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**Lindbergh Lecture
“The Spirit of Innovation”**

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(Remarks as prepared for delivery)

Good evening, and thank you for that most gracious introduction. Before I get too far along, I'd like to thank the Royal Aeronautical Society for inviting me to take part in this lecture series. When I look at the list of those who have delivered the Lindbergh Lecture before me, it's really quite humbling. I'm more than honored to have the opportunity to be here and share some thoughts with all of you.

The namesake of this lecture certainly provides fertile ground for a discussion of change, a reflection on aviation's amazing past and what lessons it has for the present and future. It's one thing to make your mark in history. It's quite another to blaze a path that billions – that's billions, with a “B” – will follow.

Even at that, when you look at Lindbergh's place in the great sweep and clatter of history, I think it's worth noting that by the time Charles Lindbergh made his incredible flight across the Atlantic Ocean, the Royal Aeronautical Society had already been in existence for 61 years!

Indeed, when the Duke of Argyll and his “aerial navigation enthusiasts” came together for the first time in 1866, the Wright brothers' famous flight was still 37 years away. Most of the world had its focus on lighter-than-air dirigibles. The people whose steps we follow in this room had something bigger in mind. This society instead focused on heavier-than-air flight. I must say that I love seeing a blimp slip its way across the horizon. That's one of those things you've just got to stop what you're doing and enjoy the view. But when I'm doing the traveling, I certainly prefer something with a little more zip, and I know the RAeS feels the same way, both today and back then. This explains why the RAeS is held in such esteem around the world and has had such an impact on aviation for 143 years.

I want to begin tonight by taking maybe a different approach than usual for this lecture. Instead of concentrating on a famous name in aviation, I want to mention someone decidedly not famous – Tom Rutledge. I suspect that's a new one for most of you. Rutledge was a 24-year-old engine builder at an aviation company in New Jersey. One day a special order came in that demanded a lot of extra time and effort. Rutledge was not thrilled with this special assignment, but he did what he was directed to do. He came up with two special features to modify the company's base engine. One allowed the engine to self-lubricate in flight, and the other added a mechanism that cleaned the engine as it was operating. History's a funny thing sometimes. Simple things sometimes leave the biggest wake, and these innovations would be no exception. They would prove to be extremely important.

Tom Rutledge comes up in tonight's lecture not because he's an aviation luminary, but specifically because he's not. We mention Rutledge because he's an integral part of the manufacturing side of our industry. When technology makes a leap forward, it is the manufacturers who are putting ideas into action.

I'll say it as plainly as I can. An anonymous engine maker made an aircraft engine markedly better, taking a step forward in aviation technology and pulling the industry ahead with him.

Without a doubt, Tom Rutledge showed the spirit of innovation inherent in early aviation. Lindbergh certainly had this quality, not only in his faith in his own ability, but in the Ryan Aircraft Company. Ryan Aircraft designer Donald Hall had to tap into the spirit of innovation to come up with an aircraft that would actually make it over the Atlantic Ocean. The Spirit of St. Louis was looking to catch lightning in a bottle, with everyone knowing full well that three previous attempts at the flight took six souls.

We know how that story ended. But I think we must use it as a compass for what we face today. The challenge spurred the very same spirit of innovation we need to use today to address the challenges that are coming tomorrow. I'm going to talk about the importance of this spirit when it comes to the economics, environment and enterprise – the three E's, if you will – of worldwide aviation.

When we look through the lens of history, we see those grainy photos of Lucky Lindy during the high-flying 20s; the roaring 20s.

But on further reflection, looking through the lens of world economies, we also know that there was a mild recession in 1927 – the year of Lindbergh's flight. At the heart of that very recession were unstable oil prices and terrible circumstances in the U.S. auto industry.

History loves a sequel, doesn't it?

While some of the details from those days were much different, they're a reminder that as difficult as today's world economic downturn seems to be, we've been down this road before. The question of the moment's got to be: Have we learned enough to make these economic challenges a springboard to launch a new period of prosperity?

The U.S. aerospace and defense industry is in an interesting position. We have, without a doubt, seen the negative effects of the recession across the industry, and companies up and down the supply chain have had production cuts and layoffs. But there are portions of the industry that are remarkably stable in spite of the economic atmosphere. And layoffs in our industry have been in the thousands, not the hundreds of thousands, that we have seen in many other corners of the economy.

One reason for this relative stability in the U.S. aerospace industry comes from the defense and space sectors. Since these areas are largely government funded, they are much more stable than others that are more susceptible to the open markets. We'll see what happens in 2010, but the U.S. budget this year has solid top-line levels for NASA and the Defense Department. Proposed increases in both areas for fiscal year 2010 may be slight, but the arrow is green. We've got to look at the big picture.

While some major changes are going on within the DoD budget for one program or another, the fact that the overall budget is in good shape should not be lost. So space and defense are providing two strong foundations for the industry in the U.S.

Commercial and general aviation are different stories all together. We know all too well that civil aviation has been hit hard all over the world. Demand has slowed to a crawl for virtually every airline, and they are cutting flights and reducing capacity to make ends meet. The credit markets have made it much more difficult to secure financing to purchase aircraft – both private and commercial. However, both Boeing and Airbus have huge backlogs that will insulate them somewhat from order deferrals and/or cancellations. And there have been a few new orders. But the talking heads and the analysts are in sharp disagreement. For every analyst predicting dire straights for airlines, there's another saying blue skies are in the forecast after all. We won't know until we're looking back over our shoulders about this one until it plays full out.

And we have a special circumstance in our country where small airplane manufacturing is big. In an already tough economic climate it was hit with an additional challenge – U.S. auto executives flew to Washington in their corporate jets to ask for government bailouts! That image made biz jets a favorite punching bag for politicians looking to score points with an angry public. The problem is they ignored some important facts – business aviation supports more than a million high-wage jobs and increases productivity for companies all over the country. This is even more important in the current economic climate.

There is another lesson in history here. Aviation has been an economic workhorse that has helped lead world economies out of lean times in the past. The obvious example is that in the United States, during the Great Depression, the aviation industry actually grew while many others were collapsing by the day. There were several underlying reasons for this, both practical and psychological. Some credit the growth of civil aviation with the penchant for escapism during tough economic times. There's nothing like the view from 10,000 feet to make your problems seem small. And the daring new industry fit that escapism bill along with motion pictures and photography. On the practical side, militaries were recognizing the almost unlimited value of aviation as technology continued its steep ascent while passenger aviation picked up steam. To be sure, there were some aviation-related companies experiencing hardship in the 1930s, especially during the early part of the decade. But overall the performance was strong.

The list of venerable aircraft that were developed and/or entered service in the 1930s is long and impressive:

- Bombers like the Martin B-10, Boeing B-17 and Consolidated Aircraft B-24.
- Fighters like the Grumman F4F, Curtiss P-40 and Lockheed P-38.
- Passenger aircraft like the Boeing Model 247, Douglas DC-2 and DC-3, Lockheed L-10 Electra and the large flying boats from Boeing and Martin that ushered in long-haul passenger service, including Pacific routes. These aircraft are largely credited with keeping U.S. airlines profitable through the Great Depression.
- Here in the UK, companies like Hawker and de Havilland produced so many models of both civil and military aircraft during the 1930s it's hard to keep count!

And in 1932, a patent was issued to a certain Royal Air Force pilot named Frank Whittle for a contraption that was attracting little attention through regular military channels. Soon enough, the turbo-jet engine would forever transform aviation.

I think that the lesson here is that aerospace and aviation are bright spots in an otherwise bleak economic landscape. That was certainly true during the Great Depression. Aircraft sales in the U.S. totaled \$93 million in 1930, and, while they bounced around a bit during the decade, they were a healthy \$168 million by 1939 – two years before the Lend-Lease program went into effect. Technological innovations drove this strong economic performance back then, and they do the same today. This is a fact governments all over the world should keep in mind when coming up with plans to get their economies back on their feet.

We are at another time of game-changing technology in aviation. Boeing and Airbus have new models under construction that are poised to revolutionize airliner materials and performance.

There are many other advancements under way on smaller scales within the industry that could prove to be no less dramatic on an economic basis. There's one thing we all know for certain by now, and it's that the spirit of innovation is going to find a way.

And nowhere is that more true than for the environment. Now, I don't have to spell out how important the topic of climate change has become to a crowd here in London. Some of the most vehement – and, at times, misguided – criticism of our industry and our environmental performance has come here, including the protests at UK airports. Let's not presume for a moment that volume is a function of truth. Those protestors might make headlines, but they miss the point. If you're looking for a bad guy in the politics of pollution, it most certainly is not aviation. "Big engine" does not mean "big polluter."

But let's be very, very clear on this one. We take this challenge very seriously, even though aviation contributes only 2-3 percent of emissions worldwide. We all have a shared concern and responsibility when it comes to climate change. And we know that environmental issues have the greatest potential to hamper aviation's growth in the future.

And make no mistake, we will need growth to keep up with increasing passenger loads. There might be a downtick in passenger totals at the moment, but it's temporary, and it's economy-related. If you think aviation's not on the way back, you're in the wrong business.

When it comes to being green, the rest of transportation has quite a bit of catching up to do if it wants to match us.

Aviation's track record on the environment is remarkably good. Aircraft entering the fleet today are 70 percent more fuel-efficient than those built 40 years ago on a per-seat-mile basis. I can't think of any industry, especially in transportation, that even comes close to that. New jet engines are more fuel efficient, on a per-passenger-mile basis, than all but the most fuel-efficient automobiles.

All you have to do is look at a modern airliner compared to early passenger aircraft to see advances in aerodynamics and engine technology. As we know, the very first passenger jet engines were noisy and smoky.

But we turned that corner a long, long time ago. Today's jet engines are relatively silent and virtually sip fuel when compared with the early models. They are so powerful and reliable

that we can now safely cross oceans on just two engines, while producing fewer emissions. Composite materials came into use for various parts of the airframe, making airliners lighter while maintaining strength. Another great example is the use of winglets, which have proven so effective that airlines are retrofitting their fleets, seeing efficiency benefits of as much as 5 percent.

The story doesn't end there. Composite materials will make up almost all of the fuselage, wings and tail of the new Boeing 787, and its Airbus competitor has followed suit. The lighter, stronger material will result in substantial efficiency gains.

Engine makers are also looking at the next leap forward. Pratt and Whitney's PurePower PW1000G with geared turbofan technology is expected to increase efficiency by 12 percent.

GE Aviation and Snecma are working on open rotor technology, and Rolls-Royce has taken the lead on the Environmentally Friendly Engine program here in the UK.

Biofuels also are pushing the envelope. There are several programs involving airframers, engine makers and airlines that have powered jet engines with biofuels, and the results are nothing shy of amazing. If you told me 1998 that in ten years 747s would be flying on fuel blends made from coconut and jatropha seeds, I would have said, "sure" and thought you crazy. Well, we now know that it's not crazy at all.

For the last two years, AIA has participated in the important Aviation and Environment Summits in Geneva. Those events have resulted in commitments from the global aviation industry to perform even better.

The people holding up signs that talk about how aviation's the problem have chosen to ignore our stance and history on climate change. Go figure. When you consider all this information, you would think those concerned with the environment and reducing carbon emissions should be applauding aviation and holding us up as a positive example of industry doing the right thing the right way at the right time. Governments should be congratulating us on our accomplishments and encouraging further innovation.

But, as we know, they are not. In fact, here in Europe governments have already instituted a carbon emissions cap-and-trade system that includes aviation, which will go into effect in 2012.

In the U.S., lawmakers are in the early stages of putting such a system in place, and so far aviation is included in the proposals. This ignores the fact that aviation has nothing to trade – we're only a donor in these schemes and we have every incentive already in place to push innovation as fast as we can.

The 2009 summit communiqué tackled this head-on. It ended with a key statement: Regulation of aviation must be comprehensive and global in nature, not piece-meal on a national or regional level. The summit concluded that ICAO should recommend the appropriate global framework – let me repeat, global framework – to regulate aviation emissions.

Think about it. The realities of aviation are such that patchwork regulation is clearly the wrong way to go at exactly the worst time to go there. How are authorities going to deal with flights that take off in one country and land in another? What about flights that spend much of their route over a certain country or region, but never land there? National and regional emissions frameworks are ineffective when it comes to a global endeavor like aviation and are

almost sure to fail. Everyone in the aviation industry and other advocates must spread this message.

Our industry is not against market-based measures for reducing emissions. But they have to be positive incentives that will encourage even further advancement in environmental performance, not punitive measures that provide negative reinforcement. And if emissions trading or a tax system is put into place, the revenues generated should go back to R&D and technological advancement, not general revenues.

There is a very important point here. The 787 and A350 didn't come about due to government mandate. Winglets weren't developed to address an emissions cap-and-trade scheme. Remarkably efficient jet engines aren't the result of a carbon tax. All these advances occurred organically as the industry continued making strides to become more efficient. Thrusting the stick of government into the smoothly running spokes of the aviation industry's environmental performance just does not make sense. In fact, it runs counter to the spirit of innovation.

Before I get to the final "E" tonight, I'd like to mention another example of the spirit of innovation, and a lesson in practicality. Like the aviation manufacturing advances I mentioned earlier, it also takes place in the 1930s. In the lead up to World War II there were harrowing reports that the Germans were working on an electromagnetic "Death Ray." The British Air Ministry began a focused study of the possibility of employing electromagnetic energy for such a use, and found it to be impractical. But they found out something else – you could use it to detect flying aircraft!

Now, scientists in several other nations were also looking into this type of technology, and some were further along than you here in Great Britain. But the Air Ministry decided that putting basic technology into practical use was better than concentrating only on research. The result was the famous Chain Home system that detected German aircraft before they reached your shores. It was the first ever practical use of technology that would come to be called radar.

That brings me to the final aviation challenge we must address, and that's enterprise. By this I mean how the enterprise of world aviation is carried out. I'm talking about where the proverbial rudder meets the sky in our air transportation systems. This is perhaps the most pressing challenge we have, because the technology being used around the world – even in places we like to think are advanced like, say, the U.S. and Europe – is hopelessly outdated. We still use radar as the backbone of our air traffic control systems – a technology that has its roots in the same World War II of the Chain Home system.

We are once again counting on the spirit of innovation to tackle this challenge. Of course, in the U.S. we are working on NextGen and Europe is working on SESAR. While there are some differences in the two systems, both are based on satellite navigation and Automatic Dependant Surveillance-Broadcast, or ADS-B. As you may know, ADS-B not only can significantly reduce air travel delays by allowing more point-to-point flying and eventually reduced aircraft separation, but it can provide huge environmental benefits as well as major advances in safety.

Now, NextGen is obviously of great personal interest to me, since we undertook much of the planning and development when I was at the FAA. And we looked closely at the very early stages of ADS-B technology test beds and decided to employ it as the foundation for the system. Of course, there were some growing pains along the way. But we quickly realized this

technology was not just another air traffic control tool, but a totally transforming way of dealing with the entire air transportation system.

A few weeks ago, I participated in a roll-out ceremony at Miami International Airport marking the first 11 ADS-B ground stations installed and in use as part of the regular NextGen system. The program went from concept to deployment to implementation in less than a decade – a remarkable achievement for a federal program of this magnitude. It's worth mentioning that contractor ITT is on time and under budget. All 793 ground stations are slated to be installed by 2013.

Much of the technology needed to implement NextGen is already developed. It just needs to be put in place. The missing piece of the puzzle in the U.S. is providing an incentive for users to equip their aircraft with the ADS-B avionics needed to take full advantage of the advantages the system provides. The economic and environmental benefits of NextGen – reduced flight times, fewer delays, less greenhouse gas emissions – should be all the incentive system users need to equip. But, the real benefits only come when everyone is equipped. In today's tough economy, who's going to be first? That's why we have been trying to convince Congress and the White House that aircraft equipage grants are a good investment in infrastructure that have the double bonus of stimulating the economy and helping the environment – which we all need these days!

Now, I said there are differences in the way the EU is approaching SESAR and, as I understand it, there are plans to incentivize equipage. There will also be a mandate to require ADS-B use by 2015 – five years earlier than in the U.S. Both these steps are likely to propel your system more quickly.

Underneath this, too, are two rather different approaches to governance. SESAR is an industry-led initiative, while NextGen is much more a U.S. government-led enterprise. There is some irony in this for me since I had a hand in the architecture and governance of the U.S. system and now sit with industry, at times champing at the bit to have a larger role in guiding NextGen's development. But for those who study how major systems develop and how transformational changes occur, this is one to watch as we see how the two models play out.

But most importantly, we all need to ensure that all air transportation system advancements around the world are seamlessly interoperable. Again, an industry that knows no borders can not operate in a world where navigation and surveillance technological specifications are different from country to country. NextGen and SESAR, are the world leaders in ADS-B. We have a great opportunity with ICAO to set the standards and prove the value and effectiveness of seamless interoperability. Not surprisingly, ICAO must play a large role in making this a global reality by coordinating advanced air transportation system efforts around the world. At this point in the game, the spirit of innovation probably lies more in human organization than technology!

Let me close by bringing this full circle. Earlier tonight, I mentioned a name that few people would recognize – Tom Rutledge. There was a reason. Rutledge worked for Wright Aeronautical producing J-5C Whirlwind engines, and the special order I mentioned came in 1927 from an unknown aviator named Charles Lindbergh.

It seems he wanted an engine that could run non-stop for an extended period of time, leading Rutledge to come up with the self-lubricating and self-cleaning features that made the

trans-Atlantic flight possible. When you mix the spirit of challenge with the spirit of innovation, you get the Spirit of St. Louis. That same formula has worked over the years, and it will work today.

Thank you.

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