



Mitchell Institute for Airpower Studies

**Presentation: The Vanishing Arsenal of Airpower
AFA National Offices, Arlington, Virginia
October 30, 2009**

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Mitchell Paper: [The Vanishing Arsenal of Airpower](#)

Dr. Grant: Good morning, and thanks to all of you for coming out on this fall morning. I'm Rebecca Grant. I'm the Senior Fellow at the Lexington Institute, and I'm also proud to say I'm the Director of the Mitchell Institute for Airpower Studies.

I want to tell you first about the work of the Institute. The Institute was founded at the Air Force Association. It seeks to honor the leadership of General William Mitchell through high quality research and writing on timely airpower topics.

I always like to remind our audiences a little bit of who Mitchell was. Mitchell was the first combined or joint forces air component commander ever in history. In September of 1918 he took a force of American, British, French, Italian aircraft combined then into a force of about 1100 ready fighting machines to support the first US attack as a single American Army during World War I. It's a little known battle called the Battle of San Miguel, but it was an important debut led, of course, by General John J. Pershing and interestingly planned by one Lieutenant Colonel George Catlett Marshall.

This was America's debut on the world stage and the debut for air power in support of and assisting the combined arms. Not only did Airmen under Mitchell gain air superiority which they had to do again every morning when dawn arose, but they also supported the ground forces with observation, with attacks on the back areas or the interdiction of German forces and in other supporting roles.

From this, of course, General Mitchell was awarded his first star by Pershing. He came back to Washington and didn't have a great time in Washington even back then. He went down to Langley and led important tests including the bombing of the Ostfriesland, a joint Air service and Navy effort to test aircraft against battleships.

As we know, he was very outspoken on airpower and was court marshaled and retired from the Army as a result of his actions in the mid 1920s.

He died in 1936 long before airpower fulfilled much of its technical promise in World War II. And perhaps the most important legacy he left us was in the younger

commanders that he influenced, top among them General Hap Arnold, General Spaatz and many, many others including Ira Eaker and that generation.

So at the Mitchell Institute we seek to honor his legacy of leadership but also particularly his interest in current airpower topics and in the technological advances of airpower.

This morning we're going to kind of draw the circle a little bit further because Mitchell was also extraordinarily interested in production of aircraft and in what we now call the industrial base.

And with that I will turn to the topic of this morning's briefing. I have to say this is not the most cheerful briefing that I've ever given. There have been a number of studies of the defense industrial base and even of the aerospace industrial base. One thing I found is that they always seem to say that the present moment is a moment of great crisis whether this is the early 1920s or the 1960s or the 1970s, and back in 2008 the Defense Science Board, having completed a study on transformation, had this to say about where we were with our industrial base. It said that while competition still occurs between a few firms in each sector, the overall US federal government, quote, "can no longer benefit from a highly competitive defense market."

That warning was issued actually before the changes of April 2009 which rather substantially cut a number of programs—Future Combat System, Transformational Satellite, and of course, a number of airpower programs as well.

So it leaves us with the question, I think, to what extent do we still have an arsenal for airpower? And hence the title of the talk, the "Vanishing Arsenal."

You're very familiar with how this industry looks at a glance. Most of the statistics tracked by the government don't clearly separate out the military and commercial side of this industry, nor really do many of the major competitors and major firms which comprise the health of the industry. Most of our large firms do both commercial and government work. It's a long-standing tradition pretty well embodied in the two shots that we see here of the production lines.

There are a number of firms including really a surprisingly large number of small businesses still in the industry. The workers in the industry in the most recent numbers, which sadly date back to 2006, total about 472,000. That's not all manufacturing jobs. Manufacturing jobs are the larger share of that topping around at about 380,000.

It's a very well paid and very productive and very hard working industry. The average for an aerospace manufacturing worker is about a 43 hour week. The US average for manufacturing overall is about 41 hours. And for all types of labor in the US the average week is about 33 hours. So this is an industry that works hard for its good wages and has been a very steady source of product improvement over a long period of time.

It won't surprise you that 60 percent of those employed in the industry at a big firm with over a 1,000 employees; but there are still quite a number, as I mentioned before, in this relatively large number of small businesses as well within the sector.

In addition to the Defense Science Board, AIA put out a terrific report on the defense industry as a whole with again what I think is this very, very apt quote. You know the President, Mary Blakey, was very pointed in her remarks in saying that the Pentagon does not consider industrial policy or industrial based health. They ought to, and they simply assume, that the defense firms across many sectors will be there to produce the products and the competition that our national security requires. And she has said this just may no longer be the case.

The aerospace industry has been a healthy one in this decade. If you look simply at the sales and the outlays what you'll see is a pattern of increases, and yet we know that we are really at a very clear turning point. I think we've begun to see this obviously in the larger economic picture, but we really are at a point where the numbers going forward are likely to look substantially different. How that impacts our national security is a major question.

So let's go back for a moment to the era when Billy Mitchell was interested in these topics. As you know perfectly well, the aerospace industry always has been a bit cyclical in nature and it struggled particularly in its earliest decades until it linked up with some more coherent government policy for how we go forward. So you think we have problems, this is how the situation looked at the time that Mitchell and others separately than the Navy were advocating for more expenditures on airpower. The graph shows air service allocations in and around the World War I period. The money peaks in 1919, interestingly, because although the war obviously ended in November of 1918, all the allies had made plans for big offensives in the year 1919 and this was the year that American production was really working overtime to go forward.

As you know there were basically zero American-built aircraft in World War I. Rickenbacker flew a French built aircraft, others trained on French and British types. So this was not an industry that had gotten off the ground in any way.

In writing about this time period Mitchell coined a phrase that I thought was really apt for where we are today. He said we need a satisfactory nucleus of manufacturing. He, like others, didn't think that we should continue to spend a billion dollars of 1919 dollars on aircraft. They wanted this money to come down rapidly but they wanted it done in such a way that as he says here, you have this nucleus of manufacturers to go ahead and advance the art, particularly with engines and weapons and all the other things that had to be done to get from this De Havilland model licensed here in the US to the airpower that we would see later on.

A lot of this fell initially on deaf ears and yet in the late 1920s there was a realization across federal policy that more needed to be done with the development of aircraft and a few contracts were put in place that in a way helped lay the foundation for the

tremendous expansion of production in World War II.

You're all familiar with that but I wanted to just show you again the numbers compiled looking at the major US aircraft manufacturers and what they managed to produce in World War II. They started from about 5,000 aircraft of all types produced in the late 1930s each year and going to literally hundreds of thousands in this time period.

Now there are some reasons why this was possible, of course the dire national security threat top among them, but this was also an economy that very strong in manufacturing. Because of the Depression that manufacturing capacity was not at full tilt. There was considerable idled factory space; there were workers who even at the end of the 1930s still had not been brought into the work force. As production accelerated over half a million women were hired to work on the aerospace production lines and in various capacities, something that again was very new to the industry. So America had the industrial and manufacturing might to create excess capacity in the economy and to produce this type of aircraft production.

The other thing that's important here is that a lot of these skills were transferable. Everyone thinks of the famous pictures of Ford's Willow Run Plant churning out bombers, but these were skills largely that you could take from other types of manufacturing disciplines and turn them quickly to high rate production of fabulous and capable but relatively simple aircraft types. By the time that manufacturing was parceled out from the designers to additional factories, this was a very, very steady and smooth production and it was easy to ramp up to this point.

So if you look at the names here, they're pretty familiar. Some remain today and others remain as parts of larger companies. But what this did was set the pattern for how post war manufacturing would proceed as well, and most of my talk will hinge on the coming to an end of this period that we set in the late 1940s.

There was a very strong program legacy immediately after World War II again. Budgets went down, a period of crisis in the industry, but by the late 1940s a number of new designs were picking up. One of these was the B-47 which was produced in quantity. I like this picture because although it's taken at an overseas location, the deployed location, it shows the sort of mass of what was going on.

It was also, there was a philosophy that guided production in this period and that was that you needed to build new aircraft types on a regular basis in order to advance technology. That's why I like this quote here actually taken I believe about the discussion of the B-36, the bomber we purchased in quantity and Spot says to Kenny you know, we wouldn't buy anything if we were waiting for the next great thing that was around the corner. And in this era the next great thing around the corner tended to be maybe even 18 months or just a few years away. But nonetheless the philosophy was to bring aircraft quickly to production, test them, buy them in reasonable quantities, and then learn from this experience and move rapidly onto the next program advancing the art all along.

Of course there was little doubt that a thriving aerospace industry was essential to the nation. There was a clear technological threat that had very much been present during World War II when other nations had significant advances in their air forces, more capable types at the beginning of the war. The Russians quickly proved that they were very able contenders, enough to keep the aerospace industry constantly on its toes, whether that was from the detonation of their first atomic bomb in 1949 or the aircraft we see here, Sputnik going on. There was argument perhaps over the level of the threat but not about the technology that backed it up. No one was doubting their political intent either. The spread of world communism was a very clear goal. It was going to be challenged at all points in time. There was a Cold War. No question about the political intent of the adversary.

And finally there was strong domestic consensus in the US I like this picture at the bottom of Ambassador Paul Knutson and John Kennedy going through some of these hearings, you know the Senate hearings talking about the bomber gap and various issues like this. And in fact we saw this steady support for a strong aerospace industry and strong products extend through the early days of stealth when three successive administrations of three different parties strongly supported the early investments taking place from the early to mid 1970s right through the mid 1980s. So it was this in a way that drove the industry and kept the philosophy of continued new production rolling forward.

And what an era it was. This chart shows first flights of fixed wing military aircraft that occurred from 1950 through 2009. And I want to thank the staff of Air Force Magazine, I think absolutely every one of them participated in checking through this data which you'll find included in the table of the study, but particularly to thank Suzanne Chapman who was the one who really, really took this table and made it into the accurate data source that it is. It tells a fascinating story. Over 50 first flights in the 1950s, and some of these are aircraft that you probably never wanted to fly again. [Laughter]. Others are ones that turned out really well, the B-52, the C-130, and many, many others. But there was a string of jets, particularly across the Navy inventory that seemed to be perhaps one more dangerous than the next until it was all worked out. But this is what helped create and sustain the diverse regional aerospace industry that we still have parts of today. This is what set the pattern. We're going to look at each of these decades in a little bit of detail before going on to where we stand today.

The sheer number of programs in the 1950s ensured that you had typically a dozen major aircraft companies in competition with one another. What this did also was very important in terms of the labor force; there was always a job somewhere else. If the program you were working on ended or you wanted to go somewhere else you could get job at Long Beach, you could get a job up in Seattle, you could get a job in Wichita, you could get a job someplace else. So this also created the pool of experienced people going from the designers to those performing the touch labor on the lines which was a much greater share of the industry than it is today, and particularly important the program managers who knew how to translate the designs into a flyable aircraft in the period of time required by the customer.

The 1960s weren't so bad either, and this was a period of pushing the boundaries of speed in particular. This venerable aircraft of which only a few were ever made managed to fly Mach 3 and complete a pretty rigorous series of flight tests in the early 1960s before it was discontinued. That's the sort of thing that we most likely wouldn't see happen today, and there were huge technology choices being made as service to air missile threat grew and while the industry was exploring the limits of speed, they were also looking at other ways to improve survivability and starting to make some of these very difficult tradeoffs. But again everything was rolling forward.

In the 1970s you see a bit of a decline in first flights, but it's also in my mind the decade of the fighter. The lessons of Vietnam had been learned and the principle fighter types that are still out there today experienced their first flights ranging from the F-14 up through the F-16 as well as some of the contenders that didn't quite make it into production the first time going along in that competition. Now I realize this is not the type of F-16 we flew in 1978 by any stretch of the imagination, but it symbolizes what this era was able to produce. We also see the introduction of a [inaudible] large scale battle management program bringing in the philosophy of melding information in order to increase the effectiveness of air operations.

The 1980s are now best remembered for the recapitalization that took place largely under the two terms of the Reagan Administration. I like the shot of the production line at Fort Worth, F-16s, I thought it summed this up very well. This is the period of time when the force that we have today was bought. It was tested and flown in the 1970s, some of it was purchased in the 1970s but the rest of it was bought out in the 1980s.

We also saw full production for the F-117 and struggles and successes with two remarkable bomber programs the B-1 and then the B-2 which made its first flight at the very, very end of the decade in July of 1989. Yet again, though, a sign is apparent—the declining number of first flights. That and the change in the threat at the end of the Cold War leads to the period in the 1990s which gives us the industry that we know today.

We all remember the famous Last Supper and the waive of industry consolidation that went on in that decade as major aircraft primes who had been listed on that list in the 1940s combined with one another in order to have viable programs going forward. We see some remarkable steps such as Boeing and the large part acquiring shares that reintroduced it into the major aircraft production business. It was inventive, it was [inaudible] commercial that came right back in as a major military producer during this decade.

Saw an unusual start up from an unusual type of company, General Atomics, still a privately held company with some diverse interests in everything from mining to various other things having success with a little known funny looking aircraft called the Predator. We also see a certain amount of derivative types and the competition for the YF-22 and YF-23 yielding the F-22 Raptor that is about to finish production in the next couple of years.

So the 1990s were a change in the industry but someone I respect a lot has said it wasn't so bad. I want to put in this slide which summarizes a report that was done by Dr. Paul Kaminski back in the mid 1990s. He had been asked to look at the risks of closing permanently the B-2 production line and what he found at that time was that there wasn't a particularly insurmountable risk to doing this. There was no unique heavy bomber industrial base. There were a number of suppliers that worked on the program, that contributed to other programs as well, and his feeling was that the capabilities required would still be resident within the aerospace industry even if the B-2 came to an end and its production line was shut down when the last B-2 rolled off its assembly line in late 1997.

It's rather interesting to look back today more than ten years later and see how much of this remains true. I think Kaminski's risk assessment here was spot on, thoughtfully done by someone with extensive background in the area and really quite an accurate description of where the risks in the industry were. There was not a special risk to getting rid of just one program because the industry could still shoulder the capabilities to produce in people and to innovative new designs going forward.

We saw a lot of this happen from the 1990s to the decade today. Of course the most famous example that comes to mind is the planned migration of technologies from the F-22 program into the F-35 program. What we're seeing now of course is the potential for some of that to cycle back from F-35 into F-22. It's a healthy process.

In its initial phases it covered such critical areas as engine development. So going forward with an F-22 type of the F-119 into the F-135 and F-136 models, there was a clear continuity produced by the industry. You saw this happen in other programs with systems like ASEA radar, which is something that we can hardly imagine the shape of the future for us without what AESA provides.

We didn't get to some of the other technology hurdles. Not to hypersonic platforms. Obviously to hypersonic missiles are in test and have had some successes and show some promise. We never got to a space transiting vehicle, you know a space capable bomber or some of the concepts that we talked about in the 1990s. But there was a steady progression and handoff within a very capable aerospace industrial base.

This decade actually saw not such a different number of first flights for the 1990s, but if you look at the types of aircraft you see a real diversity [inaudible]. Basically two fighter types that make their first flight, both competitors for the Joint Strike Fighter program. EA-18 comes in later on; it's obviously a derivative of a very different aircraft but based on the F/A-18E. And then you see a strong recapitalization across the Navy as well—first flight of P-8, et cetera, et cetera. But at this point if you look at the difference from the 1950s through the 1970s and down to this decade you simply have to ask, are the programs dwindling to the point that they will unravel this process that was put in place.

We really count more than anything else on programs to sustain the aerospace

industrial base. It is programs that train people across time. I was told that the average age of individuals working on the C-17 is just over 50 years of age, I believe; and the average experience of these individuals is over 20 years. This is not something that you recapture quickly. It's not a level of expertise that you can get quickly by bringing in new people and training them while you're supposed to be working on the production line. It's something that takes program, after program, after program to sustain.

We saw this very clearly in the development of the stealth technologies where Lockheed and Northrop contended over a long period of time on different programs, and where government policy deliberately kept them both working on similar requirements to see which one would do best. One would win one competition and then the other would win the next one. What it created was a very fruitful development of the skill set for advanced stealth aircraft design.

What we have in this decade I think is simply the end of the road of the program-based production model that has sustained the aerospace industry. So when we hear the larger reports about the defense sector from the Defense Science Board or AIA and others, we're really looking here at a sector that has reached this point of crisis. We simply now do not know whether we have the base to sustain what really matters—people, innovation, the ability to produce to requirement, and on schedule.

A friend of mine told me a couple days ago that he and a colleague of his had put together a list of the ten most likely aircraft programs for this decade, and as they looked down them they would simply cross out every one that they thought would probably never go forward. A key example being the next generation bomber. He never really told me what the final number was that they came up with for the number of programs we might see, but I've taken a stab at it here and I'm sure you all have thought of similar things.

Perhaps if we were to make this list again several years from now we'd say right we have two tankers and they competed. I think we should all hope we get to the point that we have two tankers that can compete and that there can be a tanker procurement going forward. We may have a light utility aircraft, we may have a light attack aircraft, we may have a stealthy UAV. The Navy has announced plans for a Super Hornet follow-on, but with not a lot of clarity about what that is as yet, and I think probably within their budgets not a lot of sense yet of how they will get there.

F-22s probably need a replacement program as well because under the extremely small fleet that we will now have the first retirements of the F-22s are likely to begin shortly after 2020. If you consider that the Navy is looking at 2024 as a milestone in its next fighter program you can see that we are already well inside the point where we need to be thinking about this.

But I want to make two points on this chart. One, someone I respect a great deal said yesterday this is the first time that any of us can remember when there have been no new major military fixed wing aircraft programs going forward; no new fighter types; no

new bomber types. We'll see potentially others with a question mark over what we may or may not see with airlift. The first time anyone can remember that this has been the case. And it simply gets us into a period where the risk is impossible even to assess or calculate.

The second point is, I was asked to go up to New York in about ten days from now and speak to an investor's conference on Wall Street. These are always fun because it's fun to see exactly how young all these hedge fund managers really are as they sit there and tap on their I-phones while everyone's briefing. And so I talked to my friend at what used to be Merrill Lynch, and there's great complaining about how it used to be Merrill Lynch and now it's Bank of America. Anyway up we will all go. And I said well what do you want me to talk about? He said well talk about the Air Force and, you know, what they're doing. I had gone to the same conference last year and I started off talking about airpower in Afghanistan because I wanted everyone to understand everyone's really pretty fully engaged in Afghanistan, Iraq around the world.

Then my friend says of course you know what these folks want to find out is what's the Air Force going to buy? I said well that could be a very short chart indeed, and I'm struck that even more than this time last year when you could say well we may do some of this or we may do some of that and this may stay and this may go away and F-35 still looks really strong, we don't know what's going to happen in several other areas. The picture now is simply very weak. One cannot in all conscience stand up in front of a group of these late 20 and 30 something's who want to know what is going to get bought so they can rate all the buy and sell of new companies, and say that we expect to buy much of anything. It's simply not in the plan, and how remarkable this is that we have come to this point in time.

I think some of it is quite natural; a lot of it is planned. You all have heard me talk before about the crisis in the Combat Air Forces, about the plans to replace larger inventories with smaller but more capable inventories. We all support and believe in that, and yet now it has truly come to a point when there are great questions about how this industry will look going forward.

What are the risk factors that are driving this? Well I think the top one of course is the defense budget. It has been through a period so unusual in this decade that I think we will for a long time still be grappling with the consequences of it.

I'll put this chart up just to point out some of the highlights. I'm sorry it's a little bit hard to read. This bottom line shows research and development dollars; these are all adjusted to constant year I believe '08 dollars. The middle line is procurement, there's Korean War; we needed to buy a lot of stuff for the Korean War. In red shows operations and maintenance.

So what you see here is that in previous war time periods procurement has gone up, so has O&M, but procurement has either led as in the case of Korea or stayed relatively close as in the case of Vietnam. What you see here is the Reagan era defense buildup.

And then a tremendous gap that has opened. Peace dividend, planned decline. These numbers change and this gap spreads either as O&M goes up or as procurement goes down. This one is largely driven by procurement going down.

If you wanted to put the trend line it should be hitting about here, there should have been a gap but probably not quite as big. But then with the wars in Afghanistan and Iraq that we've had this decade the O&M understandably has gone to well higher than the Korean War and higher than Vietnam. It's really epic proportions with procurement down here.

That is the condition in which all of this has happened and I have to say it's a puzzle to even the real defense budget experts like Steven Koziak and others who have written about this and said while we understand that O&M is vital and it supports what's going on in the war, we are at a loss to determine exactly why it has gone up as much as it has and exactly what this means. But we know what it means on the procurement side for the defense budget as a whole and for the aerospace industry.

Then there is our overall national outlook. My friend Lauren Thompson is quite fond of quoting a statistic that goes about like this, at the beginning of the decade the US produced about 33 percent or about a third of the world's output; and now it's less than a quarter. And he will always follow this up by saying we have no money for anything. A pretty stark statistic and certainly a factor in all this as well.

Then of course comes what I just spent several slides talking about and that is of course the lack of planned new starts. Simply not knowing what the next programs will look like. This is a projection of how it all may play out and again I think all you have to do really is look at the relative size of what we did in the past here and what we hope to do in the present. This assumes as I hope will be the case with no major cuts to the F-35 program. Under any condition what you see here is pretty much one game in town in the fighter or strike business and a much, much, much lower level of procurement than anything we've seen in the past.

What about the markets of the future? Well as you all know if you read the trade press, the civilian market is not in very much better shape. There has been a reduction in orders for commercial airlines. The business aviation market has been reeling from the double whammy of the recession and the unpopularity of flying business jets which was a constant refrain during last winter and even into the spring both from the White House and from Capitol Hill and enraged Americans everywhere who thought that corporate jets had suddenly come to symbolize everything that was wrong. I'm sure it looks pretty different if you are one of the makers of those corporate jets but the decline in the market especially in the lower and middle range aircraft has really been there.

Meanwhile, we see two competitors that are getting pretty excited about aviation markets in the future. There is no doubt that they have a way to go, but they have made very clear their determination to get there. The first is Russia with their United Aircraft Corporation; and the second of course is China which wants to have an airliner type to

meet its own domestic market needs to compete with Boeing and with Airbus. And of course they will be doing military production as well. Which I think a number of people have talked about this, it's not certain where Chinese and Russian fighter programs will go, what's certain is they're trying to get there.

This shows one of the first female pilot trainees in the Chinese Air Force several years ago getting checked out before her ride there. These nations are committed to continuing production so we don't know how any of this will shape out but what we could see in the future is a more robust aerospace industrial base among potential allies and rivals.

One thing that's been noted frequently about China is how quickly they are able to turn their cycles. In a way they're not unlike America in the 1950s and the 1960s trying different types, trying different things and incorporating new advances as well.

Observations and recommendations and I'm down to my last two slides. I think before I move onto these I do want to say something which is of course we all understand that airpower takes many forms. It has a form in the air domain, the space domain, in cyber space and the decline of the aircraft manufacturing business is not the absolute end of airpower, space power, and cyber space power. We may look back decades and decades from now and see this as a turning point where the other domains became equally or perhaps over time more important.

But my point here is that we are not able to assess the risks that we are taking now with our industrial base. The model that we have used to develop the most important asset—the people [inaudible]—has pretty much come to an end. And with that a couple of observations and recommendations.

First, we really do need if at all possible to keep that satisfactory nucleus of manufacturers. How we do that from where things stand seems very tough. What worked in the 1920s was in fact a reversal of government policy and a decision to go ahead and start a few programs when it became clear that civil aviation was not in any condition to pick up and create the market that would advance aircraft development. Perhaps for some reason we don't yet know we will see some change of heart within our national policy and perhaps a few more programs start. That path does not seem clear at this point but it's not impossible, it could happen.

Secondly, we know that the aerospace industry really thrives on a close relationship with its customers. If we looked into the details of any of those more than 100 programs that I showed you in those charts, we would find that the ones that were most successful were the ones where there was a good strong relationship between industry and the customer.

I think when you look back at it it's fair to say that really it was only the Wright brothers who [inaudible]. Everyone else had a pretty good understanding and worked hard to understand what the customer wanted while the customer tried to work to understand

what was possible within the industry. And for this reason to me it seems sensible going forward that the core industrial policy considerations perhaps not reside at the higher level of DOD but come back within the services. It's the services that best understand and plan for their future requirements; it's really not in the mission of the office of the Secretary of Defense to look at what's required 30 years out. Their focus is appropriately near term, concentrated on this year's budget, on the budget for the next five years or in this case we really are only looking at the FY10 budget, the rest still being a mystery.

For this reason I would say that the Air Force and the Navy particularly should look to take a more active role in working with what remains of the aerospace industry to see where they can best place investments and particularly to consider how they will plan for the future. I think we'd all agree that not enough of that is going on at this point.

And finally, to lead into my concluding slide, we do need to invest in technology. Technology for future threats, technology that will help us keep our lead not only for the wars we are in. And I have one great example of why that is so, and that is the jet age. Although the research and the conceptualization of the jet engine was done in the 1930s—quite a lot of it by Mr. Whittle in England—jets did not become a big part of air combat in World War II. Now they were enough of a concern to cause some pretty serious bomber raids to help slow the production of the ME-262, but the early jets just didn't have the performance and the heft and the muscle required to do the air campaigns of World War II.

And as it turned out the US managed to fly two early jet demonstrators. The first one here in the middle and the second one down below during the war. Even the ME-262 had a number of production problems generally related to the engine as well as other things. But had we decided to buy what worked in World War II we would have bought more B-51s, more P-38s, more B-36s—a type developed then, who knows how we would have managed reconnaissance, and we might miss the entire development of the jet age. A development that in its earliest years was critical to have the strength of the military research behind it before it became the wonderful expansive commercial market that we know today. Invest just for the wars that you're in and you might miss something of incredible importance to the future.

Well the jet age certainly provided a very bright period of time for the aerospace industry and some tremendous military capabilities. One can only hope that whatever comes next in this industry will take us by surprise much as the idea of the initial turbojet did with Mr. Whittle in England. But somewhere it will come out of a brilliant mind or a brilliant program manager's team and that we will see a flourishing future for the aerospace industry. The path to that is very unclear at this point in time. We need to understand the risks and we need to have the impulse to move forward.

Thanks for your time.

[Applause.]

Question: Dr. Grant, what we're seeing now is a long stretched-out set of programs. We're going to be acquiring KCXs well, in maybe four decades from now; we're going to see F-35s produced over a long period of time. What does that do to the industry's design teams? And do we need to be throwing up a little money to keep teams together to work on these things? Do you see these things, this innovation kind of fading away?

Dr. Grant: That's a great question and I think it's one that is being asked across the industry as well, what do you do to keep these teams together. We probably faced some of that in recent years I think particularly of both Grumman's and Boeing's work on their, what became the UCAS program, the Navy UCAS program. The demonstrators there both involved a lot of corporate commitment and corporate money and part of the reason for doing this was to give design teams something to do. Let's do something with this. [Inaudible] work and let's keep this going. It looks like we'll need that sort of thing in the future, [inaudible] corporations as well. But my goodness, we could certainly use some help from the government side in defining a set of requirements to work with. That's part of what's missing right now.

Otherwise certainly as systems move into production you have some sustaining work and perhaps some modification work coming along but you don't keep, I think no one knows right now what of the programs that we have, the nucleus that they provide will be satisfactory or nor satisfactory. I think we would all guess that it might not be enough and certainly the risk of that being [inaudible].

Question: I'd like to comment on that. I think your three major aircraft primes have gone on record with the Office of the Secretary of Defense to validate that if there is not some money, program type stuff made available, the workforce, the special, the stealthy kind of expertise that's required to build like a next generation bomber or long range persistent strike aircraft, we will lose that engineering expertise if there is not a program of sorts or some way to keep those guys employed. For example, the F-35 the design and development work for that airframe is pretty much done so there's got to be some kind of program to keep those kinds of engineers employed across the three main companies.

Dr. Grant: And I think we've already seen that there's a cohort of that group that is close to retirement age and many that have gone on I think we all know stories of Boeing and the experts who have already retired to help in production and look at the design and various things. And so the real question is what do you do with the new people that are coming out of college or a few years out and may have ten to fifteen years until some things are going into production, do they go to something else or is there a place [inaudible].

Question: Rebecca this is a great history lesson and focus on fixed wing airplanes, but what is the contribution to the industrial base of the helicopter industry, the requirement for vertical lift from the Army, for lifting right into the foxhole, for near space, balloon technology, for UAVs that are proliferating all over the battlefield? I mean how does all that affect this industrial base, the number of people involved in those industries, that kind of thing? That's a different study I guess, but it seems to me this

needs to be a little broader to draw some conclusions about the industrial base.

Dr. Grant: Well you're very right to bring those up and we deliberately excluded rotary wing aircraft which is tough to do and it somewhat changes numbers. On the other hand, we've been through a situation where there was what some might describe as a bit of a trough in rotary wing manufacturing. A number of our purchases have been from global consortia.

It's hard to say with unmanned systems which certainly is a thriving area. I would say that there are differences in the technologies of very light and shorter range vehicles versus the medium and high altitude vehicles. I would expect, you know, out of all that list that I showed of what we'll see as new starts in this decade coming up, I would expect to see a UAV of the larger size, an unmanned plane coming out of that list and certainly there's a lot going on there.

It was either the Chief of Naval Operations or the Chairman of the Joint Chiefs, I can't remember which admiral it was that said I'm not worried about the aerospace industrial base. They can always build UAVs. [Laughter]. I do think that didn't sound quite right but in the context I'm much more worried about ship building was a piece of this, and I would point out that ship building, if you excluded the boat building piece, ship building and repair is under a hundred thousand workers in this country, but with a very closely knit industrial policy with their principal customer.

I think some tremendous applications in lighter than air craft which were built interestingly by the air service that really run by Navy all through World War II, big lighter than air contingent there, and I think we'll be seeing some of that again, certainly great research potential and debate over the physics and applications of vertical lift. So I think we will see some things going on there. What again in those areas give me hope that we can end up with a satisfactory nucleus, but again not the clarity to know that for certain.

Well, we like to end these things promptly after one hour which you all have graciously given us, so with that and on behalf of the Air Force Association and the Mitchell Institute, thank you all very much for coming.

END TEXT

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