I. PREFACE

Since Lindbergh's historic trans-Atlantic flight, the challenges of aviation fatigue have been a matter of concern. Regulations in the United States limiting flight time and mandating pilot rest have been in place since the 1940s. While pragmatic, these regulations were developed when the scientific understanding of fatigue and its physiological drivers were poorly understood. The rules were driven largely by the experience of seasoned pilots and the needs of the commercial aviation market. Basic and applied research on fatigue has greatly expanded since that time and our understanding of the basic physiological and environmental drivers of fatigue is much more complete. In fact, mathematical models have been developed that have shown great promise in accurately simulating fatigue effects on performance. Nevertheless, the regulatory environment has not responded to this new understanding of fatigue. Often, it has become the purview of collective bargaining between management and employee representatives to create contractual work rules designed to limit fatigue, for the protection of the employee. While effective in many cases, this approach has not necessarily applied the best fatigue science and safety principles to the problem and inevitably can place the work rules into an economic context rather than a public safety context. Hence, this approach is inherently limited as a fatigue risk management approach.

At the same time, a number of technological and operational changes have occurred that highlight the need for renewed attention to the problem. We can list some of the technological and operational changes that have worked to bring the fatigue issue to a critical point:

- Aircraft have been designed for greater efficiency to fly longer distances and with nonstop flight times in excess of sixteen hours – ultra-long range routes.

- Increased traffic throughout the national air space and into major hubs has created increased pressure on air traffic control and other support work forces.

- Mushrooming industrialization of the Far East and commercial activity in Europe and the Middle East create an increased need for long distance international routes.

Fortunately, fatigue science now offers better ways to understand fatigue effects on performance. Here are some facts about fatigue that were not fully understood when the current regulations were developed:

- Adequate sleep is only half of the fatigue equation; the time of day of sleep and performance can have a dramatic effect on fatigue risk. Current regulations only address duty duration and sleep opportunities, without regard for time of day.

- Consistent sleep is required every day. Even small restrictions of sleep can lead to an accumulation of a sleep debt that will continuously degrade performance until repaid.

- It is difficult to repay a sleep debt without taking more than eight hours of sleep per day. Current regulations do not recognize the need for additional recovery sleep after conditions of restricted sleep.

- Biological rhythms adapt slowly to changing schedules and workers have difficulty adapting to shift work.

- Night workers routinely get less than six hours of sleep per day and the more night shifts that occur in a row, the greater the risk.

- Fatigue risk also increases with time on shift without a break, especially after eight hours on duty, and breaks can reduce that risk.

- Naps of 45 min to 2 hrs can measurably improve performance when properly managed and controlled.

These are just some of the principles that are now widely shared that both illuminate the nature of the problem and open the door to solutions. Many of these lessons are now captured in fatigue analysis software that permit us, for the first time, to assign objective metrics to the degree of fatigue risk potentially created by specific work schedules or duty assignments. Agencies and companies can better manage fatigue if fatigue risk can be measured. New fatigue analysis tools give us ways to examine the dynamic interplay of factors that can create fatigue and provide us a clear method to evaluate better alternatives. Often the solution is not to work less but to work smarter. Systems exist to capture critical data to assess fatigue factors and evidence of fatigue. Fatigue analysis tools allow us to find those smart solutions; solutions that are safer, more efficient, healthier, humane, and attractive to young members of the work force. In recognition of these scientific advances, the National Transportation Safety Board published in 2008 a Safety Recommendation specifically calling for the use of fatigue risk management systems to limit fatigue in the aviation industry.

With this nexus of pressing problems and ready solutions, one might ask why more progress has not been made to manage fatigue in aviation. One underlying reason is economics. The economic pressures are natural and shared – it is the nature of our competitive world. And in the face of rising operating costs, it is laudable that within the aviation industry, safety continues to be a high priority and the recent safety record highlights the effectiveness of current safety systems. Yet economics often creates pressures that can increase fatigue, if not effectively managed:

- Customers want the most modern and comfortable service technology will permit.

- Customers want non-stop service to distant international destination.

- Increasing productivity to compete in the global market can mean using fewer employees to do the same work.

- Installing crew rest facilities on planes takes away from revenue generating space.

- Employees naturally prefer earning their income in the shortest amount of time.

- Leisure activities and helping with family responsibilities in two bread winner families compete with time available for recovery sleep.

- Changing assignments can mean long commutes for employees who don't want to uproot their families.

Given these converging developments: a) technological and commercial developments create conditions that can cause increased fatigue, b) major increases in our understanding of the causes of fatigue, and c) demand for productivity that can conflict with efforts to reduce fatigue, the FAA decided it was time for the aviation industry to take a closer look at all this information and stimulate discussions leading to a shared understanding of the

challenges that lead to fatigue, the barriers to fatigue management, and the scientific principles that can be applied to reduce fatigue and its potential effects on aviation safety. This was the fundamental motivation behind the initiative to sponsor the "Aviation Fatigue Symposium: Partnerships for Solutions."