Aviation Safety – Successes and Challenges

This is a look at a success story - aviation safety today. I want to review the world's safety performance in the recent past, and then take a look back to when we started flying jet airliners – and how and why safety has improved since then. Finally, I want to address some challenges that aviation safety faces as it heads into the future.

Let me start with some data on how safe commercial aviation is. Even those who work in aviation every day may be surprised by the magnitude of the success we have achieved in risk reduction over the years. For instance, in 1947, commercial aviation averaged about 600 fatalities a year, and that was while flying approximately 9 million passengers. Over the last 5 years, commercial aviation has averaged about 500 fatalities a year, and that was while flying approximately 2.5 billion passengers a year (300 times more passengers than in 1947!). Even 11 years ago – in 1996, there were 16 million flights and 1,300 fatalities. Last year there were 25 million flights and 745 fatalities.

Figure 1 shows the improvement in the commercial jet accident rate we have made over the past 4 plus decades since the introduction of the jet airliner. We have maintained a steady decrease in the accident rate – an average improvement of 32% per decade. That means we have reduced the accident rate by an average of one third every 10 years. For an already safe system, that is an impressive accomplishment.

Now let's look at some recent data. Figure 2 is the world's aircraft fleet in 2006. Approximately 10% of the world's turbojet fleet is Eastern built, while almost 25% of the turboprop fleet is Eastern built. The commercial jet numbers grew approximately 1.6% from 2005, while the commercial turboprop numbers remained virtually the same. The business jet numbers showed the greatest growth rate, with a 2% increase from the 2005 numbers.

Figure 3 lists the business jet major accidents for 2006. There were 10 major accidents, which is just slightly above average for this type of aircraft. It is significant to note that 9 accidents happened prior to September, and there was only 1 accident in the final 4 months of 2006. Of note is that 9 of the 10 business jet accidents were approach and landing accidents. Figures 4 and 5 list the turboprop major accidents for 2006. This list includes all Western and Eastern built turboprop aircraft with greater than 14 seats. 11 of the 24 turboprop accidents were approach and landing accidents and 6 were controlled flight into terrain (CFIT) accidents.

Now let's look at the last three years of commercial jet accidents. These include all scheduled and unscheduled passenger and cargo operations for Western and Eastern built commercial jet aircraft. In 2004 there were 13 commercial jet major accidents. For the first time in history, there were no CFIT accidents. In 2005 there were 16 major accidents. 13 involved Western built aircraft and 3 were Eastern built aircraft. 10 of the 16 major accidents were approach and landing accidents, and there were 5 CFIT accidents and 3 loss of control accidents. In 2006 there were 11 commercial jet major accidents (see figure 6). There was one CFIT accident and three loss of control accidents.

I highlight approach and landing, CFIT, and loss of control because, as has been the case for the last 20 years, approach and landing, CFIT, and loss of control accidents continue to claim the majority of our aircraft and account for the majority of our

fatalities. As proof of this, in 2004 there were 283 fatalities in commercial jet accidents. In 2005 there were 788 commercial jet fatalities. The difference? In 2004 there were 0 CFIT accidents and only 1 loss of control accident. In 2005 there were 5 CFIT accidents and 3 loss of control accidents, and they accounted for over 70% of the fatalities for that year. Figure 7 shows the commercial jet CFIT accidents since 1993. You will note that 2004 was the first (and only) year ever with 0 CFIT accidents. The red line is a 5 year rolling average, and it indicates that the CFIT rate is improving, but slowly (30% improvement since 1998). We have continued to average 4 commercial jet CFIT accidents a year for the last 10 years, and 12 a year overall for all commercial aircraft (jet and turboprop). Of all these CFIT accidents, there has never been one involving an aircraft with a terrain awareness and warning system (TAWS) installed. Even if you don't know a lot about risk management, it is obvious that the best way to reduce the risk of a CFIT accident is to install TAWS. Figure 8 shows the CFIT, approach and landing, and loss of control accident rates for commercial jets in major accidents per million departures since 1993. As you can see, there is an improving trend for all but loss of control.

Figure 9 shows both the commercial jet major accident rate in losses per one million departures and the 5 year running average of that rate for the last 14 years. The rate is only for Western built commercial jets because, even though we have the number of accidents for Eastern built aircraft, we do not have reliable worldwide exposure data to calculate rates for them. As you can see, the rate shows a significant decreasing trend. Now you may have heard people say the accident rate has not improved much in the last 20 years. Figure 8 shows that's not true. Last year there were 11 major accidents – and 25 million departures – for a rate of .44 major accidents per million departures. The gap between where we were and where we are now is really a measure of the accidents prevented and lives saved. If we had not improved the accident rate at all over the last 10 years, there would have been 30 major commercial jet accidents in 2006!

Now a question we need to ask is how are we getting the rate so low? Why have we been so successful? First of all, it is because of the aircraft. Each new generation has been better, safer, and the accident rates show that. For example, until the A340 accident in Canada, there had not been an accident with the newest generation of aircraft (B 777, B 717, A 330, A 340) in over 14 years of commercial operation. Training is another area where we have made great strides. With the advent of programs like line oriented flight training (LOFT) and other training initiatives, training has been a great asset in reducing risk. Technology has helped in training by making simulators much more effective training devices. Technology has also helped in other areas. Traffic alert and collision avoidance systems (TCAS) continue to reduce the risk of mid-air collisions, and the mid-air safety record reflects its great success. TAWS is in most commercial jets today (92%). Despite averaging over 4 CFIT accidents a year over the last 20 years for commercial jets, there has still never been a CFIT accident involving a TAWS equipped aircraft. This one piece of equipment has probably saved more lives than any single piece of aviation equipment ever. There are also emerging technologies: Heads up displays (HUDS) are just coming into more widespread use, and those who are using them are quite impressed with their capabilities and their risk reduction potential. Electronic Flight Bags (EFB's), like HUDS, are just coming into use, but the risk

reduction potential they bring is significant. In addition, there are still other risk reducing technologies like RAAS (runway awareness and alerting system) coming into use.

Another reason we are so successful is that safety is data driven. We use data to identify high risk areas, and we use data to see if the safety interventions we produce are working. To be effective and credible in aviation, you need data to support your efforts. To get the data, we don't just rely on accidents anymore. The good news is we have so few accidents that it is hard to get much data. We use new sources of data – proactive and preventative type data. An example of this is runway incursions. There are not a lot of runway incursion accidents, but a lot of effort is focused in this area because of the risk precursors we see. The key is to use data to identify high risk areas, develop interventions to address those risks, and then get the interventions to the people who can put them to use.

In addition to aircraft, training, technology, and being data driven, safety efforts today are more focused, and more cooperative, both within regions, and between governments and industry. The US Commercial Aviation Safety Team (CAST) is a great example of industry and government working together on a common safety agenda. The Pan American Aviation Safety Team (PAAST) is an example of a regional safety effort that has really accomplished great things. The COSCAP (co-operational development of operational safety and continuing airworthiness) programs are attempting to do the same thing in regions of the world that are new to this type of effort. There is now an ICAO Global Aviation Safety Roadmap. This was developed for ICAO by an industry safety strategy group (ISSG). The roadmap has 12 focus areas, or roads. The 12 focus areas were grouped into 3 areas according to the primary sector of the aviation system most responsible for carrying out measures to achieve them. There are focus areas for states, industry, and regions.

So why have we been so successful? It is everything I have listed: it is the aircraft, it's training, it's technology, it's being data driven, and it is having cooperative efforts on an international level that have enabled the success that we enjoy and that the public benefits from every day. All stakeholders in the system (aircrews, management, airports, ATM, and regulators) contribute to our success. However, despite our impressive record and our great success, the public expects us to get better. I would like to highlight two significant challenges that we need to address to try to meet the public's expectations. The first is human error.

Jerry Lederer, the founder of ISASI and the Flight Safety Foundation, and the most celebrated aviation safety professional ever, stated that "The alleviation of human error, whether design or intrinsically human, continues to be the most important problem facing aerospace safety." Note that his statement says alleviation, not elimination. Most of the current information on human performance and human error deals with flight crews because that is where most of the data is available. We know there will always be human error, but it is understood that the vast majority of human errors are inadvertent - well trained, well intentioned aircrews, controllers, maintenance technicians, and even management make errors while maintaining, operating, controlling, or managing well designed equipment and organizations. Why? Because we are all humans, and humans make errors. There are many reasons why people make errors, reasons like training, design, corporate culture, and fatigue to name just a few. The first step in addressing this challenge is to admit that human error is a problem, and acknowledge it is not going to go

away. Multiple studies from 1985 to today all show that human error is the primary cause of accidents. Unfortunately, human error is not an easy area to work on. It is difficult to make a hardware change or a technology update and solve the problem. Addressing human error requires working with people, so it is very complex. It is not like passing a rule will help. As a matter of fact, human error does not normally lend itself to regulatory fixes. So we know what the problem is – human error. The real challenge is finding the solution. One part of the solution is education and awareness. Just making humans aware of the issue helps. A good crew resource management (CRM) course, training on threat and error management (TEM), an in depth discussion on fatigue, hearing the basics of risk management or decision making, reading lessons learned from an accident all will help improve human performance and reduce human error. There are also other ways to address this challenge. One is by the use of technology. The technology does not have to be high tech. It may be as simple as a physical guard on a critical switch. Examples of technologies that have helped reduce the impact of human error are flight operations quality assurance (FOQA), engineered material arresting system (EMAS), TCAS, minimum safe altitude warning (MSAW), and TAWS. Note that most of these technologies are not designed to prevent human error. Things like EMAS, TCAS, MSAW, and TAWS are designed to mitigate an error once it happens. In fact, these systems are designed to function only if there is an error.

It must be acknowledged that we will not eliminate human error. It is like risk, as long as we fly airplanes it will always be present and need to be addressed. However, we want to eliminate as much of it as we can, and we always want to reduce it if possible. Accident investigators are getting better at addressing human error. Dan Maurino of ICAO once said "The discovery of human error should be considered the starting point of an investigation, not the end point." I think this statement accurately reflects the progressive and proactive approach necessary to successfully address the challenge of human error. If there is an accident, the question is not "was there human error?" If there was an accident, there was. The question is why was there human error, and more importantly, what can be done to prevent, or at least reduce the probability, of it happening again.

The second challenge we need to address is safety and the law. This challenge has two parts – the protection of safety information and the criminalization of safety. Aviation safety has an enviable and well earned reputation for accident reduction and risk management. We use information from investigations of accidents and incidents, FOQA, and non-punitive reporting systems to constantly improve our system. How we use this information has given aviation safety unprecedented success, and that success is much envied by other high risk organizations throughout the world

Now the protection of safety information is critical to aviation safety's well earned reputation as the premier risk management specialists in the world. We have achieved the successes we enjoy today because of our ability to investigate accidents and focus on preventing future ones. We are able to do that because of the availability of safety information and how we use it. It has been said that the greatest enemy of safety is blame. ICAO annex 13 states that: "The sole objective of the investigation of an accident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability." This is vastly different from a legal investigation, whose sole objective is to apportion blame or liability. The recent change

to annex 13 strengthens our ability to protect this critical safety information. There are some good examples of successes in this area – the CVR example right here in New Zealand, changes to Canada's transportation act, the failure and then new success of Denmark's safety reporting system to name just a few. Of course, New Zealand and Australia lead the way in this area. You are examples for the rest of the world on how to protect safety information. However, we must also strive to reduce the criminalization of safety – that is the tendency for legal authorities to bring legal action against aviation personnel for basic human error, often well before any safety investigation has been completed to determine the cause of the accident, and many times to the detriment of the investigation. Now we are talking about legal action for basic human error, or the unintentional result of someone's actions. How human error is approached is a matter of culture, customs, and the type of legal system used. However, in all cases, error by definition is unintentional. Punishment, which may be effective against intentional acts, will not reduce unintentional errors.

So to sum up, we are doing great safety wise. We are improving on an already impressive record, and the public benefits from our success every day. There are reasons that we are so good. Aviation safety is still the model for other high risk organizations because of our risk reduction success and our focus on preventing future accidents.

We have made great progress toward achieving the Flight Safety Foundation's goal of making aviation safer by reducing the risk of an accident. However, as we saw, there are still challenges like human error and protecting safety information that need to be addressed. In an industry where the risk will never be 0, we face a constant challenge in meeting the public's expectation of perfection as the minimum acceptable standard. However, all of you are addressing the challenges as safety professionals always have, and constantly showing that aviation safety is indeed a real success story!