martin Moore-Ede
President
Circadian Technologies, Inc.

I will discuss how to take the information provided by the science of alertness and fatigue and apply it to real world transit operations.

The mission of the transit industry is to transfer people from the highways onto trains and other transit vehicles. In terms of dealing with the issue of fatigue, this mission can be thought of in another way. It is to put 2,000 people who might be dozing off in their cars while driving to work onto a train where they can read the paper or snooze in their seats. However, all of their safety is then in the hands of one person, the locomotive engineer. So should not that person be 2,000 times safer than any one of those individual drivers on the highway? Should not his state of alertness be 2,000 times more of an issue than that of any of those highway drivers?

The mission in mass transit is not only to provide convenience, but, also, above all, safe transportation. Indeed, mass transit as an industry is incredibly vulnerable to public perceptions of its safety. This whole mission is undermined if operator fatigue is allowed to affect the operation of any train or bus. It is therefore sobering to think that some of these locomotive engineers or bus drivers may be on more challenging and fatiguing work schedules than the commuters on the highway. They may have to work split shifts or get up at 2:30 or 3:00 a.m. in order to commute into the city for a 4:30 a.m. run.

The issue then is how to bring fatigue management into the practical limitations of this demanding industry. At the same time, costs cannot be added because the operations are already subsidized. Subsidized operations face enormous political pressure to keep their costs under control. So in that context, the issue becomes how to use the science of circadian rhythms and biological clocks to actually make a difference in the safety level. Thus, the real focus of this address will be the steps that need to be taken in order to accomplish that.

I had the privilege of leading the team at Harvard that worked on the basic scientific discovery of human biological clocks and circadian rhythms. But as my career moved forward, I realized that a bigger challenge lay in taking the science and using it to obtain, not only measurable business and employee benefits, but also improved safety, efficiency, and health. In order to do this, two major steps have to be accomplished. First of all, an “alertness toolbox” of tools and methods must be created. The property must have the proper software, surveys, training programs, and other tools. The next step is to make the tools work. Implementing them requires significant changes of behavior, which takes time. These changes take concerted effort, but they are possible. The napping policies in the railroad industry and the process by which they came into place are a good example of that.

Over the last five years, there has been a radical change in the belief systems, policies, and behaviors of the transit industry. Still it takes time, and the process of implementing the tools is

even more challenging than the process of building the “alertness toolbox.” While there are many nice tools out there, they cannot simply be grabbed and made to work.

There are a large amount of tools available. There are fatigue assessment tools, software tools that estimate fatigue or alertness levels, workload analysis tools, and sleep monitor devices. There are also alertness planning tools, modeling tools, simulation tools, and various planning methods and designing systems. In addition, there are various educational programs and materials such as seminars, training sessions, publications, train-the-trainer programs, alertness management web sites, and scheduling software that processes data and conducts staffing level analyses. There are overtime policies, work/rest scheduling policies, and optimization tools. Finally, there are very specific countermeasures and polices, such as napping policies and sleep disorder screenings.

The bigger challenge by far, however, is implementation of these tools because it requires collaboration between labor and management. Neither side can put fatigue management into place by itself. Both sides must work together, which is often made difficult by their historical lack of trust. Although they should not even be on the bargaining table, the issues of work hours and staffing levels are invariably discussed there. Solutions to these issues are too often sought through labor negotiations. The problem is that while many of the solutions reached through these negotiations raise employee pay and lower company costs, they also raise company fatigue-related costs and result in long-term ill health and poor quality of life for the employees. Yet these negative results are often not attributed to the very negotiation that caused them. Another party must be brought to the bargaining table—the physiology of fatigue and stress management. If it is not brought in, it will be impossible to find a solution with long-term value. It is an optimization problem and if the physiological optimization is left out, then the right solution cannot be obtained.

So, how do properties do this? There are a number of steps that must be taken, and the order in which they are done is important. However, the most important thing is to at least start somewhere. If the property looks at the problem as a whole and feels that it does not have the resources, time, or people for such a huge effort, it will put it off again and again and nothing will ever happen.

GO Transit is an example of a property that started with baby steps. They show that small things that are done today will add up incrementally and create a real difference. The key in phase one is getting all of the various parties to buy into the program, and education is the key to accomplishing that. Employees and managers must be made aware of fatigue and how it is negatively impacting their goals. This process cannot be completed through the use of one video or one booklet. It must be an ongoing, consistent message that travels all the way from the top to the bottom of the organization.

GO Transit is a case study to which the attendees can relate. Richard Chorkawy and Greg Percy already gave an overview of some of the work GO did with Circadian Technologies to introduce an Alertness Management Program. It all started with a commuter train coming into Union Station, which is the downtown terminal in Toronto. The locomotive engineer had a lapse of attention and hit the back of another train. Although not much real damage occurred to either

people or equipment, the downtown law firms were well represented on the passenger list and their business cards were handed around. It eventually cost GO over ten million dollars just to settle the claims that had resulted from the incident.

The first step GO took was to develop a plan to address the risk of fatigue. Circadian Technologies started a consultation with the unions, which brought them into the discussion, and did a fatigue risk assessment of the train crews. Fatigue risk assessments can be done just through the analysis of duty/rest data. The files can be downloaded, a computer simulation done, and the fatigue risk benchmarked without even consulting the union. This can be done very inexpensively and efficiently, and it will show the property where its hot spots are.

Fatigue is not just spread evenly across organizations. Instead, there are little pockets of fatigue that require special attention. It is important to find out where those areas are because the property can then focus resources, which provides a big cost savings. Properties should not try to institute a blanket program or tackle everything at once. Instead, they should try to locate the hot spots of fatigue.

GO did a fatigue risk assessment, and Circadian Technologies documented both the extent of the problem and where it was occurring. After compiling the data, Circadian Technologies shared the results with management and the union together in a workshop. There the data was intensively analyzed and probed, and a series of planned fatigue countermeasures was developed.

Circadian Technologies then moved to crew scheduling feasibility and studied how we could reschedule the commuter rail train crews. We set about optimizing the rescheduling of the crew schedules by first implementing the schedule and lifestyle education. Education workshops and seminars were used to educate the GO workers and to get them to buy into the program. These were designed to build awareness and to involve managers, union leaders, and representative employees.

Any property has to start with union leaders in order to be successful. Circadian Technologies conducts a great deal of one-on-one discussions with them and reassures them that the goal is not to cut pay or to reduce quality of life. In these discussions, it is vital to address how fatigue management improves quality of life, personal safety, and personal health, and how it enables employees to deal with issues about which management hears complaints every day. At the same time, there has to be the same one-on-one discussions with the managers. And representative employees must be brought in because the opinion leaders should be brought in regularly.

Circadian Technologies gathers data from interviews with managers and employees, and then starts to build the initiative. We also send to the homes of employees monthly newsletters, which contain objective authoritative advice that is sensitive to labor-relations issues and that provides an education. To support these endeavors, Circadian Technologies now has a fatigue management web site, which has information about all of the various sleep problems and solutions. The web site address is *GoodSleep.com* and it provides education awareness around the clock for people who live an around-the-clock lifestyle. Interestingly, it is often the spouse

who hacks around on the web site and gathers information for the employee.

On this web site, users can be typed according to their sleep personality on four different scales. These scales are fixed sleepers versus adaptable sleepers, larks versus owls, nappers versus consolidated sleepers, and short sleepers versus extended sleepers. For example, some people have sleep/wake patterns that are relatively fixed. They wake up at the same time everyday, whether it is the weekend or a weekday. On the other hand, some people can move their sleep around fairly freely, and, hence, are “adaptable.” The sleep and fatigue management advice needed by these two types is quite different. Some people are early morning types who get up at 4:00 or 5:00 a.m. of their own volition, some people are late night types, and the rest lie in between the two. A person can be anywhere along the scale between the “larks” and the “owls.”

While some people can nap, others are unable to do so under any circumstances. Therefore, a property cannot have a fatigue management policy where all employees have to nap, because it does not suit everybody. Some people are naturally short sleepers, while others are naturally extended. Neither sleeping for six hours nor sleeping for nine is necessarily a bad behavior because both can be normal. What is important is that each person gets the right amount of sleep.

The fastest way to turn people off when giving them advice is to give them some that does not quite fit their circumstances. Telling an extreme morning person who spontaneously awakes fresh and alert at 4:00 a.m. everyday to sleep in until 7:00 a.m. is not good advice. It would just frustrate that person and would cause mistrust of the advice giver.

The next major component of starting a program is quantifying the problem through the use of a fatigue risk assessment. Sometimes, organizations already realize they have a problem, so they do not want to spend money on a fatigue risk assessment. Instead, they simply want to implement some solutions. That can be fine, but if they want to find out where their hot spots are, where their points of risk are, and who is at risk, or they want to focus their resources on key problem areas, then a fatigue risk assessment can be of help.

For example, at GO Transit, Circadian Technologies uses special wrist activity monitors, which use motion detection to record when each operator is awake and when or asleep. With each subject wearing the devices 24 hours a day, it can measure exactly how much time they are awake and when they are awake to the nearest minute. It can also measure exactly how much sleep the subjects are getting, and can get some information about the quality of their sleep. Circadian Technologies can then use this information to construct a chart to indicate what sort of problem the person working on a given schedule has.

Over the course of four weeks, Circadian Technologies typically records the times of day that sleep occurs. As an example, one employee was monitored going to bed at about midnight every night, waking up at about 8:00 a.m. every morning, going to work at about 1:00 p.m. five days a week, and having the weekends off. This sleep pattern was absolutely consistent. Work never intruded into sleep, except for one late run. If every worker lived like this, there would be no need for this symposium. Unfortunately though, some of the workers monitored had highly irregular patterns of sleep.

When an employee works erratic hours, a number of things stand out. First, that employee earns more than an employee with the consistent hours. Second, the employee is much easier for managers to cope with because he will work overtime and fill any gap. Therefore, crisis managers prefer this type of employee to ones with stable sleeping patterns.

On the other hand, the fatigue risks associated with an employee with high overtime and an irregular schedule are far higher than the risks with other type of employee because of the lack of regularity, the lack of predictability of sleep patterns, and the lack of recovery opportunities. He never has enough opportunity to catch up on sleep. His nocturnal schedule is also a problem, as it causes poor quality sleep.

On a split shift schedule, the sleep pattern is invariably truncated because the split shift workers do not voluntarily go to bed earlier. Instead, they tend to live their normal social life, and they tend to go to bed at more or less the same time as when they are not working a split shift schedule. So their actual amount of sleep is quite truncated, since they get up at 2:00 or 3:00 a.m. to go to work and run the morning rush-hour shift. After this they have a break, during which they may or may not nap. Either way, they go back into work again for some more runs.

What is very interesting is that when the time of sleep during the weekend days was recorded, it actually coincided with the time of work during the workdays. This is not reassuring at all as on the weekends, the bodies of split shift workers are actually telling them when they would like to get sleep. So the level of alertness for split shift workers during the morning rush hour tends to be lower than it is in the afternoon or evening rush hour. This is the opposite of people who work from 9:00 a.m. to 5:00 p.m. who get sleepier in the afternoons.

So what can be done with this information? Circadian Technologies has developed some software tools that can take that data and actually convert the sleep/wake patterns into predicted alertness levels. Although there are a number of models available that have modeled sleep and alertness patterns from research laboratory data. Circadian Technologies has recorded 10,000 days worth of the work of North American transportation employees and measured their alertness in order to calibrate our Circadian Alertness Simulator (CAS) program.

So, Circadian Technologies did not calibrate the CAS program against lab data. Instead, it calibrated it against real live normal people who actually operate vehicles and trains in the transportation industry. We can now convert any work/rest history into a pattern of alertness.

The CAS output chart is divided into different zones. The first zone represents the times when the subject is wide awake. In that state, he could not fall asleep even if he tried. The very middle of the middle zone represents the alertness level of the subject when he is about to go to bed at his normal time. At this alertness level, the subject can easily choose to postpone sleep. The last zone represents the times when the subject is actually fighting sleep. At that critically low alertness level, the subject has to actively do something just to stay awake.

Circadian Technologies can get a month's worth of work/rest data from time and attendance

records, payroll, or crew-calling systems, and convert it into a fatigue risk for the entire population. Using this, we can then benchmark any organization against any other. Generally, we prefer to use a pool of comparable companies in fatigue risk calculations, so that we can then benchmark any company against only companies comparable to it. The CAS provides a Fatigue Index that runs from zero to one hundred. On this scale, a person who works a standard 9:00 a.m. to 5:00 p.m. day job and sleeps eight hours every night would score about four or five.

In my life, I had a personal experience with the other extreme. When I came out of medical school, my first job was as a surgical intern in an operating room. To my shock, this job called for me to work 36 hours straight on duty with only 12 hours off before another 36-hour shift began. During this time, I found that I would nod off in the operating room and write prescriptions that I could not make sense of the next day. This experience actually got me more interested in fatigue than surgery, and that is where my career in fatigue research and consulting began.

Recently, Circadian Technologies, which, by the way, never mentions the name of any of its clients unless given permission, surveyed a famous Boston teaching hospital. We found that their surgical interns, on average, scored 93 on the CAS Fatigue Index scale, which was completely consistent with my experiences.

When a person is so highly fatigued, sleep becomes their all-consuming need. In fact, it has been documented that even people in the middle of a firefight on the battlefield have lain down and slept when they reached a certain level of fatigue. Obviously, there is a certain point where sleep is more important than anything else.

A look at GO Transit's Fatigue Index scale is instructive. As might be expected, the split shifts were high on the fatigue risk scale, while the non-split shifts did not look like a very challenging situation. However, the most interesting information was not in the mean scores, but in the distribution of the Fatigue Index scores for all of the individual employees. The problem was that while there was a relatively low Fatigue Index mean value, there was a trailing edge of higher Fatigue Index scores. So the fact that passengers could climb on a train with one of the high Fatigue Index score people at the controls was a real danger.

Circadian Technologies also looked at absenteeism at GO. One of the biggest staffing problems in industry is sick leave absenteeism. Those can be lumped together because, quite frankly, an employer cannot tell the difference between somebody who is sick, somebody who is having a mental health day, and somebody who is absent for some other reason. The only data that supervisor can believe is whether employees are there or not. For GO, Circadian Technologies found that 76 percent of the absenteeism, adjusted for the number of people in each job, was on the split shift job versus the day job or the afternoon job.

The sickness/absenteeism problem led to the calling in of extra board employees; those with the most erratic schedules. So in other words, whenever an employee was sick/absent, the person who replaced that person had a far worse sleep/wake pattern and was far more fatigued.

Now that Circadian Technologies had the data on the extent of the problem, we had to decide

what to do with it in order to create a buy-in and a sense of direction. We realized that we needed to start first with GO senior management because they controlled the budget and thus the mission. They had to make a decision on what they wanted to do and had to have the commitment to support the process.

After this, Circadian Technologies needed to quickly bring in the union and share the data with it while still protecting the confidentiality of individual employees. We next had to jointly develop an alertness management plan that functioned 24 hours a day, seven days a week, as well as the commitment and buy-in of both the union and management. All of that took a great deal of time. Once Circadian Technologies had the necessary buy-in, the next stage was to look at restructuring the crew scheduling assignments. We wanted to find a way to lower the Fatigue Index scores of the relatively high-risk, fatigued people, who were the outliers in the trailing edge of the distribution.

Because we were dealing with economic and business realities, labor relations, and sociological realities, Circadian Technologies had to define a set of boundary conditions. The first was that there was a customer demand, since the people of Greater Toronto wanted more commuter rail service. The second was that Greater Toronto was not going to write a bigger check. This was a constraint that had to be taken into account. The third condition was that only a limited number of train sets were available. A fourth boundary condition was that there was a big bottleneck getting trains in and out of Union Station at rush hour because everyone wanted to arrive at 8:08 a.m., not 6:08 a.m. or 10:08 a.m. A fifth condition was that there had to be a certain amount of maintenance time and refueling locations. A last condition involved employee fatigue risk and safety tolerance. Circadian Technologies and GO could not go for 100 percent avoidance of fatigue, but they were also not going to accept the current situation. So they had to figure out what was feasible to achieve.

The conclusion from the analysis was that the requirement for expanded service provided an opportunity to redesign crew schedules. Circadian Technologies got GO Transit, the BLE representatives, the CN engineers who were operating the trains under contract for GO Transit, and the CN staff all on board to ensure that fatigue was minimized and that safety was improved. It was also critical that operational efficiency be maintained and that the personal needs of the crews were integrated into the solution.

Existing crew jobs were protected, as part of the commitment made to the union was that no workers would be eliminated as part of the process. The Circadian Technology plan was to improve GO crew work schedules, fatigue awareness level, safety level, and quality of life, to minimize GO split shifts and to achieve an optimized result.

Circadian Technologies looked at all of the GO schedules. We then used our crew scheduling optimization software to balance the fatigue score for every employee, the work load score of every job, the hours per week worked, and the pay earned. Basically, we undertook an optimization exercise in order to obtain the best possible solution.

The end result was that Circadian Technologies was able to convert the distribution of Fatigue Index scores from a range of 5 to 76 to one of 5 to 20. In other words, we virtually eliminated

fatigue risk. It did not achieve this by adding more trains. Instead, it found that there were some people who were holding onto the plumb high alert jobs. So, it restructured the schedule so that they were forced to give up some of their reserve of alertness in order to reduce the excess fatigue in some of the other jobs.

This process was not easy, however. For one, Circadian Technologies could not do away with seniority. That was not even a discussion point. In fact, we had to get the permission and support of the senior people in order to implement any type of rescheduling. That is why properties have to work so long on this process.

Circadian Technologies is now moving onto other fatigue issues at GO Transit. For example, it is looking at the extra board issue, and the potential of building a special extra board that avoids an erratic pattern.

Mark Rosekind has already talked about obstructive sleep apnea, which is a big problem in the transportation industry. The cessation of breathing in sleep, the constant fatigue, and the increased risk of accidents associated with apnea make it a critical issue.

In solving this issue, it needs to first be recognized that most people will not voluntarily come forward and tell their employer that they have sleep apnea. Most employees do not want their employer to know that they are at a two to three times larger risk of an accident than their coworkers.

Circadian Technologies has found that encouraging employees to come forward behind a confidentiality wall works. Working as a neutral third party, it is given the names and addresses of all safety critical employees. It then sends a survey to their homes, which enables both it and those employees to identify their risk level. Circadian Technologies then arranges for the individuals identified to be at risk to have an overnight recording in a sleep lab and to obtain a diagnosis. Once the sleep doctor has diagnosed the sleep disorder, Circadian Technologies helps the employee get the appropriate treatment, follows up with that person, and provides the outcome results, to the company with patient anonymity protected.

The key to this process is individual counseling. Circadian Technologies has a bank of telephone counselors who individually “hand hold” each employee identified at risk through the process since the employees often are unable to successfully navigate the health care system on their own. In some cases, Circadian Technologies may even have to educate an employee’s doctor on sleep disorder management. And we often have to deal with the insurance companies of these employees.

Circadian Technologies has now done this sleep apnea screening and treatment process for employees at a wide variety of railroads, including 10,000 at Conrail and thousands of people at CSX. It is currently launching into UP and is also working with Amtrak.

The CPAP positive airway pressure system that is used to treat sleep apnea keeps the airways open. It is a miraculous cure. Its effect is noticed either within a day or two or very soon thereafter. It is unlike conditions, such as high blood pressure, where a difference cannot

personally feel it. Instead, the sufferer can instantly tell the difference when CPAP is working.

However, there are still problems with the CPAP system, such as masks that do not fit and suppliers who provide the wrong equipment. So people need to have their hand held through this process as well, and that is the real secret. If an organization stays with its people and solves their problems with them, then they will get 95 percent compliance six months later. It is the difference between long-term success and failure.

So it is clear that the science of alertness and sleep can be moved into practical application in transit operations where it can improve safety and employee quality of life. But in order to do this, the property must first get started somewhere, even if it is only by taking a baby step.

Some of these baby steps can be taken by the property itself, such as undertaking a fatigue risk analysis, providing an educational program, and interviewing its operators and managers for their ideas on the issues. It is even better if the property can find someone who has done it before a few times to help it through the baby steps. Circadian Technologies has found that companies often do some things themselves, and that they often have outside support to do some other things. Circadian Technologies will work with a property any which way that is required, but the property must get the ball rolling.

The attendees of this symposium should bring this message back to their organizations. They must start building a buzz, to start building awareness, and to start making people understand what the possibilities are. They need to ensure that their colleagues realize that this is not just a simple safety issue, but, instead, a core operational issue that affects the performance of the whole organization.

SESSION IX: SUMMARY/NEXT STEPS

Greg Hull
Manager, Operations Safety and Security
American Public Transportation Association

I plan to work with the attendees to bring closure to some of the issues that have been discussed at this symposium and that should be brought forward. Nobody wants these issues just hanging in the air. Instead, all transportation professionals want to do something about them and bring them to some constructive conclusion. There were some highlight comments made about different issues at this symposium that transportation professionals need to be conscious of as they map out a future direction for themselves.

In her address, Jolene Molitoris stated that transportation professionals should consider expanding the NARAP program into a NARAP concept by building it into a broader base for transportation and by including transit into it.

Bill Millar, President of APTA, stated in his address that the transportation industry must be challenged if it is going to find the courage to change.

Bob Lauby of NTSB, encouraged the attendees to include fatigue countermeasures in their system safety programs and audits. Dr. Mark Rosekind indicated that as they look at developing whatever program it is that they choose, the attendees should try to include in it education, research, scheduling, strategies, healthy sleep, design and technology, policy and regulations, and scientific guidance.

GO Transit delivered a strong message saying that the attendees should not delay and should learn from the best practices in other industries.

The American Trucking Association urged transportation professionals to encourage the government to give greater support to the funding of training.

Anita Rothblum and Steve Klejst delivered the message that transit professionals need to start including fatigue parameters into their incident and accident investigations.

Drew Dawson raised a number of points. First, despite the fact that the effects of fatigue are comparable to alcohol impairment, little funding support is directed to fatigue and alertness. Transportation professionals should not regard safety as a negotiable item. In addition, it should be remembered that safety issues involve not only operators but people in management also. So simply providing a course or a training program will not solve the issue. Instead, a cultural change must take place.

During the course of this symposium, speakers also pointed out that self-regulation is much more effective than regulation, that there is a need to understand the dangers of prescription and over-the-counter medications, and that there is supportive research data available that must be used. It

was also stated that sleep disorders are more prevalent than the attendees realize, that educational outreach needs to include the families of employees, and that education is critical for enacting policy and organizational cultural changes.

An oft-repeated message heard at this symposium was that labor must be involved if efforts are to be successful. This came not just from senior level speakers, either. It was noted by a few speakers that the biggest challenge is to overcome history and economics. One of the last messages delivered was that everyone must get started as soon as possible.

With that overview as food for thought, I am looking for input from the attendees. In addition to the comments in the addresses, what other issues and processes would you like to see pulled together to help give future direction?

Audience Participants

Comment 1: As planning is undertaken for a subsequent conference, there should be good lead time so that other people within transportation organizations, especially labor people, can be included.

Comment 2: There was a strong emphasis on the rail industry at this symposium but there is interest in looking at bus operations as well, especially since bus operations account for over 60 percent of all public transportation.

Comment 3: While there is a greater sense of awareness about fatigue and alertness in other modes, this same sense of awareness has not yet been developed in bus operations.

Comment 4: On the continuum of whatever progress has been made to date, bus operations are at the beginning stages.

Comment 5: The transit industry needs to include causal data in its accident and incident investigations, including, of course, fatigue parameters.

Comment 6: Transportation professionals need to reach an agreement on common terminologies. They also need to ensure that information gets out, particularly to bus operations, on the significance of the issues of fatigue, alertness, and labor.

Comment 7: As transportation professionals address these issues in their industry, they need to look at ways and means that are cost effective. Obviously, a more cost-effective action would lead to a more immediate buy-in.

Comment 8: On the napping issue, more information should come forward as to what effective policies have been developed to assist organizations that are addressing the issue of legal napping. Also, there needs to be some information on whether there are gender differences in fatigue and alertness issues that need to be addressed. If there are such differences, then organizations need access to this information.

Comment 9: A format should be developed whereby information pertaining to these issues could be accessed. Also, a model that could help determine costs associated with the implementation of a program should be developed.

Comment 10: An assessment procedure should be included at the next symposium, as it would be beneficial to have a methodology by which the transportation industry deals with the issues brought forward here.

Comment 11: Conferences of this nature should be spread around the country, so that there is greater exposure of these issues throughout the various regions. Also, the conferences that APTA organizes should place more emphasis on these issues.

Greg Hull, Manager, Operations Safety and Security Programs, American Public Transportation Association. To the latter point, in the last year-and-a-half, APTA has had sessions devoted to this issue within all of its conferences. However, APTA can certainly benefit from the input of attendees, and it can also look at how it can be more constructive in what it is delivering.

Audience Participants

Comment 12: Transportation professionals cannot simply go blindly into some of these issues within their organizations as they develop a programmed approach. They have to think very carefully through the processes they want to see in place. As they look to develop an industry-based approach to dealing with accident investigation, follow-up, and training, they need to be aware of all of these issues.

Greg Hull, Manager, Operations Safety and Security Programs, American Public Transportation Association. There is a research project that has just gotten underway through the Transit Cooperative Research Program to develop a fatigue toolbox for the transit industry. Bill Millar will discuss this further in his address.

Audience Participants

Comment 13: The industry should consider development of a consortium to address these issues.

Comment 14: In building a consortium to address these issues, there should be a low-cost buy-in, so that, at least from a cost perspective, a greater level of participation can be encouraged. This symposium has shown that there are some very cost effective ways of addressing these issues.

Comment 15: If a program is developed, it should be piloted at a bus operation, and a number of things should be addressed within it.

Greg Hull, Manager, Operations Safety and Security Programs, American Public Transportation Association. The staffing of operators is certainly a big issue throughout the country. It leads to the dilemma in a lot of transit systems of requiring operators to work more hours than desirable in order to be able to put out the desired level of service. At the same time, there are absenteeism issues, which need to be tackled through better models of scheduling and staffing.

Audience Participants

Comment 16: From a liability or a legal perspective, transportation professionals need to be aware of what the consequences are of using certain databases or data when they implement a program.

Greg Hull, Manager, Operations Safety and Security Programs, American Public Transportation Association. It is interesting that a number of legal firms registered for and are attending these sessions. Obviously, the issues of fatigue and alertness are of great concern in the legal community as well.

Audience Participants

Comment 17: Transportation professionals can mitigate punitive damage risks if they can demonstrate that they are using best practices and, of course, exercising due diligence.

Greg Hull, Manager, Operations Safety and Security Programs, American Public Transportation Association. All of this participation and feedback has yielded quite a bit to work with. This use of audience participation was designed to gather the essence of some of the critical issues, as well as a sense of the direction that transportation professionals want to move.

**William Millar
President
American Public Transportation Association**

I want to thank Hiram Walker and the FTA for taking a leadership role in putting this symposium together. The quality of the speakers has been excellent. Hopefully, this and other similar efforts will result in transportation professionals feeling more confident about taking ideas back to their properties and organizations on how to take the crucial first steps. A couple of speakers talked about the importance of simply doing something to get started, and the speaker is in full agreement with that.

It is a learning situation, though and, as several of the attendees indicated in their questions and comments, there is some nervousness. Yet, while nobody wants to do the wrong thing, there is enough knowledge out there now so that things can be designed properly and good results can be obtained. APTA is both committed and prepared to work with the other stakeholders involved in this issue. This includes not only the obvious ones, such as DOT, the NTSB, and organized labor, but any of the stakeholders that are involved.

During this symposium, I noted to myself that perhaps I should be working at the international and national level with the ATU, the UTU, and some of the unions that represent the majority of transportation industry employee. It would be useful to see what their thinking is on these issues, and on how the industry as a whole might proceed. Inside APTA, the members believe it is this collaboration that is going to be important. We are thinking about perhaps putting together a formal pass group on this issue as opposed to leaving it to other committees. However, as we think that through, it is important that a wide variety of the interests inside APTA get involved.

Regarding the comment about legal implications, APTA has a Legal Affairs Committee, although I do not know where fatigue and alertness issues are on their agenda. However, they will have a seminar in February 2001, and there is no reason why I cannot work with their program planning committee to get this issue on their agenda, if it is not actually already there.

Many of the attendees have been involved in many of the bus operations committees over the years in APTA. So, maybe that is one of the areas where APTA needs to work with its leadership on identifying the most important issues. Since the target audience for this conference really was not those people at the senior management level, it is very important that the attendees go back to their properties and raise these issues with their general managers. This is especially true for those attendees whose properties are APTA members, because then their general managers can communicate that this is an important issue to the voluntary leadership of APTA. Although I already knows this, it is helpful if the people I report to feel that this is an issue that APTA ought to undertake. In fact, the APTA executive committee is willing to consider special efforts connected to the issue of fatigue if they hear from the members that the efforts are important.

If the attendees have ideas for research projects, the Transit Cooperative Research Program may be of great use to them. The projects conducted under its auspices are intended not to be long-term, multi-year deals, but instead very practical things that need to be done most. In fact, this is a launching pad for much of the content of the toolbox that Greg Hull mentioned. The development of a transit toolbox was put in the research program for 2000. That contract has now been let to Foster-Miller, Incorporated in Waltham, Massachusetts. It is expected that it will take about a year to put it together, but the toolbox is intended to help evaluate the risk for each level of fatigue, to give guidance on developing an awareness program for fatigue, and to begin to pull together strategies that might be practical in the transit industry.

So, that effort is proceeding, but there may be other projects too. For example, research money could be used to transfer an idea from another industry to the transportation industry. Anyone can submit an idea to the Transit Cooperative Research Program for research, and it particularly encourages people from transit agencies to do so because it was originally designed to deal primarily with operational issues faced by transit agencies. This program is a joint effort by FTA, TRB and APTA. If the attendees need more information on it, they can either get it off the APTA web site or contact APTA or FTA.

Some of the attendees participated in an APTA survey on these issues that was conducted over the last year. The Human Factors Committee of the Rail Safety Committee took the lead in putting together this very comprehensive survey. It got a response rate of about 40 percent for a 16-page detailed survey, which was quite high. We hope to finalize it by the beginning of 2001 so we can publish it. It will be interesting to see if the survey indicates that bus operators really are not as far along as the rail operators, which was the sentiment of several of the comments to Greg Hull.

It was mentioned that there should be more sessions at APTA meetings, but what should the focus of these sessions be? Again, APTA needs the input of transportation professionals. We need to know if the sessions should be centered on the basics and the fundamentals, or if transportation professionals are ready for things to be taken to the next level.

The planning committee for APTA's Bus and Paratransit Conference, which will be held in Calgary in May 2001, is scheduled to meet in early December 2000. One commitment I will make, in line with what I have heard at this symposium, is to get some sessions on fatigue included there, if they have not been included already.

Transportation professionals also ought to make better use of other APTA communications techniques, such as *Passenger Transport*, which is our weekly newspaper. APTA would certainly welcome articles on the successes, lessons, or problems that properties have had in this area. Also, APTA could focus, periodically, on these issues in *PT*.

Modern technology must be utilized as much as possible. In fact, if APTA does not already have a list of napping policies for its members on its web site, it will set one up now. Posting information on web sites is an excellent way to disseminate it to colleagues and other interested parties as it does not require any travel. It does require some knowledge of computers, but almost everybody in the transportation industry now has access to the Internet.

So, those are some clear ideas on things that transportation professionals can do. APTA certainly wants to continue to partner with FTA, as it is very important that they work together and with the other stakeholders. We also want to encourage labor/management partnerships in this area all around the country. If one lesson has been learned at this symposium, it is that things work better, ideas bubble up faster, and more progress is made when there is collaboration between management and employee representatives.

There is no shortage of things that should be done. This has been a great symposium, but how important it actually has been will depend on what is done with it.

Chairperson Hiram J. Walker
Associate Administrator for Program Management
Federal Transit Administration

As the Alertness 2000 Symposium comes to a close, I want to commit FTA to working collaboratively with the transit industry, labor, and other government agencies on alertness and fatigue issues. FTA has not been as active in the last six months as it would like to have been, and it has not had a safety director since Judy Meade retired to the consulting industry about six months ago. However, we have now selected Harry Saporta from TriMet in Portland, Oregon as our new Safety and Security Director. He will be reporting at the end of November 2000. Once he arrives, FTA should be much more involved with fatigue issues on a national scale.

Several speakers mentioned that Administrator Molitoris challenged the transit industry to join the North American Transit Alertness Partnership. FTA can accept that challenge and will join. There were also comments that the system safety program plans did not address fatigue to the extent that they should. FTA will do this by inserting the proper requirements during its revision of its state safety oversight rule. We will also make sure that this is done for the bus industry by including it in the bus safety project it is about to launch. Bus safety will be focused on in a more active and aggressive way in the next year.

In the last year for the first time, FTA held four drug-and-alcohol abuse seminars around the country. During the next year, we will be holding four more of these seminars, but they will be expanded to include alertness and fatigue issues, sleeping disorders, and a number of other such things.

Lastly, FTA is revising its National Transit Database to include safety data and causal factors. Once that revision is made, we hope to have more information on the cause of accidents. This is a very important initiative for FTA.

I think that transportation professionals have come a long way in the last two years. The speakers at this symposium were very impressive, and it went very well.

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4. *An Annotated Literature Review Relating to Proposed Revisions to the Hours-of-Service Regulations for Commercial Motor Vehicle Drivers*, November 1999, Publication No. DOT-MC-99-129 (available at <http://fmcsa.dot.gov>). This report provides some of the extensive body of scientific research concerning hours of service, operator performance, and highway safety outcomes to those who have an interest or a stake in the Federal Motor Carrier Safety Administration (FMCSA) development of new hours-of-service regulations. It consists of a synopsis of over 100 research studies and other documents that the FMCSA obtained from researchers in the U. S. and overseas, including many that were provided by commenters to Departmental Docket OMCS-97-2350 and by members of a Scientific Expert Panel that provided consulting services to the Department in 1998.

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Plain Language About Shiftwork, Rosa, Roger R., and Michael J. Colligan. U. S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Report No. 97-145, July 1997 available at <http://www.cdc.gov/niosh/pdfs/97-145.pdf>. What are the hazards? Sleep after night work is usually shorter and less refreshing or satisfying the sleep during than normal nighttime hours. Many workers cannot avoid night or rotating shift work.

GLOSSARY OF SLEEP TERMINOLOGY

Automatic Behavior Syndrome (ABS). Automatic behavior syndrome is a state of fatigue in which we are essentially sleeping with our eyes open. While able to perform simple or familiar tasks, we are unable to respond quickly to more critical tasks and situations. In sleep lab studies, participants who experience ABS show brain waves characteristics of sleep. (*Transportation Safety Board of Canada*)

Acute Sleep Loss. This type of fatigue is associated with physical or mental activity between two regular sleep periods. (*Transportation Safety Board of Canada*)

Advanced Sleep Phase. *See Phase Advance.*

Alertness. The optimal activated state of the brain. Without alertness, there can be no attentiveness, and without attentiveness, performance is affected. Selection, training, and motivation are ineffective if the human brain is not alert. Alertness is a dynamic state and may vary from second to second. When people are alert, they have a better awareness of what is happening around them and are able to think and take action. (*Transportation Safety Board of Canada*)

Alpha-Delta Sleep. A type of sleep during which the EEG shows a mixture of alpha (awake) and NREM (asleep) waves. Alpha-delta sleep is often nonrestorative, leading to malaise upon awakening.

Alpha-Delta Sleep. A brain wave pattern seen in relaxed wakefulness, characterized by 8- to 12-cycle-per-second.

Antidepressant. Anything that counteracts clinical depression.

Apnea. A pause in breathing that lasts ten seconds or longer. A person with the sleep-apnea syndrome has many apneas during sleep.

Arousal. *Partial* arousal is a change from a deep stage of NREM sleep to a lighter one. *Full arousal* means awakening. During an arousal, your EEG changes, your muscle tone increases, your heart beats faster, and you may move.

Awake. A state in which brain waves are of the alpha or beta patterns or random low-voltage fast; also known as fast EEG. The person is conscious and aware of the surroundings.

Beta Waves. Usually associated with alert wakefulness. They are faster than alpha waves, cycling about 13-35 times per second.

Biofeedback. A technique using instrumentation to provide moment-to-moment information about body processes that a person normally is not aware of so that he or she can learn to control them. It may be used to teach a person to regulate muscle tension, heart rate, blood pressure, blood flow, skin temperature, and the activity of the gastrointestinal tract, among other processes.

Biological Clock. Also referred to as our internal clock or circadian clock, our biological clock is a group of nerve cells located in the brain which regulate the precise timing of body functions, including daily cycles of alertness and sleepiness. The biological clock sustains circadian rhythm. Studies have identified major characteristics of our biological clock:

1. It is an internal physiological system that measures the passage of time; it is not a passive responder to environmental cues, although it is affected by external cues, such as light and dark.
2. It has its own daily cycle length, which is close to, but not exactly, 24 hours.
3. When exposed to normal environmental clues, such as the day-night cycle, the organism adapts to a 24-hour day.
4. When cues of the normal day-night cycle are not available, the organism's own internal cycle length determines its cycle. (*Transportation Safety Board of Canada*)

Cataplexy. A sudden attack of complete or partial muscular paralysis, usually precipitated by a strong emotion. Cataplexy is usually a symptom of narcolepsy.

Chronic Insomnia. A complaint of insomnia (*see Insomnia*), which occurs on a regular basis for a prolonged period of time; e.g., greater than a month.

Chronic Undersleeping. This type of fatigue refers to sleeping less each day than one's biological need for sleep. Chronic undersleeping can lead to cumulative sleep debt. (*Transportation Safety Board of Canada*)

Chronobiology. The science of rhythmic functions in living things.

Chronobiology. That branch of science that studies rhythms of life that are an outgrowth of biological systems. Chronobiology is based upon repetitive measurement of naturally occurring physiological phenomena. (*Transportation Safety Board of Canada*)

Circadian Disruption. Disturbance of the circadian rhythm. Circadian disruption can result from transmeridian travel, irregular work schedules, or failing to get adequate sleep during the night. It can lead to difficulty sleeping at appropriate times, problems maintaining alertness, and fatigue. The body will adjust, but slowly. Adjustments can be very complex because, although experts often speak of the circadian rhythm, there are actually several circadian rhythms, and they do not necessarily adjust at the same rate. (*Transportation Safety Board of Canada*)

Circadian Rhythm. An innate, daily fluctuation of physiological and behavioral functions, including sleep and waking; generally tied to the 24-hour light and dark day-night cycle. The innate periodicity usually is not exactly 24 hours, hence the prefix *circa* (meaning about).

Circadian Rhythm. Over time, the daily cycle of light and dark has become hardwired into our brains in the form of a biological clock. This biological clock controls various chemical and neurological systems which affect sleep, eating, digestion, and other essential functions. One of the most important features of circadian rhythms for safety is that people are programmed to be awake during the day and asleep at night. We do adjust to new schedules, but slowly. The night worker who reverts to daytime activity has to begin the adjustment all over again when he/she return to work after a couple days off duty. (*Transportation Safety Board of Canada*)

Cognitive Therapy. A form of psychotherapy based on the idea that a person's emotional responses are influenced by thoughts and behavior. The therapist works with the patient to change maladaptive patterns of thinking.

Conditional Insomnia. A form of chronic insomnia caused by the development during an earlier experience of sleeplessness of an association between characteristics of the customary sleep environment and arousal.

Delayed Sleep Phase. *See Phase Delay.*

Delta Sleep. The time of deep sleep marked by large, slow EEG, waves called delta waves, when most bodily recovery is believed to occur. Delta sleep includes both sleep stages 3 and 4. Most delta sleep occurs during the first 90 minutes of sleep. The amount decreases with age.

Delta Waves. EEG waves occurring chiefly in delta sleep; also known as sleep stages 3 and 4 or slow-wave sleep. Delta waves cycle one-half to two times a second.

Dyssomnia. A disorder involving the amount and/or timing of sleep, such as insomnia, excessive daytime sleepiness, or circadian rhythm disturbances.

Entrainment. A process of synchronization whereby the intrinsic 25-hour cycle of the human biological clock is automatically reset forward by an hour each morning by the light of dawn so that it adapts to the 24-hour schedule of day and night. (*Transportation Safety Board of Canada*)

Excessive Daytime Somnolence (Sleepiness). Difficulty in staying awake, even after apparently adequate sleep.

Fatigue. Fatigue is used as a catch-all term for a variety of different experiences, such as physical discomfort from overworking a group of muscles, difficulty concentrating, difficulty appreciating potentially important signals, and problems staying awake in the context of an investigation. Fatigue is important if it potentially reduces efficiency, erodes the safety margin, or otherwise impairs cognitive or physical performance. (*Transportation Safety Board of Canada*)

First-Night Effect. The finding that many people do not sleep as well on the first night in a sleep lab as they do later. Some insomniacs display a reverse first-night effect, sleeping best during the first lab night.

Free-Running. A term in chronobiology indicating that a person's internal rhythm is not being synchronized with the cycle of the sun. It occurs when people are put into time-free environments.

Free Running. When freed from the usual daily time cues provided by daylight and darkness, the biological clock runs under its own day length. Humans allowed to free run typically have a 25-hour day cycle, hence the term "circadian rhythm." (*Transportation Safety Board of Canada*)

Half-Life. The time it takes for one-half of a drug to be eliminated from the body by excretion or metabolism.

Hypnagogic Hallucinations. Vivid images that occur at the beginning of sleep. These are particularly intense when sleep begins with an REM period, as frequently occurs in narcolepsy. Such images also may occur just before awakening; these are called *hypnopompic* images.

Hypnagogic Jerk. A startle reaction; a harmless, sudden body jerk that many experience just as sleep begins.

Hypnotic. Related to sleep. The term is also used as a synonym for sleeping pills.

Idiopathic Insomnia. Insomnia without a known cause.

Insomnia. A perception of insufficient, disturbed, or non-restorative sleep.

Insomnia. Insomnia is a general term that describes a number of problems that prevent sleep. It is viewed as a sleep disturbance rather than a sleep disorder, although it may be precipitated by a sleep disorder such as sleep apnea or narcolepsy. While about 12 percent of the general population suffers from insomnia, two-thirds of workers with regular schedules complain about insomnia. (*Transportation Safety Board of Canada*)

Insomnia, Clinical. Describes the condition when a person has difficulty sleeping under normal, regular conditions and in phase with his body rhythm. It is an inability to sleep when the physiological system is calling for sleep. (*Transportation Safety Board of Canada*)

Insomnia, Situational. Difficulty in sleeping in a particular situation; e.g., when the biological rhythms are disturbed or one is trying to sleep in a strange environment. This often occurs when the brain and body are not in the sleeping phase. There are wide differences between individuals in their ability to sleep out of phase with the biological rhythms and in their tolerance to sleep disturbances. (*Transportation Safety Board of Canada*)

Intermittent Arousal Insomnia. A form of chronic insomnia resulting from excessive mental activity; induced by too-conscious efforts to sleep and underlying apprehension that all attempts will fail.

Intermittent Insomnia. *See Episodic Insomnia.*

Jet-Lag Syndrome. A maladjustment experienced when an abrupt change in time zone causes “body time” or circadian rhythm to be temporarily out of phase with local clock time.

Jet Lag. A brief maladjustment experienced when a change of time zones causes biological rhythms to become out of phase with the new local time. (*Transportation Safety Board of Canada*)

Light Sleep. A term often used for sleep stages 1 and 2.

Microsleep. A lapse from wakefulness into sleep that lasts just a few seconds; often associated with excessive daytime sleepiness and automatic behavior.

Microsleep. A very short period of sleep lasting from a fraction of a second to two or three seconds. Although its existence can be confirmed by EEG recordings, the person is not generally aware of it. This makes the phenomenon particularly dangerous. Such periods have been shown in tests to correlate with periods of low performance, and they occur most frequently during conditions of fatigue. Microsleeps are not helpful in reducing sleepiness. (*Transportation Safety Board of Canada*)

Multiple Sleep Latency Test (MSLT). A test to measure how sleepy one is by observing how long it takes to fall asleep during normal waking hours. It is given at least four times in one day at two-hour intervals and is often used to diagnose various sleep disorders and to evaluate sleeping pills.

Nocturnal Confusion. Episodes of disorientation close to or during nighttime sleep; often seen in the elderly and indicative of central nervous system deterioration; often referred to as the *sundowner’s syndrome*.

Nonrestorative Sleep. Also called alpha-delta sleep. Sleep that is not refreshing. During nonrestorative sleep, there is a mixture of alpha and NREM sleep waves instead of the usual pattern of sleep waves.

NREM Sleep (pronounced Non-Rem). Non-rapid-eye-movement sleep; that is, all the sleep except for REM sleep. NREM and REM periods alternate during sleep in cycles that last approximately 90 minutes. NREM sleep includes stages 1, 2, 3, and 4.

Parasomnia. A disturbance that occurs during sleep, such as a nightmare, bedwetting, or sleepwalking.

Pavor Nocturnis. Sleep terrors or night terrors that occur almost exclusively in children. Episodes of this sleep disorder usually arise from the depths of the first stage 4 sleep of the night and are generally associated with intense body movements.

Periodic Limb Movements (PLM). Repetitive twitching, usually of the legs and feet, during sleep. Leg jerks occur in regular intervals, 10 to 60 seconds apart, and may or may not wake the sleeper.

Phase Advance. The movement of sleep to a position earlier in the 24-hour sleep-wake cycle; for example, a change of sleeping from 11 p.m. to 7 a.m. to sleeping from 8 p.m. to 4 a.m.; often seen in the elderly.

Phase Delay. The opposite of phase advance; that is, a shift to a later sleep time, for example, a change of sleeping from 11 p.m. to 6 p.m. from 3 to 10 a.m.; often seen in 15-25-year olds.

Phototherapy. The treatment of circadian rhythm disturbances with bright lights (usually more than 2,500 lux).

Polysomnogram. The continuous and simultaneous recording of physiological variables during sleep. The three basic variables that are measured are brain waves, eye movements, and chin-muscle activity; breathing, heart rate, and other functions are also recorded.

Rebound Insomnia. Markedly disrupted sleep that may occur after a person stops taking sleeping pills; not observed with all patients and most likely when short-acting medications are used.

Restless Leg Syndrome. A disorder characterized by disagreeable leg sensations, usually prior to sleep onset, that causes an almost irresistible urge to move the legs.

REM Behavior Disorder. A parasomnia during which the patient carries out part of his or her dreams. It is thought to be due to malfunctioning in those brainstem nuclei that are supposed to inhibit all muscle tone during REM sleep.

REM Sleep. Named for the rapid eye movement that typically occurs during this state. It is a period of intense brain activity often associated with dreams. There is a paralysis of voluntary muscles. REM sleep usually represents about 20-25 percent of total sleep time in a young adult. In humans, REM sleep occurs regularly about every 90 minutes.

Restorative Rest. Restorative rest is sleep. People who do not get enough sleep or whose sleep is of poor quality become fatigued and their performance suffers. The only way to restore performance decrements caused by fatigue is to sleep. Rest without sleep will not suffice. Interrupted or poor quality sleep will not restore alertness. How much sleep is needed depends on the severity of the fatigue and the demands of the situation. Napping can be an effective short-term tactic. In cases of severe sleep deprivation or accumulated sleep debt, two nights of normal sleep will usually be sufficient to restore normal alertness levels. (*Transportation Safety Board of Canada*)

Short Sleeper. A person who usually sleeps less than five hours without there being anything wrong with his or her sleep.

Sleep Architecture. The nightly pattern of light sleep, deep sleep, and REM sleep episodes is often called sleep architecture. Disturbing normal sleep architecture has the same effects as sleep deprivation or sleep debt. The pattern of sleep, not just the quality of sleep, is important for maintaining alertness. Sleep architecture can be disturbed by drugs, alcohol, awakening due to outside disturbances, or sleep-related pathology. *(Transportation Safety Board of Canada)*

Sleep Cycle. Typically, NREM and REM sleep alternate through the night. The first sleep cycle lasts from sleep onset to the end of the first REM period; the second sleep cycle is measured from the end of the REM period to the end of the second REM period, and so forth. When all cycles are totaled and averaged, their mean value is near 90 minutes for young adults.

Sleep Debt. Everyone has a minimum sleep requirement to maintain alertness and a reasonable level of functioning. There are differences between people, but over 90 percent of the population needs between 7.5 and 8.5 hours of sleep per day. If they obtain less than their requirement, they develop a sleep debt. Sleep debt is cumulative. That is, missing an hour of sleep per day for four days results in about the same degree of impairment as missing four hours of sleep for one night. When a sleep debt is combined with circadian disruption or a long day, the effects can be very serious. The extent of someone's impairment cannot be assessed without their recent sleep history. Looking only at the current day could lead to underestimating the level of fatigue of a person who had accumulated a significant sleep debt during the preceding week. This is why investigators are encouraged to obtain at least a 72-hour history for the principal participants in an occurrence. *(Transportation Safety Board of Canada)*

Sleep Disturbance Threshold. That level of noise, worry, or any other stimulus sufficient to inhibit sleep onset or cause more than a momentary arousal.

Sleep Efficiency. The ratio of total sleep time to time in bed. If one stays in bed for eight hours but sleeps only six hours, the sleep efficiency is 75 percent.

Sleep Hygiene. The conditions and practices that promote effective sleep. These include regularity of bedtime and arise time, restriction of alcohol and caffeine before bedtime, exercise, proper bedroom environment, and other factors.

Sleep Inertia. A transition period of performance impairment that occurs immediately upon awakening for deep sleep. Sleep inertia is affected by a variety of factors, but most importantly by duration of deep sleep and circadian time of the sleep. Typically, the impairment is modest and short-lived due to gradual awakening from sleep. It can be more severe, however, if the arousal from sleep is abrupt and during the first half of the night. It is most dramatic if the sleeper has been sleep deprived and is forced to awaken and function after only a few hours of deep recovery sleep. In such cases, the impairment in performance of a cognitive task, such as mental arithmetic, problem solving, or dealing with an emergency during sleep inertia, exceeds that seen prior to sleeping by a factor of ten. *(Transportation Safety Board of Canada)*

Sleep Latency. The time from "lights out" until the beginning of sleep.

Sleep Log. A daily, written record of an individual's sleep-wake pattern containing such information as time of retiring and arising, time in bed, estimated total sleep time, number and duration of sleep interruptions, quality of sleep, and daytime naps.

Sleep Mentation. Images and thoughts experienced during sleep. Imagery is vividly expressed in dreams during REM sleep; in REM sleep, there is usually only short and fragmented thinking.

Sleep Paralysis. An inability to move voluntarily, occurring just at the beginning of sleep or on awakening; may last from a few seconds to a few minutes. Sleep-onset paralysis is usually related to narcolepsy; paralysis at the end of sleep may be scary, but is not clinically significant and frequently occurs in health people.

Sleep Spindle. A typical waveform seen in EEGs during NREM sleep and characterized by bursts of very regular oscillations at a frequency of 12-14 cycles per second. Sleep spindles are observed most often during NREM EEG stage 2, but they may also be seen in stages 3 and 4.

Sleep Stages. Sleep is not a passive state, but rather a complex activity. Although the body is quiet, the brain is active. The brain goes through several phases of sleep, starting with light sleep and becoming progressively deeper. After the deepest stage is reached, REM sleep episodes occur in a fairly regular pattern. It appears that all stages of sleep are required in order to maintain or restore alertness. (*Transportation Safety Board of Canada*)

Sleep State Misperception. The complaint of disturbed sleep despite essentially normal sleep patients in sleep recordings.

Somnologist. A specialist in the study of sleep and in the diagnosis and treatment of sleep disorders.

Soporific Environment. Some environments are more stimulating than others. A soporific environment is one that makes it easy to fall asleep or hard to stay alert. Environmental factors which make it easy to doze include comfortable temperature, low light, quiet or low level white noise, and a general lack of activity or stimulation. The environment itself is not sufficient to induce sleep. People only sleep during circadian lows or when they have a sleep debt. When sleep need exists, however, a soporific environment can make it hard to stay awake and be alert. (*Transportation Safety Board of Canada*)

Stimulus-Control Therapy. A treatment for conditioned insomnia in which the patient is asked to get out of bed if he or she cannot fall asleep easily.

Transient Insomnia. Represents sleep disturbance temporarily related to acute stress, conflict, or environmental change causing emotional arousal and lasting less than two weeks.

Wake After Sleep Onset (WASO). The amount of time one is awake during the night after initially falling asleep.

Zeitgeber. Literally, *time-giver*; an environmental time cue (such as light) that helps to entrain the body's rhythm to the 24-hour day.

Zeitgebers. German for time givers, zeitgebers are the daily time cues that serve to synchronize our circadian rhythms. (*Transportation Safety Board of Canada*)

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4. *An Annotated Literature Review Relating to Proposed Revisions to the Hours-of-Service Regulations for Commercial Motor Vehicle Drivers*, November 1999, Publication No. DOT-MC-99-129 (available at <http://fmcsa.dot.gov>). This report provides some of the extensive body of scientific research concerning hours of service, operator performance, and highway safety outcomes to those who have an interest or a stake in the Federal Motor Carrier Safety Administration (FMCSA) development of new hours-of-service regulations. It consists of a synopsis of over 100 research studies and other documents that the FMCSA obtained from researchers in the U. S. and overseas,

including many that were provided by commenters to Departmental Docket OMCS-97-2350 and by members of a Scientific Expert Panel that provided consulting services to the Department in 1998.

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8. *Plain Language About Shiftwork*, Rosa, Roger R., and Michael J. Colligan, U. S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Report No. 97-145, July 1997 available at <http://www.cdc.gov/niosh/pdfs/97-145.pdf>). What are the hazards? Sleep after night work is usually shorter and less refreshing or satisfying the sleep during than normal nighttime hours. Many workers cannot avoid night or rotating shift work.