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U.S. INVOLVEMENT IN AEROSPACE RESEARCH

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED EIGHTH CONGRESS

FIRST SESSION

FEBRUARY 27, 2003

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED EIGHTH CONGRESS

FIRST SESSION

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U.S. INVOLVEMENT IN AEROSPACE RESEARCH

THURSDAY, FEBRUARY 27, 2003

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:30 p.m. in room SR–253, Russell Senate Office Building, Hon. Sam Brownback, Chairman of the Subcommittee, presiding.

OPENING STATEMENT OF HON. SAM BROWNBACK, U.S. SENATOR FROM KANSAS

Senator BROWNBACK. I call the hearing to order. Thank you all for joining us here today on the opening hearing about the U.S. involvement in the aerospace research area. I anticipate holding several hearings on this, and I think there will be some other members joining us throughout the hearing time. I am pleased that those of you here could join us today.

A hundred years ago, a great journey with unlimited promise began in this country, and that was the journey of powered flight. Through this journey we have led the world in amazing technological advances and the development of innovative products and services. As we celebrate the great successes of the past one-hundred years, let us reflect on where we have been and turn to where we need to go.

On December 17th, 1903, the Wright Brothers made history with a 12-second flight over the sand dunes of Kitty Hawk, North Carolina. Since then, flight has gone through the plains of Kansas and out across America. In the 1920s and early 1930s, some of the original aviation entrepreneurs, Clyde Cessna, Walter and Olive Ann Beach, Lloyd Steerman, formed the companies that continue to be the leaders in general aviation today. The industry continued to soar over the plains with the addition of the Boeing Company through its purchase of the Steerman aircraft in 1929 and a major expansion of a Kansas presence during World War II. This journey encompassed the continued development of U.S. military, commercial, and general aviation industries throughout the 1930s, 1940s, and 1950s that set the standard for the world.

The journey of flight continued as Americans continued to push the envelope. In 1947, Chuck Yeager broke the sound barrier and established a leadership role in the infancy of the jet aircraft age. This propelled us to the next step that leads us to the stars with the establishment of NASA in 1958, and the journey continued,

eventually taking us to the moon and the triumph of July 20th, 1969, with Neil Armstrong's steps on the surface of the moon.

These wonders of space flight continued through the space shuttle, its first flight in 1981, and our current involvement with the International Space Station. And while NASA has suffered a recent tragedy with the Columbia Shuttle accident, we will continue to be the leader in aeronautics and astronauts. We must not back down.

U.S. commercial and general aviation manufacturers have made the world open for business with unlimited opportunities for travel and commerce. This tells only a fraction of the wonderful success story of the U.S. aerospace industry and the significant role it plays in our leadership security posture, the strength of our economy, and our leadership role in the world.

The current downturn in the U.S. aircraft industry, and I have certainly felt it, and my State has felt it, with some 11,000 jobs lost in my State alone, and the increasingly competitive challenges we face in the global marketplace only elevates the importance of today's subject matter of aerospace research. Aerospace is a technology-driven industry, and U.S. leadership in aerospace industry is a direct result of our preeminence in research and innovation.

Government policies and investments in long-term research are vital to the maintenance of the United States global aerospace leadership. The relationship between industry, government, and academia is crucial to the production of new products and services.

With a renewed focus and bold commitment by government, industry, and academia, we can help propel this industry to even greater heights during the next hundred years of this incredible journey. A new era of innovation lies ahead. The U.S. must continue to blaze the trail in the areas of developing advanced materials and propulsion systems for commercial and general aviation, new and innovative air-traffic management systems that utilize network-centric systems of satellites and ground-based stations, as well as a new generation of space vehicles and propulsion.

I want to welcome our witnesses here today, and I am excited to hear what they have to say. Senator Chris Dodd has a proposal that he wants to put forward and will speak first, and we will have Bob Walker and Ed Bolen, who will share with us their thoughts from the Commission on the future of the U.S. aerospace industry. Dr. Creedon will enlighten us on the position of the Administration. And I am also pleased to welcome Dennis Dietz and Bob Tomblin here from my State of Kansas. Mr. Dietz will comment on the perspective of industry, and Mr. Tomblin will highlight the successful involvement of academia in the process. I look forward to their input, and I look forward to this leading us towards legislative and some hopefully research solutions as to what we should be doing to keep the United States' leadership in this aerospace industry.

I thank my colleague from Virginia for joining us today, and I will turn the microphone to him for an opening statement.

Senator Allen?

STATEMENT OF HON. GEORGE ALLEN,
U.S. SENATOR FROM VIRGINIA

Senator ALLEN. Thank you, Mr. Chairman.

This hearing is very timely, and it is going to provide all of us, a wonderful opportunity to discuss the current state of the U.S. aeronautics industry as well as what will be necessary to ensure the U.S. continues to lead the world in all aspects of aeronautics technology. I very much agree with your bottom line assessment, and I am glad to see that there are some in the Senate who share the views of Senator Dodd and myself.

I will talk about the measure that Senator Dodd and I introduced last year and have reintroduced again, which we think goes a long way towards addressing our competitiveness, the importance of our military superiority, as well as how important it is for our economy that we make the proper investments in our aeronautics research and development.

We have seen, in the last five years, that NASA's budget for aeronautics research and development have been literally cut in half, from $1 billion to its current level of $500 million. In making these cuts, the United States has been rendered more vulnerable to foreign competition in the field of aeronautics. There is nothing wrong with competition. I am competitive. But if you are going to compete, you had better be investing right and making the right decisions; otherwise, you are going to get left behind.

The nations of Europe, have moved in the exact opposite direction, dramatically increasing such funding in an effort to enhance their competitiveness in the world's aviation market.

I commend the commission on the future of the U.S. aerospace industry for crafting a comprehensive and frank report on the state of the U.S. aerospace industry. I do find it disturbing that our aerospace industry is still living off research and development initiatives that began during the Cold War. If the United States is going to develop the stealth aircraft of the 21st century, it must make the commitment to research and development.

This country's ability to lead the world in innovation and technological breakthroughs are a direct result of our commitment in the past, and it is obviously essential that there needs to be significant investment in research and development on a sustained and strategic basis. And to make the research and development initiatives as beneficial as possible, there must be consensus amongst all parties involved on priorities and goals and the best path to achieve those goals. A commitment to an integrated aerospace policy will also be necessary for the United States to remain the global leader in cutting-edge aeronautic technology.

Senator Dodd and I have a great concern with the growing atrophy of the Federal commitment to funding for aeronautics research. After reviewing the commission's report and discussing the pressing issues with many in the aeronautics community, I have joined with Senator Dodd to introduce, this session again, the Aeronautics Research and Development Revitalization Act. This legislation will provide aggressive funding authorizations to provide NASA aeronautics program with the resources it needs to keep the United States on the cutting edge on all aspects of aeronautics and avia-

tion. The United States complacency must change now to prevent further damage to our competitiveness in aviation.

The bill that Senator Dodd and I have developed is aggressive, and it will require a commitment of significant funding for the next five years. However, I believe this money will be well spent when considering the positive impact aeronautics research and development has on both the U.S. economy and on our military.

We have received strong support for this initiative, Mr. Chairman, and I ask consent that the letters in support of the Allen-Dodd bill from the Aerospace Industries Association, the American Society of Mechanical Engineers, the Boeing Company, and Airbus be made part of the record.

Senator BROWNBACK. Without objection.

Senator BROWNBACK. Thank you.

[The information referred to follows:]

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.
Washington, DC., February 7, 2003

Hon. GEORGE ALLEN,
Russell Senate Office Building,
Washington, DC.

Dear Senator Allen:

On behalf of the member companies of the Aerospace Industries Association of America (AIA), I am writing to thank you for your leadership in introducing the Aeronautics Research and Development Revitalization Act of 2003. We are solidly behind your effort. If enacted, your legislation will help to reverse the long-standing decline in Federal aeronautics research funding and help the United States preserve its leadership in aerospace technology.

A measure of the future competitiveness of any high technology industry such as aerospace is the degree of investment in research and development. AIA has been examining the issue of trends in aerospace research and development for the last several years. We have documented a significant decline in investment by both the government and industry since the mid l980's, which has already begun to undercut the U.S. aerospace industry's future contribution to national security and national economic prosperity.

By ramping up aeronautics research and development funding increases in NASA and the FAA each year to over $1 billion by fiscal year 2007, your bill would reverse these troubling investment trends and help set the U.S. aerospace industry on a course of continued preeminence in the global market for both the civil and military aerospace products. Furthermore, we are pleased that provisions in your bill correlate with recommendations in the final report of the U.S. Commission on the Future of the Aerospace Industry.

We urge you to keep up this effort that is so vital to our national interest. We stand ready to support you in any way.

Sincerely,

JOHN W. DOUGLASS,
President and Chief Executive Officer

U.S. AVIATION RESEARCH AND TECHNOLOGY
February 5, 2003

Hon. CHRISTOPHER DODD and Hon. GEORGE ALLEN
United States Senate,
Washington, DC.

Dear Senator Dodd and Senator Allen:

As leaders in the nation's aerospace, aviation and aeronautics community, our organizations, representing major manufacturers and more than 1 million scientists, engineers, researchers and professionals, strongly endorse the "Aeronautics Research and Development Act of 2003."

In recent years, we have expressed concerns that reducing federal funding for aviation and aeronautics research and technology will jeopardize the nation's leadership in providing the technologies needed to develop the next generation aircraft,

improve aviation safety, and security, and attract the next generation of aerospace scientists and engineers. Assuring the nation's ability to develop advanced technologies for our air defense network is of paramount importance.

The November 2002 report of the Presidential Commission on the Future of the United States Aerospace Industry states, "The United States must maintain its preeminence in aerospace research and innovation to be a global aerospace leader in the 21st century," and that "Government policies and investments in long-term research have not kept pace with the changing world." The Commission report recommends that "the federal government significantly increase its investment in basic aerospace research, which enhances U.S. national security, enables breakthrough capabilities, and fosters an efficient, and secure and safe aerospace transportation system" and that "the Administration and Congress work together to fund a new R&D initiative to develop a new 2lst Century air transportation system for the nation."

According to a recent report on "The National Economic Impact of Civil Aviation," the total economic impact of civil aviation exceeded more than $900 billion and 11 million jobs to the U.S. economy in the year 2000, roughly 9 percent of the total U.S. gross domestic product. The National Aeronautics and Space Administration's (NASA) and Federal Aviation Administration's (FAA's) budget should reflect this by striving for a strong national commitment to aeronautical research. If the American public expects the U.S. aviation industry to continue to be the largest positive contributor to U.S. balance of trade, then we must have the ability to develop the next generation of aircraft that will enable it to compete internationally.

Over the last decade, funding for NASA's aeronautics research and development (R&D) program has fallen by approximately 50 percent, and unfortunately this trend is continuing, The "Aeronautics Research and Development Act of 2003" will provide the necessary funding resources for NASA to compete with the European Union by implementing a program plan for their "Aeronautics Blueprint-Toward a Bold New Era of Aviation." We strongly support your efforts to counter the dramatic decline in U.S. research and development spending in aeronautics.

As we approach the centennial of the Wright Brother's first flight, it is more important than ever that America renew its national commitment to leadership in aviation. We commend you for your leadership in introducing this important legislation, and we look forward to working with you and other Members of Congress, in re-establishing the investment in aeronautics research and development as a national priority.

THE BOEING COMPANY
Chicago, IL, February 10, 2003

Hon. George Allen,
United States Senate,
Washington, DC.

Dear Senator Allen:

We at Boeing want to commend you on your foresight with Senator Dodd, in the introduction of the "Aeronautics Research arid Development Investment Act of 2003."

Your leadership in ensuring that the United States maintains its aerospace leadership is greatly appreciated by this aviation industry, which contributes $900 billion annually to the United States economy. Together the Federal government and the aerospace industry, working hand in hand, can assure our Nation a robust economy, a strong national defense, and a better quality of life for our citizens.

Your bill will enable long-term progress in aeronautics and aviation with a continued Federal investment in fundamental aeronautical research In addition, growth in productivity and our gross domestic product are directly related to an efficient and growing air transportation system. Your bill also proposes to aggressively move out to modernize our air traffic management system for improved capability.

We thank you for your vision and foresight and look forward to working with you in these areas of great importance to both the Boeing Company and our great Nation.

Sincerely,

DAVID SWAIN

AIRBUS
Herndon VA, February 25, 2003

Hon. George Allen,
United States Senate,
Washington, DC.

Dear Senator:

Thank you for affording me the opportunity to review legislation recently introduced by you, Senator Chris Dodd and Congressman John Larson that strives to reinvigorate the U.S. aerospace industry.

Airbus is very interested in, and supportive of, many aspects of the Aeronautics Research and Development Revitalization Act bill. This interest is based on the fact that Airbus, though headquartered in Europe, is a global company that has long depended on a vibrant, creative and innovative American aerospace industry.

Today, we are a key player in the U.S. industry—both through our U.S. operations in four locations in three states and through our investments and procurement with our American business partners. Last year, for instance, as a result of the great aerospace engineering talent that exists in this country, Airbus established an engineering office in Kansas. In Airbus North America Engineering, Inc., based in Wichita, American engineers are making vital contributions to the design work for the Airbus A380 aircraft. Furthermore, Airbus spent 40 percent of Its global procurement budget last year in the United States—with American aerospace manufacturers—to provide key components for our full range of aircraft. This $5.6 billion expenditure (greater than Airbus procurement expenses in any other country in the world) is recognition of the fact that American companies are successfully competing and successfully producing valuable components of high quality and competitive costs.

Your bill aims to help ensure that American aerospace companies continue to compete successfully, and we support that aim. There are several key provisions in this bill that we find compelling and positive for advancing the aerospace industry generally—and the industry in the U.S. particularly.

- Your legislation recognizes that adequate investment in education, training and research is crucial.
- It focuses on some of the most vexing problems facing commercial aviation today, putting needed resources into reducing noise and emissions.
- When the aviation industry fully recovers from the economic downturn and the events surrounding 9/11, we will be back to the old problem of congestion of the airspace. Again, your legislation would attack this problem head on, by investing in weather research and air traffic control systems.

Without dramatic improvements in all these areas, commercial aviation will not be able to meet the demands of tomorrow's marketplace.

Senator, we salute your efforts, and those of your colleagues, to maintain the competitiveness of the U.S. aerospace industry—one comprised largely of our business partners and one clearly integral to our own business success as well.

Sincerely,

T. ALLAN MCARTOR,
Chairman

Senator ALLEN. I would advise my colleagues that the U.S. aviation industry is the largest contributor to the U.S. balance of trade and directly accounts for $343 billion to the U.S. economy and 4.2 million positions in our job market. These workers earn an average income that is 35 percent higher than the average income in this country. Continued reductions and stagnation in aeronautics funding would lead to a continued loss in highly-trained human resources to countries that are placing a greater emphasis on aeronautics.

We must also consider the impact aeronautics research has on our military. Every military aircraft design the United States military currently flies incorporates advanced technologies that were

developed at NASA research centers. Aeronautics research has made the United States the dominant air power in the world, with technologies years in advance of our closest pursuers. As a result of these advancements, U.S. troops are placed in far less harm and more precise in their strikes against enemy targets, and that is important, as well, so that there is not as much collateral damage with less precision in the aeronautics.

In the future, our troops need to continue to have the most technologically advanced equipment and armaments for their safety when protecting our freedoms and our interests. Making the United States the clear leader in aeronautics research and development, in my view, is in the best interest of our military, it is in the best interest of our civilian airline industry, and means a great deal for quality jobs and also our balance of trade. The aviation industry affects the lives of almost every American, and I am hopeful that this hearing will highlight the importance—and I believe it will—of aeronautics research and facilitate positive changes to our aeronautics policies.

So, Mr. Chairman, I thank you very much for your leadership and your insight in organizing this important hearing, and I look forward to the testimony of our esteemed witnesses.

Thank you, Mr. Chairman.

Senator BROWNBACK. Thank you very much, Senator Allen.

Senator Dodd, welcome to the Subcommittee. Delighted to have you here, your interest and your leadership on this topic.

STATEMENT OF HON. CHRISTOPHER J. DODD, U.S. SENATOR FROM CONNECTICUT

Senator DODD. Well, thank you, Mr. Chairman. And I will ask unanimous consent my remarks be included in the record, but I suppose I could just testify by saying, "Amen."

[Laughter.]

Senator DODD. As you both have——

Senator BROWNBACK. We will recognize that in this Committee.

Senator DODD. Yeah, go ahead.

[Laughter.]

Senator DODD. It is terrific. Both of your statements really say it very, very well and very comprehensively.

What brings me to the Committee is obviously the comments of our colleague from Virginia, who I am pleased once again to be coauthoring a proposal that he has outlined very thoroughly for you. We think it is worthy of the Committee's consideration, the full Senate's consideration.

I was thinking as I was coming in and testifying before this Subcommittee, as both of you are aware, my father served in the Senate back in late 1950s, early 1960s, and one of the committees I used to love going to was a freestanding committee called the Committee on Space and Aeronautics. It was an individual committee.

There was a time when we placed such a priority on this subject matter that there was a free, separate committee that dealt with these issues. And I am not here to suggest—I do not see the chairman of the full committee around, so do not tell him I said this, because there is an always an argument to be made that, given the importance of this—and Senator Allen has just laid out the eco-

nomics, put aside some of the other very legitimate issues of national security—why we have full standing committees in certain areas which have a marginal impact on our economic and long-term security, and subject matters like this, putting aside the issue of appropriations and the like, just the priority we in the Congress give to this subject matter seem to have been higher in times past than it is today. And it is reflected, obviously, in what has happened over the last decade in budget allocations. But maybe we ought to think at some point about how we might revive again the notion and the Senate of the United States placing a greater emphasis on this subject matter.

Competition is healthy. It absolutely is. We are all better off for it. But if you are going to compete, you have got to be in a position to do so. And we have declined in our capacity to compete effectively. We are all making note—I do in my statement—about December 17th, 1903, of course, the Wright Brothers' famous powered flight in Kitty Hawk.

I recently was in Ireland and visited a site that I never knew existed before. It was the site where a couple of guys named Alcock and Brown, in 1919, flew a plane from Newfoundland, and it crash landed in Ireland. It was the first successful transatlantic flight. Obviously, Lindbergh's flight some years later is the one that has got all the attention. I had never heard of Alcock and Brown before. They flew that plane, imagine, 16 years, only 16 years, after the Wright Brothers' 12 seconds—flew a plane, an open-cockpit plane, the two of them, with twin engines. They were Rolls–Royce engines, I noted when I read the plaque.

So early on, there has been competition from the European community and elsewhere, and that is not a bad thing. We welcome that. But we have maintained, as you both have pointed out, in the 20th century, really the dominant position in the world, particularly the area of commercial aircraft, of course, and in our defense structures, as well.

We have been the world leader, and not just in terms of market share, but also of innovation. The great ideas, the most breakthrough technologies that occurred, occurred in the United States. There were obviously ones that occurred off our shores, as well, but the bulk of them occurred here.

There has been a dramatic change in the U.S. aeronautics priority in the last ten years. In 1985, in commercial aircraft, we controlled about 73 percent of the world market. That has declined now to less than 50 percent of the world market in the past decade. I do not know that much needs to be said, I mean, just in what has happened. Now, there are a lot of reasons for it—a united Europe, they are beginning to work more closely together, various other reasons. But the fact of the matter is, we are declining. And if you look at the budgets during that same period of time, the research budgets out of NASA's Aeronautics Research and Development Program have fallen to about 50 percent of what they were. So you do not need to have to connect a lot of dots here to understand what has happened.

Now, again, there are a lot of pressures, and very legitimate pressures, on scarce dollars, but you both have made the point that

from an economic standpoint, from a national security standpoint, this is not an area where we ought to be losing market share.

I think we all accept the notion that we are going to face a far more difficult time in competing when there are low-value products out there. Given wage rates in developing countries, it is awfully difficult for the United States to maintain a competitive position in those market areas. Why in the world we would ever, ever, ever allow our Nation to fall as far behind as we are doing so, in this particular area, would be unforgivable. The indictment, historically, will be pronounced and severe if we do, in my view.

So we owe it to future generations—just as previous generations have bequeathed this generation a very strong and vibrant aerospace industry—we owe a common commitment to the future generations to be no less than what we have been left. In fact, the commission, which you have referenced to, I think said it very, very, well and even more concisely. And I quote them when they said, "We stand dangerously close to squandering the advantage bequeathed to us by prior generations of aerospace leaders," end of quote. I think that is about as concise and to the point.

Now, we have not lost it yet, but it is waning, and I think the warning signs are all there. And so it is going to be extremely important that we do everything we can to respond to it.

In contrast—as, again, Senator Allen has made the case that maybe deserves repeating here—contrasts our disappointing trend line in this area. Two years ago the European commission unveiled a report entitled "European Aeronautics, A Vision for 2020," to show you how far they are thinking. We are talking about a five-year bill, Senator Allen and I are; and they are talking in generations. We are talking in increments of five years. Remember, there was a country not long ago that used to talk about five-year plans. And they have committed $93 billion by 2020, and outlined ambitious goals of attaining global leadership in aeronautics and creating a world-class air transport system for Europe and ultimately the entire industrialized world. That is their plan and vision. The U.S. is now in a position where it must catch up in an effort not to lose its economic and technological dominance over the international aeronautics market.

It is important to point out, as well, that the declining investment in aviation R&D is causing real economic pain right now. And, again, both of you made this point, Senator Allen very directly when he cited the numbers and statistics. In my State of Connecticut, and across the Nation, highly-trained workers are being laid off, engineering jobs are being outsourced to other nations where labor costs are obviously lower. I find this to be an unacceptable threat to our Nation's long-term economic future and national security issues.

That institutional memory, that synergy that occurs when you have people who have the experience and background that bring all of that wealth together, when we start losing that and start relying on others to provide it for us, it gets very, very dangerous, indeed.

Again, the industries of civil aeronautics and civil aviation bring about $900 billion and 11 million jobs to our economy. Senator Allen has made this point. Again, it is an important piece of our economy that should be strengthened and continued. Just in the

year 2000, roughly 9 percent of the total U.S. gross domestic product was directly related to this industry. And we are now finding ourselves in a very shaky position.

So our bill has been laid out for you. You understand what it does. We know there are a lot of ideas you will be getting, Mr. Chairman. The good news is, you are going to do something about it. I am confident you will, confident the full Committee will. We are confident the Senate will. We introduced our bill, I think a little late probably, last year to kind of get the kind of attention. But we are in early this year. This is a great hearing to be having, here in the early weeks of February, to get us going.

Lastly, I would just mention—and it is not the subject matter of the Subcommittee directly, but just the very notion of basic research, Mr. Chairman. The one area that we have been very good at in the last few years in basic research is in health, and I think the evidence is so overwhelming, what has happened in medical devices and products, there are miracle drugs that are appearing, because we in the public sector made a commitment to basic research. And you cannot rely on the private sector to pick up the slack on basic research. Applied research, they can do, but basic research, there are so many empty holes in basic research that just do not produce anything at all, and you would have a hard time explaining to shareholders and boards of directors if you invested hard-earned money as often as you have to in basic research and to come up empty. But it is something we ought to be able to do more of, because it has been a critical component of our economic success in developing new technologies and being on the cutting edge, internationally.

And so, as a general matter, I wish we could find some way to reignite the interest in basic research in this country. And this is, of course, one area where I think we can do something about it, but I would like to excite you imagination about looking at the basic research component that we used to play a far more critical role in, and I think that role contributed, in no small measure, to the success we enjoyed throughout the 20th century. So I raise that just as a subject matter for your consideration in future conversations and debates.

But I am delighted to be joining my colleague from Virginia as his cosponsor in this very exciting proposal, and we hope you will find it worthy of your consideration.

[The prepared statement of Senator Dodd follows:]

PREPARED STATEMENT OF HON. CHRISTOPHER J. DODD,
U.S. SENATOR FROM CONNECTICUT

Chairman Brownback, Ranking Member Breaux, and Members of this Subcommittee, I appreciate the opportunity to make some brief remarks today regarding the importance of U.S. involvement in aerospace research.

Aerospace and aviation are important assets for America and for my home state of Connecticut. In addition to its obvious national security benefits, the aeronautics industry makes a critical contribution to our nation's economic growth and standard of living. As all of you are aware, this year marks the 100th anniversary of Wilbur and Orville Wright's first successful powered flight. Since those humble beginnings, aviation technology in the United States has reached remarkable heights. In the 20th century, the U.S. became the world leader in the aerospace market. Some say that the age of American preeminence in this field is on the wane. They point to the fact that in 1985, the United States controlled more than 73 percent of the com-

mercial aircraft industry—while today we control less than 50 percent of the global market.

Over the last decade, funding for the NASA's Aeronautics Research and Development program has fallen by approximately 50 percent. Recently the Presidential Commission on the Future of the Aerospace Industry confirmed these concerns by concluding that government policies and investments in long-term research have not kept pace with the changing world, and in order to do so, the Federal government must invest in aerospace research. I think the Commission said it well when it stated that "We stand dangerously close to squandering the advantage bequeathed to us by prior generations of aerospace leaders."

In contrast to this disappointing trend in the United States, two years ago, the European Commission and aerospace industry executives unveiled a report entitled "European Aeronautics: A Vision for 2020" which commits more than $93 billion by 2020 and outlines ambitious goals of attaining global leadership in aeronautics and creating a world class air transport system for Europe and ultimately the entire industrialized world. The U.S. is now in a position where it must catch up in an effort not to lose its economic and technological dominance over the international aeronautics market.

It is important to also point out that the declining investment in aviation R&D is causing real economic pain *right now* to American workers. *Right now,* in Connecticut and across America, highly trained workers are being laid off. Right now, engineering jobs are being outsourced to other countries where labor costs are lower. I find this to be an unacceptable threat to our nation's long term economic future.

How do we turn this around? Obviously, we cannot order a company to keep people on a payroll, and we would be hard-pressed to try to redirect the flow of intellectual capital into and out of the country. As the Wright Brothers so vividly showed, our country has always had a competitive edge in the world economy: the ingenuity of our people. This ingenuity has been cultivated by two factors above all others: one, the quality and funding of education; two, by investments in research and development. Obviously education is within the jurisdiction of another committee, but R&D is in the control of this Committee and specifically this Subcommittee. It is critical that we invest in our research and development and technology sectors so that American workers will lead the world in developing and building the technologies of tomorrow. The importance of civil aviation to our economy cannot be underestimated. It generated more than 900 billion dollars and 11 million jobs for the U.S. economy in the year 2000, roughly 9 percent of the total U.S. gross domestic product. This is not a sector that we can afford to continue to ignore.

Our colleague Senator Allen and I recently reintroduced legislation addressing this very issue. The Aeronautics Research & Development Revitalization Act of 2003, S. 309, establishes a broad-based agenda to reinvigorate America's aeronautics and aviation R&D enterprise and maintain America's competitive leadership in aviation.

Our bill doubles NASA and FAA research and development funding by 2008 to $1.15 billion and $550 million respectively. It sets new research goals for supersonic transport, rotorcraft, high-efficiency and other technologies that the private sector has identified as critical to future success in this industry. In addition, it establishes professional training and scholarship programs to cultivate the talent of tomorrow.

I am pleased that you are holding this hearing, Mr. Chairman, because it is important that all of Congress, the Administration, and America know that these are the facts, and the affects of losing this leadership will be detrimental to this nation as a whole. I hope that members of this Committee will take a look at our bill in the coming weeks. Senator Allen and I believe that this legislation merits the support of our colleagues. I look forward to working with you and other of our colleagues in the future. Thank you.

Senator BROWNBACK. Thank you very much, Chris, and I appreciate your thoughts and your comments. And I would say amen to yours, as well, because I really think that is where we are in my State, where we have so many of these manufacturing jobs in the aviation sector. These are the highest-waged, highest-skilled manufacturing jobs in the world, and so it is obvious why others would want them, and it is also obvious why we should do everything we can to protect them.

And I appreciate your last comment about basic research. We are going to hold some hearings with the head of NSF and other

groups. And I have asked her about what is her real focus and interest, and she—we talk about nano-technology and a number areas, but she says, you know, really we need to put money into physics, mathematics, and she was really digging at that same point, as well, that there is a feeling like you are just not planting the seed corn that you need to in those areas.

We have moved forward in a lot of nice areas very strongly, NIH's doubling of budget over the last five years, great investment producing great results, human genome project, beautiful technology, beautiful information. Almost weekly you are seeing something, we have found for the gene for this or for that. I wonder how many of those bad genes I have, but I have not asked yet, and I do not know if I want to know. But it is really going to help us a lot in the future. But I do not know that we have invested in the same sense in those basic physics, mathematics that we need to. So I appreciate your comments backing those up, as well.

Senator DODD. Thanks very much. Thank you both.

Senator BROWNBACK. Thank you very much for joining us.

The first panel we will have up, Honorable Robert S. Walker, chairman, Wexler and Walker Public Policy Associates here in Washington, DC Bob Walker, as former Congressman Bob Walker, was chairman of the Science Committee in the House side a number of years, a long-time advocate or research and specific research agendas to be able to help and build the strength and might of the United States. And also Dr. Jeremiah Creedon, associate administrator, Office of Aerospace Technology of NASA here in Washington, DC.

Gentlemen, thank you very much, both, for joining us. Your full statements will be put into the record if you want to summarize. It is your choice. We are delighted you are here.

Mr. Walker, Congressman Walker, we are delighted to have you here.

STATEMENT OF HON. ROBERT S. WALKER, CHAIRMAN, COMMISSION ON THE FUTURE OF THE U.S. AEROSPACE INDUSTRY, AND CHAIRMAN, WEXLER AND WALKER PUBLIC POLICY ASSOCIATES

Mr. WALKER. Thank you very much. Delighted to be with you today, Mr. Chairman. And I appreciate the opportunity to come before you to talk a little bit about the work that the Aerospace Commission has been doing over the last year to 18 months.

Obviously, we meet here under some tragic circumstances. We never would have anticipated when we were doing our work that we would lose the Columbia, but in our grief and as we struggle to comprehend that loss, the real issue here is how do we move on, and I think that what you will see and what the commission brought forward were some ideas for moving on.

In our view, nations aspiring to global leadership in the 21st century must be space faring. Freedom, mobility, quality of life, and the ability to do the difficult things that define leadership will be enhanced and discovered on the space frontier. For the vision and commitment that leadership requires, manned space flight is an imperative.

I would like to briefly summarize where we are with the work of the Aerospace Commission for you and give you some thoughts that come out of that report.

The Aerospace Commission was chartered by President Bush and by the Congress to study the future of the U.S. aerospace industry in the global economy and to make policy recommendations to ensure that the United States maintains its economic and technological leadership. The commission was comprised of 12 commissioners, six appointed by President and six appointed by the Congress. Our final report was issued to President Bush and the Congress on November 18th of 2002, but although we have completed our work, we hope that you will take our recommendations and findings into consideration as we face some of the hurdles ahead of us in the aerospace industry.

I come before you today to address two of the key recommendations that are linked together—one, aerospace research and development, and the special significance of the space enterprise.

When you ask a small child what excites them, what makes them want to learn, they usually answer "dinosaurs and space." The concept of space exploration and reaching beyond the stars comes from our American birthright as explorers and adventurers. Children do not want to just send their mechanical toys into space; they want to go themselves, and they think about it in those kinds of terms.

That American quest for knowledge brings with it the need for technological and engineering feats that make discovery possible. Basic science can produce more insights about our relationship to the universe for increasingly sophisticated astronomical missions. But the lack of sufficient and sustained public funding for research, development, tests, and evaluation infrastructure limits the Nation's ability to address critical national challenges and to foster breakthrough aerospace capabilities that could enable a new era of aerospace leadership in America.

Chapter 9 of the Aerospace Commissions report discusses our recommendation that the Federal Government significantly increase its investment in basic aerospace research, which enhances U.S. national security, enables breakthrough capabilities, and fosters an efficient, secure, and safe aerospace transportation system. We also make it clear that the U.S. aerospace industry should take a leading role in applying research to product development. Here are the transformational issues that we identified.

Propulsion and power. Development of more advanced propulsion systems will lead to faster transit times, improve operational flexibility, and reduce the impact of radiation for long-duration human exploration missions. Nuclear energy could produce high-temperature plasma that would potentially reduce the transit time for a manned mission to Mars from seven or eight months to about 12 weeks. The commission believes that once the time to explore many parts of the solar system has been reduced to reasonable durations, months instead of years, the political imperative to do those missions will follow. Increasing available power, both on orbit or beyond orbit, could expand opportunities in military, civilian, and commercial space applications.

The second thing is breakthrough energy sources. In the 21st century, new energy sources must be developed in order to achieve revolutionary new air and space capabilities. As President Bush recently outlined in his State of the Union Address, we are moving towards a hydrogen economy. Use of hydrogen fuel cells as auxiliary power in aircraft technology can be an important step in establishing a hydrogen economy that could free the U.S. from dependence on foreign sources of energy. Hydrogen fuel cells, of course, have always been an important part of our human space technology.

Another area is nano-technology. Not only did microchip technology lead to computers and the Internet during the second half of the 20th century, but it also brought us to the beginning of an exciting scientific revolution we now know as nano-technology. Recent discoveries indicate that, at the nano scale, devices and systems have completely different electrical, mechanical, magnetic and optical properties from those of the same material in bulk form. This could lead to such an increase in material strength that it could really revolutionize aerospace vehicle structural design and performance. The benefits of research may not be realized for decades, but are critical to innovation and keeping the Nation's intellectual capital fresh and vibrant.

The obstacle we face is to move forward with these advancements. We also, though, need to look at the underlying infrastructure. Testimony before the commission and the studies conducted by the Federal Government over the last decade have found that the Nation's research infrastructure is aging and unable to meet future needs. Transformational research and associated RDT&E infrastructure are the building blocks for developing breakthrough aerospace capabilities and are indispensable parts of the U.S. innovation process.

But in order to achieve true technological progress, industry has a great role and some responsibility. The commission believes that the U.S. aerospace industry must take the leadership in transitioning research into products and services. The transition of government research to the aerospace sector has been slow. The industry must aggressively develop business strategies that can incorporate government-funded research into application.

I would also like to take a moment to address another subject that the commission report spoke to and which is under the jurisdiction of this Committee. The Columbia tragedy has presented new challenges and questions about the advisability of human space flight. I believe that there is no more important mission than to extend our reach beyond the known into the unknown. We do that by investing in basic research, but we also do it on the frontiers of space.

Some may say that we can learn all we need to know by sending robots in our place. I would say that robots have their place, but it is not the same as ours.

I contend that there are three main reasons for us to continue to press forward with human space flight. The manned space program challenges us, pushes the envelope of technology to achieve the breakthroughs only made possible by humans. To those who say that robots are cheaper, better, and faster than humans, I say

humans bring curiosity and ingenuity. Robots merely see the expected. Their successes and discoveries are based upon past experiences. Humans, however, when we are confronted with the unexpected, can produce greater discoveries.

We cannot allow out international competitors to surpass us. Japan, China, India, and France all see space as a strategic and economic frontier that should be aggressively pursued. China is poised to launch a moon mission in a few short years, and I believe their intentions are not just to fly to the moon, but to stay there and set up a permanent base.

Whenever I consider why we travel in space, I have seen the hand of God beckoning us to the heavens. We stand in a moment in history when we can either respond to that call or retreat from it. I believe, for own generation and for those to follow, we must be willing to invest the resources and summon the courage to reach as far as we can into the universe.

I thank you for the opportunity to make this address.

[The prepared statement of Mr. Walker follows:]

PREPARED STATEMENT OF HON. ROBERT S. WALKER, CHAIRMAN, COMMISSION ON THE FUTURE OF THE U.S. AEROSPACE INDUSTRY, AND CHAIRMAN, WEXLER AND WALKER PUBLIC POLICY ASSOCIATES

We meet today under tragic circumstances. Words cannot describe the depths of our grief as we struggle to comprehend the loss we suffered on Saturday, February 1, 2003. Our prayers are with the families of the STS–107 crew as we pick up our hearts and move on.

And move on we must. The answer to the question why do we take the risks must be answered with how we take the risk. Nations aspiring to global leadership in the 21st century must be space faring. Freedom, mobility, quality of life and the ability to do the difficult things that define leadership will be enhanced and discovered on the space frontier. For the vision and the commitment that leadership requires, manned space flight is an imperative.

I would like to briefly summarize where we are with the work of the Aerospace Commission.

The Aerospace Commission was chartered by President Bush and Congress to study the future of the U.S. Aerospace Industry in the global economy, and make policy recommendations to ensure that the United States maintain its economic and technological leadership. The Commission was comprised of 12 Commissioners—six appointed by President Bush and six appointed by Congress. We issued three interim reports and our final report contained nine key recommendations which outlined an aerospace vision for our nation and addressed the areas of air transportation, space, national security, government, global markets, business, workforce and research.

The Commission's final report was issued to President Bush and Congress on November 18, 2002 but although we have completed our work, we hope you will take our recommendations and findings into consideration as we face another hurdle in aerospace history.

I come before you today to address two of those key recommendations that are inextricably linked—aerospace research and development and the special significance of space.

When you ask a small child what excites them, what makes them want to learn, they answer dinosaurs and space. The concept of space exploration and reaching beyond the stars comes from our American birthright as explorers and adventurers. Children do not dream of sending their mechanical toys into space, they want to go into space themselves. They want to experience space travel and respond to visits and interact with astronauts through NASA programs and such wonderful institutions like the Challenger Center.

That American quest for knowledge brings with it the need for technological and engineering feats that make discovery possible. Basic science can produce more insights about our relationship to the universe through increasingly sophisticated astronomical missions.

In 1908, Wilbur Wright stated, "But it is not really necessary to look too far into the future; we see enough already to be certain that it will be magnificent. Only let us hurry up and open the roads."

Research and development are the roads that lead to revolutionary aerospace capabilities. In the past, aerospace led the technology revolution because of large public investment in research directed at national security imperatives and goals. Today, we do not have an integrated national aerospace consensus to guide policies and programs. This has resulted in unfocused government and industry investments spread over a range of research programs and aging infrastructure.

The lack of sufficient, sustained public funding for research, development, tests, and evaluation infrastructure limits the nation's ability to address critical national challenges and to foster breakthrough aerospace capabilities that could enable a new era in aerospace leadership for America.

Chapter 9 of the Aerospace Commission's report discusses our recommendation that the federal government significantly increase its investment in basic aerospace research, which enhances U.S. national security, enables breakthrough capabilities, and fosters an efficient, secure, and safe aerospace transportation system. We also make it clear that the U.S. aerospace industry should take a leading role in applying research to product development.

Transformational Issues

Propulsion and Power

Development of more advanced propulsion systems will lead to faster transit times, improve operational flexibility and reduce the impact of radiation for long duration human exploration missions. Nuclear energy could produce a high-temperature plasma that would potentially reduce the transit time for a manned mission to Mars from seven or eight months to about twelve weeks. The Commission believes that once the time to explore many parts of the solar system has been reduced to reasonable durations—months instead of years—the political imperative to do so will follow. Increasing available power, both on orbit and beyond orbit, could expand opportunities in military, civil, and commercial space applications.

Breakthrough Energy Sources

In the 21st century, new energy sources must be developed in order to achieve revolutionary new air and space capabilities. As President Bush recently outlined in his State of the Union address, we are moving towards a hydrogen economy. Use of hydrogen fuel cells in aircraft technology can be an important step in establishing a hydrogen economy that could free the U.S. from dependence on foreign sources of energy.

Nanotechnology

Not only did microtechnology lead to computers and the Internet during the second half of the 20th century, but it also brought us to the beginning of an exciting scientific revolution we now know as Nanotechnology. Recent discoveries indicate that at the nano scale, devices and systems have completely different electrical, mechanical, magnetic and optical properties from those of the same material in bulk form. This could lead to such an increase in material strength that could revolutionize aerospace vehicle structural design and performance.

The benefits of research may not be realized for decades but are critical to innovation and to keeping the nation's intellectual capital fresh and vibrant.

The obstacle we face is to move forward with these advancements; we need to change the underlying infrastructure. Testimony before the Commission and studies conducted by the federal government over the last decade have found that the nation's research infrastructure is aging and unable to meet our future needs.

Much of the U.S. RDT&E infrastructure is 40–50 years old. We need to identify and invest in a new infrastructure that supports U.S. government and aerospace industry needs so our infrastructure does not become a constraint on our country's technological advancement.

Transformational research and the associated RDT&E infrastructure are the building blocks for developing breakthrough aerospace capabilities and are indispensable parts of the U.S. innovation process. But in order to achieve true technological prowess, industry has a great role and responsibility.

The Commission believes that the U.S. aerospace industry must take the leadership in transitioning research into products and services. The transition of government research to the aerospace sector has been slow. The industry must aggressively develop business strategies that can incorporate government-funded research into application.

I would like to take a moment to address another subject of the Commission report, which is under the jurisdiction of this Subcommittee. The Columbia tragedy has presented new challenges and questions about the advisability of human space flight. I believe there is no more important mission than to extend our reach beyond the known into the unknown. We do that by investing in basic research but we also do that on the frontiers of space.

Some may say we can learn all we need to know by sending robots in our place. I would say that robots have their place, but it is not the same as ours. I contend that there are three main reasons for us to continue to press forward with human space flight:

The manned space program challenges us—pushes the envelope of technology to achieve the breakthroughs only made possible by humans.

To those who say that robots are cheaper, better, and faster than humans, I say humans bring curiosity and ingenuity. Robots merely see the expected—their success and discoveries are based on past experiences. Humans however, when we are confronted with the unexpected can produce greater discoveries.

We cannot allow our international competitors to surpass us. Japan, China, India and France all see space as a strategic and economic frontier that should be aggressively pursued. China is poised to launch a moon mission in a few short years and I believe that their intentions are not to just fly to the moon, but to stay there and set up a permanent base.

Whenever I have considered why we travel to space, I have seen the hand of God beckoning us into the heavens. We stand in a moment in history when we either respond to that call or retreat from it. I believe for our own generation and for those to follow, we must be willing to invest the resources and summon the courage to reach as far as we can into the universe.

Again, thank you for the opportunity to appear before you today, and I look forward to your questions.

Senator BROWNBACK. Thank you very much, Congressman Walker, we appreciate that very thoughtful and stimulating and poetic statement.

Dr. Creedon, delighted to have you here in the Committee. And do not pay attention here to the clock. I guess we will try to stymie that. Take whatever time you need to testify.

STATEMENT OF DR. JEREMIAH CREEDON, ASSOCIATE ADMINISTRATOR, OFFICE OF AEROSPACE TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. CREEDON. Okay, thank you, Mr. Chairman.

I want to thank the members of the——

Senator BROWNBACK. We should get that microphone over to you, if you will. While we are tech and technology, we are not particularly high-tech here. Talk right into it.

Dr. CREEDON. Okay, thank you. I want to thank the Members of the Subcommittee for the opportunity to testify on aerospace research and development.

Before I begin, however, I would like to express the overwhelming sense of loss felt by the people of NASA in the wake of the Columbia tragedy. We are determined to find the cause, fix the problem, and move on.

Turning to the subject of today's hearing, I want to recognize the work of Chairman Walker and the Commission on the Future of the United States Aerospace Industry and congratulate them on their thorough analysis of the issues.

The Commission was asked to identify actions that the United States could take to ensure the future health of the United States aerospace industry. Of the nine recommendations of the Commission, five have a very strong focus on research and technology. The

Commission clearly stated that research and technology is the foundation for the future of the aerospace industry.

Quoting directly from Chapter 9 of the report, and I quote, "Aerospace is a technology-driven industry. Long-term research and innovation are the fuel for technology. U.S. aerospace leadership is a direct result of our preeminence in research and innovation."

The Commission recommends investments in this country's future. NASA's programs are the type of investment that the commission recommends. We believe NASA's current and planned research and development efforts are in alignment with the thrust and intent of the Commission's findings and recommendations. In particular, we are dedicated to providing technologies for leadership in aviation and in space transportation, to working with the educational community in growing and sustaining a technical workforce in our Nation, and in conducting the research that is needed to fuel the innovations of the future.

I have here a copy of our recently published strategic plan at NASA. This plan articulates NASA's mission, vision, and ten strategic goals. One of the goals is to enable a safer, more secure, efficient, and environmentally friendly air transportation system. We are investing in technologies to support the transformation of the National Airspace System, as is recommended in Chapter 2 of the commission's report. In fact, through reprioritization of activities within our budget, we propose to expand our investment in this area, and we are working closely in partnership with the FAA on this critical issue.

As Chapter 2 of the Commission's report also notes, security is a key requirement of the future air space system. We certainly agree and have been working since September 11th to develop a responsive program that draws on and reflects NASA's unique strengths. We also propose to initiate an aviation security project that seeks to enable long-term, high-leverage solutions to eliminate key vulnerabilities within the aviation system.

Another one of our goals is to ensure the provision of space access, and improve it by increasing safety, reliability, and affordability. This goal is responsive to Chapter 3 of the Commission report.

We have developed a new, integrated space transportation plan that addresses our space access needs. The plan fully funds the space station, sustains the space shuttle, aggressively pursues crew rescue and crew transfer capabilities, and also develops technologies for future launch systems. As recommended in the report, we are collaborating very closely with the Department of Defense on the National Aerospace Initiative, and we will have an integrated program with the DoD that will end up demonstrating key technologies in flight.

In addition, we are continuing our long-term collaboration with the DoD in aeronautics. NASA has requested funding for Project Prometheus to develop nuclear power and propulsion for space exploration. This will significantly reduce travel time and increase the available power to support science instruments in space. This, again, is in alignment with the Commission recommendation.

Many of our efforts address the specific recommendations on breakthrough aerospace capabilities that are noted in Chapter 9 of

the report. In fact, we have some level of investment in each of the areas addressed. We have efforts to reduce nitrous oxides by 70 percent and CO2 by 25 percent. Our investments in aviation safety will develop technologies that will contribute to a 50 percent reduction in the aviation fatal accident rate, and we plan follow-on projects that will take that reduction to an even greater extent. Our investments in small aircraft transportation will significantly contribute to opening up aviation to smaller communities and reduce door-to-door transit time.

In the case of noise reduction, our budget request increases our investment over the next few years to ensure that the noise reduction technology is aggressively transferred.

Finally, the commission is justifiably concerned about the time it takes to transition research and development into products. At NASA, we measure our success in technology by the extent to which our results are transferred and are applied. In recent years, we have transferred and seen the application of noise and emission reduction technologies, decision-support tools for air-traffic management, aviation safety technologies, and more.

In summary, we congratulate the Commission on a thorough and insightful report. We believe that the research and technology efforts are the key to the future health of the U.S. aerospace industry. We believe the NASA mission goals and technology programs are in very close alignment with the commission's recommendations, and we are committed to technology innovation and transferring of our technology into applications that benefit the quality of life in this country.

Thank you, Mr. Chairman, and I will be happy to answer your questions.

[The prepared statement of Dr. Creedon follows:]

PREPARED STATEMENT OF DR. JEREMIAH CREEDON, ASSOCIATE ADMINISTRATOR, OFFICE OF AEROSPACE TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to speak about the recommendations found in the *Final Report of the Commission on the Future of the United States Aerospace Industry*. We appreciate the diligence and thoroughness of the Commissioners and the recommendations they have brought forward. We support the Commission's overall message that Aerospace will be at the core of America's leadership in the 21st century and that for this industry to remain healthy, the critical underpinnings of this nation's aerospace industry must be strong.

To achieve their stated vision, the Commission makes several recommendations that have a strong focus on research and technology. NASA is an investment in this country's future of the type that the commission recommends. In particular we are dedicated to providing technologies for leadership in aviation and space transportation, working with the educational community in growing and sustaining a technical workforce in our nation, and conducting the research needed to fuel the innovations of the future.

NASA Strategic Plan is in alignment with the Commission's Report

Under Administrator Sean O'Keefe's leadership, we have just released a new NASA Strategic Plan that is responsive to national needs and is very much in agreement with the thrust of the Commission's report. All members of Congress should have recently received a copy of this Strategic Plan. Our new Agency Mission Statement reads: "To understand and protect our home planet, To explore the universe and search for life, To inspire the next generation of explorers . . . as only NASA can."

I want to paraphrase this Mission Statement slightly to point to the Strategic and Enabling goals that NASA developed to support each element, and from there, discuss the work we do in specific support of the Commission's recommendations in Chapters 2, 3, 8 and 9.

To Understand and protect Our Home Planet . . . leads to specific NASA goals for enabling a safer, more secure, more efficient and more environmentally friendly aviation system, and improving security and quality of life. As NASA works with the FAA and others to achieve these goals, we are in direct support of the Commission's report, especially the Chapter 2 recommendation to transform the U.S. air transportation system and the Chapter 9 recommendation to enable breakthrough aerospace capabilities.

To Explore the Universe and search for life . . . leads to specific NASA goals of assuring access to space, and developing revolutionary technologies that enable the agency's science missions of the future, which in turn, open new opportunities to science, exploration and commercial space endeavors. These efforts support the view in Chapter 3 of the Commission report.

To Inspire the Next Generation of Explorers . . . leads us to NASA goals for working with educators, K–12 students, and the university community, to ensure that the aerospace industry has access to a scientifically and technically trained workforce as recommended in Chapter 8 of the Commission report.

As only NASA can . . . leads us to the unique basic research and technology development NASA performs to fulfill our Mission, particularly in areas that offer the potential for breakthroughs in critical aerospace capabilities such as propulsion and power, information technology, and nanotechnology as recommended in Chapter 9 of the Commission report.

Early last year NASA unveiled an *Aeronautics Blueprint* that outlined a new and revolutionary technology vision to address the aviation challenges we face in the 21st Century. The four critical areas for technological investment identified in the *Blueprint* and also included in the Commission's areas of emphasis are: a Digital Airspace, Revolutionary Vehicles, Aviation Safety and Security, and a State-of-the-Art Educated Workforce. These *Blueprint* elements have been incorporated in NASA's 2003 Strategic Plan.

Specific NASA activities in alignment with the Commission's Recommendations

Through our Mission and goals, we have set the priorities that guide our investment of the taxpayers' money, and clearly inform our Enterprises, Centers, and most importantly, each of our employees, how they contribute with their particular talents and capabilities to meet the nation's critical needs. This hearing is a timely opportunity to highlight changes Administrator O'Keefe has made within NASA, as well as elements in the President's Fiscal Year 2004 budget that speak directly to the Commission's recommendations. Recent highlights include:

- NASA has an Education initiative to turn the tide on declined interest in science, technology, engineering, and mathematics.
- NASA has a new Integrated Space Transportation Plan to more fully integrate its efforts in the International Space Station, the Space Shuttle and the Space Launch Initiative to support Science activities in space.
- NASA developed (with industry, academia, the FAA, and DoD) an *Aeronautics Blueprint* to define technologies that have the potential to open a completely new era in aviation by providing unprecedented air transportation safety and efficiency, a transformed national defense, new markets and economic growth, and enhanced quality of life.

Overall NASA has aligned its programs to better represent and reflect national priorities and to better concentrate our efforts. What follows is a summary of some of our key activities.

AVIATION

The Commission has called for, in Recommendation #2, an air transportation system that meets the needs of civil aviation, homeland security and national defense. The President's Fiscal Year 2004 Budget reprioritizes investments and increases funding for three new initiatives focused on *National Airspace System Transition, Quiet Aircraft Technology, and Aviation Security.*

A critical element for the work in aviation is the need to set up an interagency organization to guide and coordinate efforts for a National Aviation System Transformation. FAA, NASA, and OSTP have coordinated a proposal for such an organization that would set goals and align missions across government to ensure that the

United States can meet future system demands, and stay at the forefront of the global aviation industry.

National Airspace System Transition: Prior to the attacks of September 11, 2001, the aviation system was showing unmistakable signs of gridlock. Most air travelers had experienced congested airports, flight delays, and unreliable service. Since deregulation of the airline industry in the United States in 1978, air travel has tripled while the air transportation support infrastructure has remained relatively unchanged. Only one large hub airport and seven new runways have been opened in the past decade, while the number of departures had grown nearly 30 percent from 7 million to 9 million per year.

As a result of the impact of September 11th on the economy and air transport system, the current demand has been reduced but we believe that the capacity issues that we faced prior to the attacks will return. Specifically, the growth in delays in the years 2000 and 2001 significantly outpaced the growth in air traffic. Our existing airspace management system clearly cannot accommodate projected growth. We need to continue the development of technology to solve the problem of limited capacity of the National Airspace System (NAS). We do not want to have a situation where the capacity of the system constrains national economic growth.

Safety and security have taken on a whole new perspective since the terrorist attacks. NASA is committed to working with airlines, airports, and other Federal agencies to develop concepts and technologies, which will reduce the vulnerability of aircraft and the NAS to criminal and terrorist attacks.

I am pleased to report that through reprioritization within the President's FY 2004 budget, there is increased funding to address these critical aviation issues and begin the development of technology to increase the efficiency and capacity of the National Airspace System (NAS).

We will invest $27 million in FY 2004 for this initiative, which we call the National Airspace System Transition ($100 million over 5 years). The major challenges are to accommodate the projected growth in air traffic while preserving and enhancing safety; providing all airspace system users more flexibility, efficiency and access in the use of airports, airspace and aircraft; enable new modes of operation that support the FAA commitment to "Free Flight" and the Operational Evolution Plan (OEP); and develop technology to enable transition to a next generation National Airspace System beyond the OEP horizon.

The research within this program will be focused on developing a more flexible and efficient operational approach to air traffic management. For example, together with the FAA, NASA will investigate and solve the technical challenges of increasing runway capacity in inclement weather to eliminate the biggest source of delays—poor visibility. We will also develop totally new concepts that allow the system to scale with increasing traffic levels. We are developing sophisticated new modeling capabilities of the nation's air traffic system so we can test out our tools and concepts.

As the Commission has pointed out, the transfer of technology—to ensure its application—is essential to realize its value. Through efforts such as an interagency program office we will strengthen ties between the member agencies, and work similarly with academia and industry to transition the research into technologies, products and services useful to the nation.

Quiet Aircraft Technology: Noise is typically a primary objection that communities have to airport or runway expansions. Airports located in remote areas when they were built are now located in the midst of sprawling communities. They are subject to an increasing number of noise restrictions affecting airport and aircraft operations. Since 1980, noise restrictions at airports grew worldwide from 250 to over 800 airports with specific additional restrictions beyond normal regulations.

The U.S. has spent more than $4 billion from the Aviation Trust Fund and Passenger Facility Charges over the last 20 years to mitigate airport noise (e.g., sound-insulating nearby homes, building protective barriers). Reducing the noise impact on communities is a key issue for 21st Century aviation.

To illustrate this challenge of reducing aircraft-generated noise, we have conducted analyses of aircraft noise at Chicago O'Hare International Airport. Using the baseline 1997 aviation fleet noise-level contours, objectionable noise levels extend many miles from the airport and affect approximately 600,000 people in the surrounding community. A quieter fleet of aircraft with a 10-decibel reduction in noise will reduce that impact on all but approximately 55,000 people. NASA's research and technology development continues to be focused on how to eliminate noise as an issue—by confining any objectionable noise to within the airport boundaries.

The President's FY 2004 budget has increased the funding to address this critical aviation issue. NASA's *Quiet Aircraft Technology* Program is the primary source of

technology to achieving the noise goal and includes an increase of $15 million in FY 2004 (an increase of $100 million over 5 years) for this work.

NASA is developing technologies that can directly change the noise produced by jet engines. Through an understanding of the basic physics of noise production we are able to interfere with the way that sound is produced, creating quieter aircraft for future travelers. We have also determined that a large part of the objectionable noise comes from parts of the aircraft other than the engines when the aircraft are approaching the runway. NASA is developing concepts for landing gear and wing configurations to reduce this objectionable noise. Physics-based tools for noise propagation allow us to test the benefits of new flight profiles to bring the aircraft noise closer to the airport while maintaining flight safety.

In FY 2001, NASA was able to conduct full-scale demonstrations of noise reduction technologies that would result in a 5 decibels reduction in perceived noise. This technology has been transferred to industry and is already being offered on production aircraft and engines. Based on these results and the increased funding provided in the President's Budget for research, we will be able to work in partnership with the engine and aircraft manufacturers to bring additional noise reduction technology to new aircraft more quickly than had been otherwise planned. We are expecting to demonstrate an additional 5-decibel reduction in perceived noise by the end of FY2007, leading to a total of 10dB reduction in comparison to the 1997 state of the art. To better understand the significance of this accomplishment, we can refer back to the illustration of Chicago's O'Hare airport. With a 5-decibel reduction the area encompassed by the contour of objectionable noise was reduced by 40 percent, with a 10-decibel reduction, the effected area is reduced almost 70 percent.

Aviation Security and Safety: Aviation has a long-standing tradition of being the safest among all modes of transportation. The rate of accidents and fatalities on a per-passenger-mile basis for commercial aviation is at least a factor of two lower than that achieved by any other mode of transportation. However, as aviation continues to grow, there are concerns that unless steps are taken to drastically reduce accident rates, increased flights will lead to more accidents. Any incident receives visibility, and some are deemed national tragedies. Each affects the public's faith and confidence in aviation as a whole. Thus in 1997 the National Civil Aviation Review Commission endorsed a goal to cut the fatal accident rate by 80 percent by 2007. Much progress has been made in NASA technology development for aviation safety. In particular we have seen the transition of advanced cockpit weather technology into operational practice—both forecast and real-time. In the area of security for aviation there is a lot of synergy with the technologies for safety.

Since the terrorist attacks of September 11, 2001, safety and security have taken on a whole new perspective. NASA is committed to working with airlines, airports, and other Federal agencies to develop concepts and technologies that will reduce the vulnerability of aircraft and the national airspace system to criminal and terrorist attacks

As part of the President's FY 2004 Budget request, NASA will begin a new effort in Aviation Security. We will invest $21 million in FY 2004 for this initiative ($225 million over 5 years). Research in this program will focus on concepts and technologies that can protect aircraft and the airspace system from criminal and terrorist attacks while dramatically improving the efficiency of security. In the near-term, NASA will develop and demonstrate decision support technologies for ground-based air traffic management systems that detect and assist in the management of threatening situations. Other areas include technologies to reconfigure the aircraft to fly safely in the event of damage, and flight controls technology that would prevent the aircraft from being purposefully crashed. While details of the program are in formulation, it is currently expected that the long-term research will address:

- Protection of Aircraft & Airborne Systems from Electro-Magnetic Interference
- Airspace Operations
- Transfer of Fundamental Information Technology to Security Applications
- Transfer of Fundamental Sensor Technology to Security Applications

NASA has and will continue to work closely and partner with the Department of Defense (DoD), the Department of Transportation (DOT), the Federal Aviation Administration (FAA), the Department of Homeland Security, academia, and industry to ensure that the research that NASA pursues is deliberately and methodically integrated into useful and timely products and processes.

ACCESS TO SPACE

The Commission has called for ensuring our nation's ability to explore and utilize space, in Recommendation #3, as well as in Recommendation #9, which calls for in-

creasing federal investments in basic aerospace research with the goal of reducing the expense and time to reach space safely and reliably.

NASA agrees with the need to ensure and improve access to space. In the President's Budget Amendment for Fiscal Year 2003, NASA has formulated the revised Integrated Space Transportation Plan (ISTP) to ensure that safe, affordable, capable, and reliable space transportation systems are provided to support NASA's missions. The Space Launch Initiative (SLI), which began in 2001 as a key component of the ISTP, will provide the necessary technology development, risk reduction, and systems analysis to enable future space access capabilities. Based on recent system analyses, the ISTP has been updated and SLI has been refocused. As a result, NASA has a more tightly integrated plan to support its science driven missions. We believe the revised ISTP is a good plan, but we are committed to re-examining it if necessary in light of future investigation findings on the Columbia accident. The Space Launch Initiative budget is now focused on the highest agency space transportation priorities: investing in an Orbital Space Plane (OSP) for assured access to the ISS and the Next Generation Launch Technology (NGLT) Program that focuses on the most critical technology development activities, such as propulsion, vehicle health monitoring, and high temperature structures.

The OSP Program will develop a human-crewed vehicle with multi-purpose utility for the Agency. Initially serving as an ISS Crew Return Vehicle launched on an Expendable Launch Vehicle, the OSP will also provide crew transfer and limited cargo capability. The results of the OSP will enable a transition path to future space launch vehicle systems under development in NGLT.

The NGLT Program will be NASA's research arm for access-to-space technologies. As in aeronautics, access to space will require interagency partnerships to meet common needs. NASA is in the beginning of a cooperative effort with the Department of Defense, through the National Aerospace Initiative (NAI), jointly working to build a technology roadmap for hypersonics research and access to space technologies. We will also work with the Air Force Space Command on analyses for alternatives, and towards developing requirements for the next-generation launcher.

In-Space Propulsion Research

Consistent with the Recommendation #9 of the Commission, *to reduce the transit time between two points in space by 50 percent,* NASA supports the Aerospace Commission's recommendation that more research is needed in power and propulsion systems. These systems have the potential for enabling missions that are not currently feasible. High performance propulsion systems will allow spacecraft to explore regions of space currently out of our reach, carry significantly greater scientific payloads, and will significantly reduce the time required to travel to destinations within the Solar System. This technology is needed to undertake sophisticated science operations in the outer Solar System that support the search for life. Moreover, this technology can greatly increase the speed, robustness, and science return of future robotic missions, while also serving as a stepping-stone to potential future human exploration beyond Earth orbit.

The NASA Research Centers successfully pioneered the basic research on ion propulsion that led to the first demonstration of this technology on Deep Space One in 1998. They also developed the pulsed plasma thrusters demonstrated on the Earth Observing One spacecraft in 2001. The President's budget continues the development of the next generation of propulsion technologies. Our goals are to increase the operating power of electric thrusters, to extend thruster lifetime, and to develop analytical models for optimizing thruster performance. The President's budget request for NASA also includes funding for an augmented nuclear program—now called Project Prometheus—as one of the agency's top priorities. Project Prometheus enables robust and flexible missions to explore areas of our Solar System where solar power is not practical, and it opens the door to a new generation of space exploration missions. Project Prometheus will focus on two major areas of nuclear power and propulsion research and development: improved versions of traditional radioisotope systems and development of a fission reactor to provide the necessary electricity to power electric engines and more capable science instruments.

The first demonstration of this capability is planned for the rovers of the Mars Science Lander, scheduled for launch in 2009. This new generation of radioisotope power systems will allow spacecraft, landers, and probes to operate 24 hours a day, seven days a week, with increased mobility and reconnaissance capabilities.

NASA will also complete research and development of the first reactor-powered spacecraft and demonstrate safe and reliable operations on long-duration, deep space missions. The Jupiter Icy Moons Orbiter (JIMO) has been identified as the first space science mission to demonstrate this capability. Scheduled for launch in the next decade, this ambitious mission will orbit three of Jupiter's moons, Callisto,

Ganymede, and Europa, to explore their makeup, history, and potential for sustaining life. This mission not only demonstrates a valuable new technology, it addresses a highest priority science objective from the National Academy of Sciences—going to Europa to confirm growing evidence that a global ocean is hiding beneath its icy surface. "Europa is likely to contain the three things necessary for life to evolve—liquid water, a source of heat, and organic material."[1] This technology makes it possible to realistically consider missions that orbit multiple targets sequentially. Such a capability is tremendously advantageous, and it paves the way for an entirely new generation of space exploration missions.

A Vision of the Future

Finally, to bring this together as a system, an approach we like at NASA, I would like to take you into the future to envision how these investments will help enable the aerospace system of the future.

The impact of information technology cannot be overstated—from the tools that help engineers develop the highly complex air traffic management system of the future, to the design of the new vehicles that will fly in it. To achieve unprecedented safety, information technologies will be critical in transforming data into knowledge to give pilots precise situational awareness of weather conditions, other aircraft, and terrain, as well as knowledge of their aircraft through "intelligent" and autonomous hardware and software systems that can adapt, self-improve, self-repair and self-reconfigure in response to component faults and failures. The application towards aviation security is equally powerful. It can detect aircraft that do not conform to normal operating patterns and determine whether there is malicious intent or help is needed. In either case, strategies would be in place to land the aircraft safely. Airports in the future are increasingly busy centers of commerce as businesses cluster there for the environment conducive for increased productivity, now free from the noise of aircraft operations and emissions, and the convenience of reliable and affordable service.

Industry-sponsored research on the Space Station will have created a constellation of commercial space platforms, some inhabited, others autonomously operated, meeting the needs of industry research, development, and production for space-based products. The Next Generation Launch Technologies research will have paved the way for reliable and affordable airline-like service transporting cargo and passengers to and from orbit on a routine basis. These new vehicles will diagnose their own "health" status, scheduling maintenance, identifying anomalies that require attention, self-correct and repair minor faults, and track trends that could lead to anomalies. Nano- and information technologies will have made these capabilities possible.

New space research vehicles will combine new propulsion and power technologies, high-strength low-mass structural materials, and sensors with dramatically increased sensitivity and low power consumption. High-speed transport to the outer planets and beyond, for science missions, will take weeks and months, not years and decades. Nano-technology will have exploited physical phenomena at the nanometer scale, creating "healing" metals for spacecraft skin to repair damage such as micrometeorite hits on long duration missions. Scientific returns per mission will increase 100-fold as research equipment and payloads are more capable and comprise the majority of launch mass. NASA will be conducting missions that go beyond our solar system. Robots will work collaboratively with humans to maximize scientific returns. Research in automated reasoning will have enabled these robotic assistants to contend with uncertainty, making them significantly more mobile, and more scientifically capable. Space communications will allow scientists high-data rate access to space assets, wherever they are, retrieving their data from extreme environments, over interplanetary distances and long mission lifetimes.

We also envision a vibrant educational system in the U.S.. Grade schools and high schools now have new teaching tools and curricula inspired by NASA's programs, and our efforts including the cadre of Teacher-Astronauts have inspired thousands of students to pursue scientific and technical careers. The universities with specialties in engineering and the sciences have full enrollment with growing programs, and their graduates will be finding exciting opportunities in both government research and the private sector job market.

These are only snapshots of the possibilities. As the last century of advances made possible by investments in aerospace research has shown, we are hard-pressed to imagine what is truly possible in an environment that nurtures innovation.

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[1] Press Release, July 11, 2002 Missions to Kuiper Belt Now, Europa Within the Decade are Key to Space Discoveries, National Academy of Sciences

Senator BROWNBACK. Thank you very much, Dr. Creedon, appreciate that.

Let us run the clock at seven minutes and we can bounce back and forth here if we have a series of questions. But I want to ask a few here.

Dr. Creedon, to start off, one of the things that really drew me to this hearing today was, in December I met with the leaders of the general aviation industry in Wichita. And, as you know, a number of companies are headquartered there, major manufacturing facilities, and the thing that really struck me was not that we are having a current downturn in the economic activity and the employment—as I noted, 11,000 lost jobs in my State alone, and these are—this is in Cessna, Raytheon, Bombardier–Learjet, Boeing, I mean, it is across the board, all of the companies. That is there, that is a problem. But what was really troubling me was, they said, as you look out in the future in developing the next wave of aeronautics, the next wave of planes, they are being approached by various countries and saying that, "Okay, we will pay for the research on the development of a new wing, new engine, for general aviation, and we will help you develop that as a company. Now, if we do that, we want to build that product, then, in our country." So that they are saying, we have got a near-term problem, and we have a cyclical nature of business. We understand that. But we are really concerned about this industry moving offshore with the researching pulling it offshore to other places or other parts.

One, are you familiar with that taking place? And if you would comment about what you feel like we should be doing as a country to stop it.

Dr. CREEDON. Thank you for the question, Senator. I would say two things. In NASA, we have had a series of three programs aimed at the general aviation industry. The first was an AGATE program that was aimed at developing some technologies that would improve the capabilities of general aviation vehicles, the kind of research of the nature that you were talking about. In addition to that, we had a program that would develop engines specifically suited for general aviation aircraft.

Within the budget constraints that we have had, we have directed the research funds that we have in this area now towards a small aircraft transportation system, which is dedicated towards coming up with the ability to operate these aircraft and offload the hub-and-spoke system and provide greater access to smaller communities and more ability to be able to make point-to-point travel plans and not have to go through the hubs by using the general aviation aircraft.

I think, as is evident in the Commission's report and the statements of everyone that has spoken today, that if you do not do the requisite research to provide the capability to compete, that in a competitive world you will soon not be able to compete.

In our funds, we pride ourselves in NASA and came up with a responsible and credible program. And within the funds that we had available, we have dedicated them, at this time, to operation of the general aviation aircraft in the transportation system, and, therefore, we are not funding the kind of research that you talk about.

Senator BROWNBACK. Chairman Walker, I am sure this topic came up at the commission. What were the narrow recommendations that would most befit the industry to try to address this topic of some of this research and then manufacturing moving offshore?

Mr. WALKER. Yeah, we were very fortunate, though, on the commission to have able representation of the general aviation industry from Ed Bolen, who is going to testify here later on today. And a number of these topics did come up.

I will tell you that the one thing that we found to be very true is that throughout the world there are countries aggressively looking to develop aircraft manufacturing capabilities. When we were in both Japan and China, we found there that they are really looking to move into building of regional jets. Why do they want to do that? Is there really a global market for regional jets? No. The Chinese could point to at least some domestic market. The Japanese could not even point to that. But they want the ability to do that kind of technological integration work, because they know that that will have reverberative effects out into the future and will allow them to be competitive not only in the aerospace area, but in lots of other areas. And so it is a great challenge to us.

And so what you will see in a number of the recommendations of the commission is our attempts to deal with that kind of technological challenge and that kind of policy challenge.

One of the reasons why we have to reform the export control policy of this country is because we have to do something that allows us to compete globally with our aerospace products. At the present time, what is happening is, as a result of our control policy, many of our companies are unable to market beyond our own shores. And the export control policy recommendation was aimed at assuring that as we develop good products here, they are marketable on a global scale. That assures not only that you keep the ability to manufacture, but also you keep the supplier base in this country that underpins that entire manufacturing capability. We will lose both manufacturing capabilities and we will lose supplier base if we do not do something about an export control policy that simply is not working at the present time.

Senator BROWNBACK. You know, I ran into that, particularly India, who is a strong ally of the United States, saying that, "We are getting all these dual-use requirements that is keeping product from us that we would like to get from the United States." And they are saying, "And we are working with you. You know, what can we do to get those off?" And here is an economy that is growing and it is quite vibrant.

Chairman Walker, have we lost the leadership in the aerospace industry, in your estimation?

Mr. WALKER. No, we have not lost it, but we are on a slope where we could lose it in the future if we do not take the steps necessary to compete. I mean, what we saw is, in the aeronautics area, particularly in commercial aviation, we are being heavily challenged from the Europeans, who, as Senator Dodd pointed out, have laid out their vision of where they are headed in that area in their 2020 report and some AIR 21 reports and some subsequent reports since then. There is no doubt that they have an entire plan for challenging our supremacy.

We are being challenged in space on the Pacific Rim. There is no doubt that the Chinese have an aggressive space program. They are willing to put substantial dollars into it. And if you do not believe that, all you have to do is talk to the Japanese and the Indians who believe thoroughly that Chinese have a substantial program in that area.

So the challenges are real. The question is whether or not we are willing to step up to the plate, do the R&D necessary to do transformational products, and then move forward. And that is the question of the development of resources that is throughout the report. It is resources not only of government funding, but the ability for industries to attract more investment money, because we revised the business model that allows them to have more capital flow into those business, and, therefore, allows us to remain more competitive.

Senator BROWNBACK. When would you expect the Chinese to put an astronaut in space?

Mr. WALKER. This year. This year.

Senator BROWNBACK. And you do not have much question about that?

Mr. WALKER. No question that they will fly. It may be a "spam in the can" kind of mission that they do, but the fact is that they will probably orbit someone this year.

I think the real challenge comes—I believe—and this is strictly me speaking, it was not in the commission report—I believe that they plan to be on the moon within a decade and that they will announce that they are there to stay permanently.

And I will tell you, as a little anecdotal information, I had a Japanese parliamentarian in my office the other day, and I related to him that that was my belief coming off this particular study that we had done, and he looked at me, and he said, "No, you are wrong." And I was kind of surprised, because some of the information we had gathered about this we had gathered in Japan. And then he smiled and said, "You are not wrong in your conclusion; you are wrong in your timing." He said they will be on the moon within three or four years.

Now, I think that has huge implications for us as a country if they truly have an aggressive program of that type. But I believe it is that aggressive, and I certainly think that they will fly humans inside this year.

Senator BROWNBACK. Dr. Creedon, do you agree with that assessment?

Dr. CREEDON. I think that——

Senator BROWNBACK. Please speak into the mike there, if you would.

Dr. CREEDON.—Across the board, it is very, very competitive. I do not have the insight or the information that Chairman Walker has, but I have no reason to doubt the conclusions that he came to.

Senator BROWNBACK. Senator Allen?

Senator ALLEN. I would love to follow up on some of these. Thank you both for your testimony.

In the event that the Chinese do get on the moon, whether it is three years or five years, and want to stay there, what are the im-

plications of that? What are they going to be doing by being on the moon that we cannot presently do? It is generally not considered a habitable planet. They may have a lot of people but do not value human life anywhere as much as we do.

Mr. WALKER. Well, for example——

Senator ALLEN. But what would that—how would that affect us?

Mr. WALKER. Yeah. For example, in order to survive on the moon, you basically have to develop close-looped environmental systems.

Senator ALLEN. Right.

Mr. WALKER. That could be a technology that would have a great deal of application here on earth and, you know, that the spinoffs of that could be very, very useful in a global marketplace. And so that is one thing I see.

There are apparently vast supplies of H3 on the moon. H3 allows you to have far more efficient fusion reactors. The ability to bring back H3 from the moon and utilize is inside fusion reactors may prove to be a huge benefit to the country that is there doing it.

So, I mean, there are some things like that that you could imagine. I also think that there is a psychological impact that comes from it. I think the American people believe that we went to the moon, we planted our flag, it is our, and——

[Laughter.]

Mr. WALKER.—you know, nobody else should be able to go there. And I think once it is realized that we not only have not gone back, but now someone else has gone there, and our ability to go there in the near term is dramatically limited, that we simply would not be able to stand up a program and get there quickly in competition with that, would have a huge impact in this country.

And I believe there are people inside our security programs who believe that a Chinese capability to go to the moon has vast security implications for this country, as well.

Senator ALLEN. Let me get a little bit closer to earth here and the focus of this hearing, which has to do with aeronautics. As far as that competition is concerned, and this is maybe a more pointed question than the chairman's. It is an international competition. And in aeronautics, is the United States winning, or are we losing?

Mr. WALKER. Well, I think at the present time, that your description earlier today of us living off of developments of the 1960s is pretty accurate, that—and we have done a pretty good job of that. I mean, we have advanced the state of the art, we have done new things as a result of our new computer technologies, we have been able to do some remarkable things building off of that platform. And in that sense, we continue to lead the world.

There is nobody that builds better, for instance, military aircraft than we do. The rest of the world is well behind our capabilities in that arena. In the commercial aircraft area, we have not moved ahead as aggressively, in large part because the investment money has not been there to do it. And in that arena, there is no doubt that Airbus is extremely competitive with Boeing at the present time and that Boeing does feel the need to come with a new generation of aircraft that will be more competitive than they are now with Airbus.

And the question is whether or not we have not only a research and development plan, but also a business plan that allows them to do that.

Senator ALLEN. Dr. Creedon?

Dr. CREEDON. To use your analogy of winning and losing——

Senator ALLEN. Or losing.

Dr. CREEDON. We were winning by a wide margin, and if we are still winning, it is by a much smaller margin. So the gap has closed, and I think Senator Dodd had some statistical examples of a closing of that gap in his statement.

Senator ALLEN. Well, my view is, if you look at all the trends, particularly in the commercial aviation market, you look at the jobs, you look at the investment, you can put a bright face on it and say it is not the end of the game, that is true. But all the trends are negative. That is the reason for this hearing. And hopefully we will be able to work on a bipartisan basis, not just here, but also private sector and the government, to reverse it.

You talk about losing manufacturers and suppliers and so forth. It is not as if you can find people just like this to be involved in aeronautics. We are losing—would you not both agree?—losing the aeronautics engineers. It is an aging workforce. Because there is less research, less investment in it, there are fewer students coming out of our universities in aeronautical engineering because there simply are not the jobs there. Would you agree with that, as well?

Mr. WALKER. Well, we speak to the workforce issues pretty broadly——

Senator ALLEN. Right.

Mr. WALKER.—in the commission report. We felt very strongly that there needs to be an investment in education to produce a more technologically competent society out of which you can draw then——

Senator ALLEN. Right.

Mr. WALKER.—more aerospace engineers. And there is no doubt that we need to do that in the future.

I will say to you honestly that the record is mixed with regard to whether or not there are enough aerospace engineers available. The fact is, we are still graduating a significant number of aerospace engineers. The problem is, they are unable to find jobs in the industry——

Senator ALLEN. Right.

Mr. WALKER.—and they move off into computer industry and other places.

But the fact is, if we have made the industry healthy, we do have the ability to bring engineers into it, but they are not going to come for an industry where they think they are going to get laid off within a few months——

Senator ALLEN. Yeah.

Mr. WALKER.—or where seniority rules guarantee that the last hired is the first gone, where the health of the industry is in question. I mean, those are all things that affect young people's decisions about where they are going to go, both with education and with——

Senator ALLEN. Employment.

Mr. WALKER.—jobs. With employment, that is right.

Senator ALLEN. You mentioned, Congressman Walker, the nanotechnology. That is something Senator Wyden, who is also a Member of this Committee, both of us worked on that, making sure—that is very basic broad science, everything from health to material of sciences in a variety of ways. We were able to get it through the Senate. Now we have got to get it through again this year. So we are working on that, as well.

Dr. Creedon, let me ask you just specifically, insofar as the NASA budget, now I understand your role and your answer to our chairman's question, and you are a good, loyal leader and understand that funds are allocated to NASA. You make those priorities, and I understand that. I was governor; I wanted all my agency heads to say these are the approaches and also did respect the fact that the legislative branch also could have their own priorities in that area. The NASA budget, the way I see it, at least the way it is being presented, you have changed the way that you address your aeronautics budget. It is not just unique to aeronautics. You have done it across the board. That makes it harder for some of us to track what is actually going on. So could you tell me whether the research and development programs will receive more funding in the coming years, and can you tell me, and tell us, how much of the $559 million contained in the President's budget has been allocated for research, specifically?

Dr. CREEDON. Okay, there are several questions——

Senator ALLEN. Right.

Dr. CREEDON.—in there.

Senator ALLEN. Understood. And I understand your role and responsibility.

Dr. CREEDON. First of all, you had a question about the structure of the budget. And this year, as you correctly point out, we have structured our budget differently. We have five mission areas, and aeronautics is one of those mission areas, and so its budget is bookkept separately. I believe that that will make it easier this year and in the future to determine the amount of funds that are actually going into aeronautics research, because there will be a line item that can be looked at and will contain that amount of money. That has not been the case in the past. So this year, for the first time, there is that budget, and I think it will make it more readily apparent how much money is going into that research.

Also this year, we are switching to a full-cost budget, so the numbers will jump around a little bit. But the $500 million that you are using is the way that we portrayed the budget in fiscal 2003. In 2004, it will be a different-looking number, but it is the same amount of work.

As far as the budget, there has been a number of comments that have been made about the budget decreasing dramatically over the past decade. And it looks like, for the future, that the budget will continue to decline some 5 percent for the coming five years. But the NASA administrator testified this morning that he felt that there were things that had not yet been taken into account in that five year budget run-out, one of which is our working very, very, closely with the FAA and jointly working with them on transforming the National Airspace System to make the capacity of that

system much greater and things such as that, and that, could contribute to a increase in the budget in the future years.

Senator ALLEN. Well, the point is, comparing budgets, you foresee, in this budget, level funding; and, in the future, a 5 percent decrease in research in——

Dr. CREEDON. I think it will——

Senator ALLEN.—aeronautics.

Dr. CREEDON.—be easier to tell, because we have a separate budget and——

Senator ALLEN. Understood.

Dr. CREEDON.—and the current projections. The current plan is for 5 percent decrease in the future, but this morning in testimony, the administrator said that there was a—the work that we were doing with the FAA could be taken into account and may yet result in a increase over that 5 percent decrease.

Senator ALLEN. That is if you include—there is nothing wrong with including that specific program, but——

Dr. CREEDON. Except that the plans have not yet been finalized, I think, is why it is not in the budget at this time.

Senator ALLEN. Well, you will understand why there will be some of us senators—myself, Senator Dodd, and hopefully others—who will be working to increase that.

Dr. CREEDON. I certainly do. And we certainly support the intent of the bill that you and Senator Dodd have introduced to point out the importance of investment in aeronautical research and the role that research and technology play in this whole area.

Senator ALLEN. I am sorry, I have exceeded this. If I may—on the SATS program for general aviation, I want to commend you in what you all are doing there, working with FAA, for small airports and for general aviation. I was there at the unveiling of it in Danville, and I think that that has a great deal of potential for not only general aviation; it is great for those communities to have access, much easier access. I even like the idea because I always like to look at what the price of fuel is. It even gives you information as to what the price of fuel is, and that does change from facility to facility, and it is, I think, an outstanding program that will really be beneficial to many smaller markets and rural areas.

Dr. CREEDON. Thank you.

Senator ALLEN. So I want to commend you on that.

Thank you, Mr. Chairman.

Senator BROWNBACK. Thank you.

Mr. WALKER. Mr. Chairman?

Senator BROWNBACK. Go ahead.

Mr. WALKER. Could I comment for just a moment on the interagency—

Senator BROWNBACK. Yes, please.

Mr. WALKER.—that Mr. Creedon was talking about, because I think that it is important to understand, coming off the commission report, that the interagency cooperation that he referenced with FAA is extremely important, we believe, for the long-term funding of a lot of these programs.

And I would reference one other program. NASA is cooperating with DoD in the National Aerospace Initiative that DoD is bringing forward. That probably has more potential for huge breakthroughs

in the aeronautical area than any other things that is being done. And the cooperative program between those two agencies in that arena could very well produce some of the breakthroughs and can assure that we have funding streams from a couple of different places that can move the program forward.

Senator BROWNBACK. Yeah, it seemed like to me when you were talking about our superiority in military aircraft, that taking some of that technology that is developed there and getting it out to our private side would really be helpful.

Chairman Walker, you have been around government a good period of time. You have seen us lose market share to Airbus from, well, it was not probably five years ago, maybe seven, when we were at 73 percent; now Airbus is passing us up, or projected, for the first time, and that is in a down market. They are expanding in a difficult market.

What are we going to have to do? Are we going to have to heavily subsidize the way Airbus is to get back into a stronger position? Are we going to have to do different business model plans or try to attract more investment dollars into the aircraft manufacturing business?

Mr. WALKER. We certainly have to do some things about changing the business model. And some of that probably does involve at least being competitive with them in the favorable financing plans that they offer to airlines and the nations around the world as they are doing it. I hope that we do not have to go to government subsidies to do that, but we certainly ought to have a financial plan that works that allows Boeing to be competitive in those areas.

The other thing that we certainly found with Airbus is that they just—they have an aggressive plan moving forward. The question that you have to ask yourself, and it is a worthwhile question, is whether or not they have bet right. I mean, they are betting on the A380, which is a huge new airplane that is going to fly lots of passengers from hub to hub. The question is whether or not the travel in the future is going to be hub to hub or whether it is going to be point to point.

And one of the ways in which we can compete in this country is by developing the point-to-point airplanes that allow us to have a generation of aircraft that would be competitive because of a very different kind of business model. And some of those will be very small airplanes. Some of those will be more general aviation-type airplanes than they will be even the regional jet capacities.

But I can imagine the business people of the future, who will not fly hub to hub, who will want to get up in the town where they live and fly to the town where they are doing business and come right back, and do so in a time frame that fits inside their business pattern. That is a huge challenge for our airlines, because that means a lot of the people that have flown in the front of their cabin and paid the big fees may be transferred off into some other mode of transportation in the future. And so that has to be taken into account.

But there is a changing business model that is already being observed. And insofar as we can get in front of that, we have a chance of being very competitive with the Europeans in the future.

Senator BROWNBACK. I cannot resist asking you this. Bob, do we go back to the moon? What is your sense? You chaired the commission, you have chaired the committee over on the House side, you have been involved in this business review policy-setting for some period of time. Should the United States be going back to the moon?

Mr. WALKER. The conclusion I have come to is—what I want us to do is have the technologies that give us all kinds of options. I want us to be able to go to the moon. I want us to be able to go to Mars. I want us to be able to go to Europa. You know, I want a lot of options out there and that we can pick and choose among those options.

And I believe that what NASA is attempting to do with Project Prometheus, in giving us the ability to fly much faster, allows you then to look at a variety of options for the future, both robotic and human options. And I think that there would be probably good reasons for people to design missions to the moon or to Mars or to Europa or to a lot of—to the asteroids, to a lot of other places. But what we have lacked up until now is the technological capabilities to explore those options realistically and in a time frame that Congress is willing to fund. And the new technologies will, in fact, permit us that kind of option, and it is where I think we should go in the near term.

Senator BROWNBACK. Anything else, Senator Allen?

Senator ALLEN. Yes, one follow-up series here.

What you are saying—I love your spirit, and that is what is great about you and why you are such a wonderful leader.

In all of these areas that Dr. Creedon mentioned, you have to have priorities. We do not have unlimited resources. That is why I think when you talk about nano-technology, when you talk—which, again, it is the material sciences, it is a variety of things. The same with the hydrogen fuel cell capabilities. Those are the sort of things that are important for space, for aeronautics, important here on earth. Those you can easily, with a modicum of imagination, see the value in that, and that is what we have to sell. You all can help.

I know where Europe is. Most people probably do not. It is not relevant to them. But there are questions. I mean, there are choices. Do you go to Pluto or you go to Europa, and you do it under $750 billion or whatever the limit—price tag may be, or do you go to Mars, and first, obviously, with robotics before you start putting people there. So these are the tough decisions.

And what I like about this Subcommittee and this discussion is what can we do, and where do we need to go? Whether it is the research, whether it is development, whether it is education, all important, working with the private sectors. What are our business models here? What are our tax and regulatory policies as a country that may make us less competitive with the Europeans? Or Bombardier does a great job in Canada, and many of their planes that they make are fit in for those regional jets.

Senator BROWNBACK. And Wichita. They are in Wichita.

[Laughter.]

Senator ALLEN. All right, well—and Wichita. Bombardier—they make great jet boats, too.

But regardless, it is a heck of a good company. I visited it when they were in Canada, but I am glad they are Jayhawkers, as well. It is a Quebecois.

The question, though, is, is this a sustained effort? And that absolutely essential. We need to educate the American public on the importance of it.

The one area—and since everything is so positive here, generally speaking—the one thing I was looking at, NASA's budget and the use of nuclear as an engine may make great physics sense for all those reasons. After the Columbia disaster, people just are going to easily imagine some problem on a takeoff, such as what happened with the Challenger, or in the event that that was a nuclear-powered plane coming in—that the Columbia was nuclear powered—what would that have impacted? Would that have the impact—would have that had a pattern of debris that we saw? Would that be a pattern of radioactive waste? That is something, insofar as nuclear, it is something that people, I think, are going to have some concerns with. If you are able to address it here, you can. But that is just one that is just a gut reaction that I think would be—it is not just viscerally felt by me. But I think that as that goes forward, I think there will be a lot of people in this country saying, well, that was debris coming down, it was tragic, if that were nuclear powered, what would have been the impact of it? And that probably, whether you want to address it right now or in the future——

Mr. WALKER. Well, I am not a technologist, but I can simply tell you what we heard, in terms——

Senator ALLEN. Right.

Mr. WALKER.—of some of those issues. First of all, I mean, you would not have an active nuclear reactor at launch. And what you would have is a reactor that would activated once you got on orbit. You would shield it very, very heavily so that any kind of tragedy and so on would not take any of the nuclear materials that were being launched into orbit out of containment.

Senator ALLEN. You would have in such a container that it would be safe.

Mr. WALKER. Yeah, that is exactly right. I mean, and those things all seem to be well inside the box of technological feasibility at the present time. I do not think we feel as though we have to do much in the way of breakthrough. A lot of what we have learned in shielding of nuclear submarines, for example, give you a pretty good base of experience for doing some of those kinds of missions.

So I think that we can address some of those things. Will there will still be people who have concerns about it? Sure.

Senator ALLEN. Well, it is logical——

Mr. WALKER. Yeah, sure.

Senator ALLEN.—because you have seen an explosion in the sky——

Mr. WALKER. Sure.

Dr. CREEDON. Exactly. I agree totally with the chairman's answer. People will be concerned, but Project Prometheus is intended to provide nuclear for one point in space to another, not in getting us from earth to space.

Senator ALLEN. Nevertheless, you are carrying radioactive——

Dr. CREEDON. Right, but as the chairman said, it could be——

Senator BROWNBACK. Encased.

Dr. CREEDON.—until you get to the first point in space.

Senator BROWNBACK. Thank you both very much for joining us, Chairman Walker and Dr. Creedon. It was very good. Appreciate that.

Our next panel will be Mr. Ed Bolen, president and chief executive officer of the General Aviation Manufacturers Association, Mr. Dennis Dietz, director of Manufacturing Research and Development, Boeing Commercial Airplanes out of Wichita, Kansas, and Dr. John Tomblin, interim executive director of The National Institute for Aviation Research at Wichita State University, where much of the aviation manufacturing business is headquartered in Wichita, and the university strives to serve them.

Gentleman, thank you all very much for joining us. We will put your full written statements into the record. If you would like to summarize, it is your choice. We appreciate your being here.

Mr. Bolen?

STATEMENT OF EDWARD M. BOLEN, PRESIDENT AND CEO, GENERAL AVIATION MANUFACTURERS ASSOCIATION

Mr. BOLEN. Well, thank you, Mr. Chairman. And I would like to begin my remarks kind of picking up where the last panel left off, and that is on the issue of coordination.

I think one of the really exciting things about the commission on aerospace is that it was tasked at looking at the entire aerospace industry, not just the civil aviation part of it, not just the space part of it, not just the defense part of it. But one of the things that we had going for us is, we had people who were very familiar with each of those disciplines. And so when we talked about issues like technology or we talked about workforce or we talked about investment or we talked about requirements, you found over and over again that representatives from civil aviation would say, "Well, here is what we need in a future communication navigation surveillance system." And the space people said the same thing. And the military people said the same thing. And we all talked about, "Well, NASA has got a program for this," or, "The FAA has got a program for that," or, "The military has already done this." And one of the things that became very clear to us right up front is that aerospace is critical to the future of the United States. And both you senators have talked eloquently about that today, and we agree emphatically.

We also know that we are operating in very tight budgets today. And we know that, as a country, we cannot afford to have redundant or conflicting research programs. We cannot afford to waste technology. We have got to be coordinated as a group. And I think that one of the things that we have going for us by having both this Subcommittee and the Subcommittee on aviation both being part of a broad committee is that you have an opportunity to make sure that NASA and the FAA are coordinated. And I would hope that as we look at how well coordinated those two research organizations can be, that we can tie the military into that, too, so that we can make sure, as a country, we are not taking U.S. taxpayer dollars and having redundant programs or wasted programs.

I also think that it is incumbent upon us, as an aerospace community, to look at what some of our needs are not just in terms of research, but also in terms of facilities and capabilities and to see how we, as a country, can use or not use the different facilities.

One of the things that came to my attention late last week, for example, was that Eglin Air Force Base, in Florida, the Air Force has decided that it really does not need its climactic center there, which his a hanger at Eglin Air Force Base which has the ability to be made very hot or very, very cold, and it is used by civil aviation to go and test products and see how they will respond in extreme cold for prolonged periods of time or extreme heat. It is the only facility like it anywhere n the world. Well, the Air Force has decided the Air Force does not need it, so the Air Force is going to close it. That is going to work to the detriment of our civil aviation community, and we do not have anyone saying, "Wait a minute, that is a national research asset. Federal taxpayers have paid for that. We need to preserve it."

So I think that, in a whole host of instances like that, there is a role to be played not just in adding new money, but in coordinating the research that is being done, coordinating the facilities we have to make sure that we are getting the most bang for the buck. And I think that the Commission on Aerospace felt very strongly on that.

We want to make sure that aerospace decisions are not really made on an ad hoc basis by a patchwork of Federal agencies, that we have some type of organizing authority that looks at it. And I think that this Committee is particularly well situated to look at aerospace in its totality, and I would urge you to do so.

The specific purpose of today's hearing is to look at the National Aeronautics and Space Administration's research requirements. And I think that it is very important that we stress "aeronautics" when we refer to NASA. Sometimes the aeronautics program gets overshadowed at NASA by the space program and we lose sight of the fact that the first "A" in NASA is "aeronautics," and they do have as a goal, and they do have as a mission, and they do have as a core capability, aeronautics research. And I think that we need to make sure that that is understood by the public, understood by the legislature, and funded accordingly. It is a tremendous capability and one that we need to focus on intently.

Now, as president of the General Aviation Manufacturers Association, my primary focus is really the health of the general aviation industry. But I also want to point out that research in aviation, research that benefits the entire aviation industry, does benefit general aviation, because general aviation is not a separate segment of the whole, it is part of the whole, an extricable part of the whole.

And so what I wanted to do today was to talk a little bit about some of the programs that NASA is involved in that are not necessarily just for general aviation, but that I think would be particularly helpful, and I think is particularly helpful, for the entire aviation industry, and certainly general aviation can participate in that. And so I want to list a couple of specific things that I think are very much needed.

I think, first of all, software certification is a critical issue for everyone involved in aviation. I think everyone in today's society recognizes the tremendous advances that are being made as a part of the computer world. And what we are seeing in aviation, including general aviation, is a transfer of those computational advances, working their way into the cockpit and improving the situational awareness of pilots, giving them better information about weather, where they are, helping us better understand where they are going.

But one of the great hurdles on trying to get the computer advances into the aviation field is trying to get it certified, because if you get, you know, the latest kind of phone, well, they are great, but at times you drop the phone call, sometimes your computer crashes. And that is fine, but it is not good enough when you are in aviation. In aviation, we demand that you have reliability 99.999—go out seven nines—it is got to be that good.

The problem that we have is, with software, it is very hard to prove that, it is very hard to understand that. And what we have found at the FAA is that it is really more of a subjective art than it is an objective science.

So one of the things that we think would be very helpful at improving the aviation technology would be for NASA to look at a tool that would help us certify software—in other words, something that we could plug software into and understand it passes or it fails, in terms of accuracy, reliability, and integrity. And I think that would be one of the great benefits moving forward, because it would allow us to more quickly get the computational advances from the computer world into the aviation world, and that certainty in the process, I think, would spur technological investment. I think more people would be willing to invest in breakthroughs if they thought the path through certification was more objective and more certain.

I think another area that would be very helpful is in the area of weather sensors. I think most of you know that weather today is understood, from the dew point and some other important aeronautical areas, as a result of either tethered balloons or sensors that are on commercial aircraft which fly at altitudes of 30,000, 35,000 feet. But one of the things that we are missing is, we do not have particularly good weather sensors in the area from 10,000 get to 29,000 feet, an area where general aviation airplanes often are. And we are very interested in NASA technologies that would take satellites and focus weather sensors in that range. We think that would help us in terms of understanding general aviation weather, but also weather patterns across the United States, not just for air transportation, but for weather patterns as a whole.

We are very interested in air traffic modeling. NASA has a program right now. It is a VAMS program, which looks at air traffic modeling. We have got a particular concern on that, because it is kind of a broad model, and we would suggest that that program focus more on, kind of, known areas. For example, look at the New York airspace and focus on the New York airspace at modeling problems to that, known problems, rather than as a whole. But I think that that is an area where NASA can be particularly helpful for us as we try to move forward on having a more efficient air traffic system as we go forward.

Vehicle systems program. This is something that NASA is developing. It is something that they are referring to as their "vehicle enabling technologies." I think that that is very, very important. And I also think that Dr. Creedon touched on NASA's transformation program, the program that they are working with the FAA to try to determine the beyond operational evolution plan of the FAA. Where do we go in the next generation of air traffic management? I think that is critically important.

Supersonic flight is something that continues to be important to the general aviation community. And I think propulsion systems are particularly important. I think if you go and look at all of the real great breakthroughs that we have seen in aviation over the past hundred years, they are pretty closely aligned to tremendous breakthroughs in the propulsion area. When we went from radial engines to piston engines, and piston engines to turbine engines, we always saw tremendous new airplane models built around that technology, and we saw safety rates improve. And I think that investing in propulsion is extremely important.

We have engines today which are very reliable, but I think that there is still room for improvement in terms of noise, and I think there is still room for improvement in terms of emissions. And NASA has got programs like the Quiet Aircraft Technology Program, or the Ultra Efficient Engine Program, which are exciting programs, but I would simply point out to the Committee that they are, in my opinion, inadequately funded.

Today we are spending tens of million dollars per year on quiet-engine technology. We are spending hundreds of millions of dollars a year going around and soundproofing homes near busy airports. And to me, that is like going and buying a lot of mops instead of figuring out how to plug the leak.

And I think we want to look at that as we go forward. I think that is important to everyone, because, as airplane technology becomes more and more environmentally friendly, I think we are going to see communities demand to have airports among their midst, instead of what you have now, which is, in some areas, some community opposition. So I think that that is important technology, going forward.

We are encouraged by NASA's commitment to technology, the capabilities that they bring to it, and we are particularly excited about their focus on general aviation. They have a strong track record of investing in general aviation, understanding general aviation, and we hope they will continue that as we go forward.

Thank you very much for giving me an opportunity to testify.

[The prepared statement of Mr. Bolen follows:]

PREPARED STATEMENT OF EDWARD M. BOLEN, PRESIDENT AND CEO, GENERAL AVIATION MANUFACTURERS ASSOCIATION

Introduction

Mr. Chairman and Members of the Subcommittee, my name is Edward M. Bolen and I am President and CEO of the General Aviation Manufacturers Association (GAMA). Recently, I have also had the privilege to serve as one of the presidential appointees to the Commission of the Future of the U.S. Aerospace Industry.

General Aviation

As everyone on this Subcommittee knows, general aviation is technically defined as all aviation other than commercial airlines and military aviation. Our aircraft

range from small, single-engine planes to mid-size turboprops to the larger turbofans capable of flying non-stop from New York to Tokyo. These planes are used for business purposes and recreation, as well as everything from emergency medical evacuations to border patrols and fire fighting. General aviation aircraft are also used by individuals, companies, state governments, universities and other interests to quickly and efficiently reach the more than 5,000 small and rural communities in the United States that are not served by commercial airlines.

General aviation is the backbone of our air transportation system and the primary training ground for the commercial airline industry. The U.S. general aviation fleet consists of over 214,000 aircraft that fly more than 29 million hours per year and carry more than 166 million passengers. According to a recent study by Global Insight, general aviation contributes more than $41 billion to our nation's GDP each year and generates over a half million jobs.

Commission on the Future of the U.S. Aerospace Industry

Mr. Chairman, serving on the Commission on the Future of the U.S. Aerospace Industry was an honor and a tremendous educational experience. Unlike previous commissions, this one looked at the totality of the aerospace industry—not just one of its individual segments like civil aviation or space or military. As a result, the Commission was not limited to viewing the industry through the prism of a single federal agency like NASA, the FAA or the DoD. Instead, we had the opportunity to see how the Federal Government as a whole treated aerospace.

What we found was that the United States did not have a unifying aerospace vision or a coordinated aerospace policy. Instead, our nation's aerospace programs, including research efforts, were the result of ad hoc decisions made by a patchwork of federal agencies.

The Commission on the Future of the U.S. Aerospace Industry believes this situation needs to change if our nation is to continue to be the world leader in aerospace. We can no longer afford to have redundant federal research programs. We can no longer afford for one federal agency to keep taxpayer funded technology from another. We can no longer afford to have research programs that industry does not value. And, we can no longer afford to work on technologies that have no chance of being certified for use in the national airspace system.

To remedy this situation, we need better coordination between Congressional Committees, government agencies and industry. There is some coordination today but it is generally fragmented and tactical. We need to be more strategic. We also need to start looking at federally funded facilities and capabilities as national assets rather than as proprietary assets of the civil aviation system or the space program or the military.

Let me give you an example of what I am talking about.

Recently, the Air Force announced that it would close its one-of-a-kind Climatic-test Center at Eglin Air Force Base because it was no longer serving an Air Force function. The problem with that decision is that the Climatic Center, which is a technologically advanced hangar that can simulate harsh environmental conditions, is used by more than just the Air Force. Domestic manufacturers of civil aviation products use the facility to test their products in extreme heat or extreme cold so that they can determine the environmental operating envelope for their products and obtain FAA certification.

The Climatic Center is an extremely valuable facility but one that would be too expensive for a single manufacturer to maintain. Its imminent closure represents the lost of an important national aerospace asset. The closure may be a good decision for the Air Force, but it is clearly not in the best interest of the U.S. aerospace industry and the U.S. taxpayer.

Situations like the one at Eglin Air Force Base can only be remedied with better coordination and cooperation between the various parts of the Federal Government. I urge this Subcommittee to use its power to facilitate that coordination and cooperation.

National Aeronautics and Space Administration

As everyone knows, one of our nation's foremost aerospace agencies is the National Aeronautics and Space Administration or NASA. I would like to focus the remainder of my remarks today on NASA's aeronautics research programs.

Let me begin by saying that NASA's research is fundamental to achieving significant breakthroughs in aeronautics. That is partially because NASA has many unique core competencies, but also because its research horizon is long term, very high risk, and not the kind of research that could be justified by a commercial enterprise.

NASA research is focused at the "pre-competitive" stage, well before commercial products are developed. In fact, experience has shown that a company may still need to invest hundreds of million of dollars to bring to the marketplace a technology NASA has designated as ready for commercialization.

NASA's Aeronautics Programs

Today NASA is involved in a number of important research programs that have the potential to benefits the entire aviation industry, including general aviation. I would like to highlight some of these programs.

Propulsion

Historically, propulsion has been a key aerospace technology. Dramatic advances in airplane capabilities are often the result of breakthroughs in engine technology, such as when went from heavy radial engines, to light weight piston engines, to turbojets and then to fuel-efficient turbofans.

Today, the environmental impact of aviation operations is a significant constraint on aviation growth because many communities are concerned about aircraft noise and emissions. These concerns prevent the expansion of airport infrastructures that could reduce or eliminate delays. They also force our Federal Government to spend hundreds of millions of dollars per year soundproofing individual homes around large airports. This kind of federal approach to noise mitigation is a little like responding to a water problem by buying mops rather than fixing the leak. As a country, we need to spend more on NASA Quiet Aircraft Technology and Ultra-Efficient Engine programs.

The NASA Advanced Subsonic Technology (AST) Noise Reduction Program has resulted in technologies that are already being used on today's airplanes to lower noise at the source. This includes engine noise reduction from advanced inlet liners and exit nozzles and airplane noise reduction from advancements in aerodynamic wing design and reduced-weight composite materials. The Quiet Aircraft Technology (QAT) Program will build upon the AST research into the next decade in support of NASA's goal to significantly reducing the environmental impact of aircraft noise on the community. In 2002, NASA and FAA initiated a new memorandum of agreement (MOA) to coordinate research activities and increase funding in support of the QAT program to speed up the introduction of lower noise aircraft technologies. GAMA strongly supports the coordination of FAA's Research Engineering & Development Program for Environment and Energy and NASA's noise and emissions research programs to remove barriers to the growth of the aviation industry and accelerate environmental benefits to the community.

Vehicle Program

NASA has envisioned expanding their Vehicles Program to develop technologies that will remove roadblocks to a vast range of aircraft, bring significant new capabilities and benefits to our air transportation system. But unless NASA is authorized to spend significantly more to develop these vehicle-enabling technologies, we will continue to lose our technology edge.

NAS Transformation

While the FAA has done an admirable job of planning upgrades to the NAS for the next ten years, NASA should undertake the types of research that will meet the needs of our air transportation system beyond the FAA's planning horizon. Key to this process would be establishing a joint program office to coordinate the aviation-related research activities of NASA, FAA, DOT, DoD and other government agencies.

Air Traffic Management

No where is the need for a coordinated national vision for aerospace more apparent than in the work NASA does in the air traffic control area. The Multi-Center Traffic Management Area is an example where common goals and objectives have resulted in excellent products that can be rapidly implemented by the FAA. But other areas, such as airspace modeling, the lack of coordination and a shared vision is quite apparent. We are especially concerned that the Virtual Airspace Modeling and Simulation Project, known as VAMS, will consume an inordinate amount of NASA's resources, and many of these resources seem to duplicate those within the FAA.

Clearly, NASA has capabilities and facilities that FAA does not have, and it makes no sense to duplicate these capabilities and facilities within our government. In the area of air traffic control, NASA is essentially a longer-term research agency for the FAA. But FAA's horizon is, and should be much shorter-term than NASA's. So it is essential that NASA's role should include "pushing the envelope" in air traf-

fic control technologies, often beyond what can been seen from today's perspectives. This role is often difficult for the FAA.

Without a single, clear roadmap for aeronautics that cuts across all parts of our government, resources will be wasted and time lost.

In addition to the current NASA programs, we believe there is additional NASA research which would be extremely beneficial to the aeronautics industry.

Software Certification

One new area where NASA's expertise would be especially useful is development of software tools that could be used by the FAA and avionics manufacturers to test avionics and other computer software used in the NAS to ascertain that it meets appropriate certification levels of reliability and integrity. NASA research in this area should be greatly accelerated and closely coordinated with the FAA, which is the organization that determines the minimum performance standards.

Weather Sensors

Another area where NASA research has great value is advanced weather sensors that can measure temperature and dew point from satellites at altitudes not typically traveled by airline aircraft. At lower altitudes, specially-equipped balloons are used to gather this data. And above 29,000 feet, many airline aircraft are equipped with sensors and automatic datalink of temperature, dew point and other data. But between approximately 10,000 to 29,000 feet, weather data is very sparse.

It is not economically feasible to equip smaller general aviation aircraft that normally fly between 10,000 and 29,000 feet altitudes with sensors and data link, and balloons are not feasible at these altitudes. And although the weather forecast models employed by the National Weather Service have greatly improved, they are still impaired by the fact that measurements of temperature and dew point in the middle altitudes are sparse. Forecasts derived from these models would be greatly enhanced if more accurate, real-time temperature and dew point data was available. Nearly all of the weather products produced by the National Weather Service would be enhanced, including many for non-aviation purposes. But most importantly to GAMA, general aviation safety would be improved.

NASA's General Aviation Research

As a representative of the general aviation industry, I would also like to take the opportunity today to mention some of the NASA programs which have been specifically focused on general aviation.

The Advanced General Aviation Transport Experiment (AGATE) was a NASA cost sharing partnership with industry to recreate and speed-up the technological basis for revitalization of the U.S. general aviation industry. The goal of the program was to develop affordable new technology, as well as the industry standards and certification methods for airframe, cockpit and flight training systems for next generation, single pilot, 4–6 place, near all-weather light airplanes.

AGATE focused attention on moving technology that had been available only to commercial air carriers into general aviation aircraft. NASA and industry worked closely with FAA to bring electronic display regulations into line with current technology. As a result of this government-industry partnership, many new technologies were either brought to the market, or they were commercialized much sooner than would have been the case without AGATE. For a detailed discussion of how effectively this research was commercialized, I have attached a copy of the "AGATE Alliance Commercialization Impact Report".* Perhaps the biggest lesson learned from AGATE was that NASA can be an effective research partner with industry.

Another success was NASA's General Aviation Propulsion (GAP) program aimed at developing revolutionary new propulsion systems for general aviation. Historically, it is new engines that have brought about the greatest changes in aircraft design and performance. At the entry level of general aviation, some very exciting new engines are on the verge of reaching the market.

NASA's GAP program is an excellent example of how NASA research brings technologies to the point where industry can later refine NASA breakthrough technologies and develop commercially-viable products.

Small Aircraft Transportation System

NASA's Small Aircraft Transportation System (SATS) initiative is a program to demonstrate how the integration of many next-generation technologies can improve air access to small communities. This program envisions travel between remote communities and urban areas by utilizing a new generation of single-pilot light aircraft

*The information referred to can be found on the Internet at: http://www.gama.aero/dloads/AGATEAllianceCommmercializationImpactReport.pdf.

for personal and business transportation between the nation's 5,400 public use general aviation airports.

Current NASA investments in aircraft technologies are enabling industry to bring affordable, safe, and easy-to-use technologies to the marketplace, including advanced flight controls, innovative avionics, crashworthy composite airframes, more efficient IFR flight training, and revolutionary engines.

The SATS program is focusing on four key operating capabilities, which we fully support:

- Safe, high-volume operations at airports without control towers or terminal radar facilities;
- Lower adverse weather landing minimums at minimally-equipped landing facilities;
- Integration of advanced general aviation aircraft into a higher en route capacity air traffic control system, with complex flows that can safely and efficiently accommodate a wide range of aircraft with diverse performance characteristics;
- Improved single-pilot ability to function safely and competently in complex airspace in the evolving National Airspace System.

It should go without saying that NASA's technical expertise is an essential element of the SATS initiative. Only NASA can cut across traditional technical boundaries and integrate research benefiting general aviation vehicles, air traffic control procedures, airspace design and safety. And more than any other government agency, NASA has already demonstrated an ability to implement an effective consortium of government and industry that can produce results. This ability is due in large part to various collaborative research structures that are uniquely at NASA's disposal.

We believe that at the conclusion of the SATS program in FY05, many of these technologies will be mature enough to be handed-off to the FAA for final development and deployment, and we are working with the FAA to develop such a program. Technologies that result from the SATS program will greatly enhance the capacity of the National Airspace system.

Conclusion

Mr. Chairman, NASA is a preeminent research agency with much to contribute to the future of the aerospace industry. The challenge for all of us as stakeholders, including this Subcommittee, will be to make sure NASA programs fit into a broad national aerospace plan and are of value to the industry.

Thank you for the opportunity to testify today. I would be happy to answer any questions you might have.

Senator BROWNBACK. Thank you very much, Mr. Bolen. Appreciate that and I will have some questions for you, as well.

Mr. Dietz, welcome to you here. The floor is yours.

STATEMENT OF DENNIS DIETZ, DIRECTOR, MANUFACTURING RESEARCH AND DEVELOPMENT, BOEING COMMERCIAL AIRPLANES, WICHITA DIVISION

Mr. DIETZ. Thank you, Mr. Chairman and Mr. Allen.

I am Dennis Dietz. I am director of Manufacturing Research and Development for the Wichita Division of the Boeing Company, and I appreciate the opportunity to bring Boeing's perspective on this very, very important issue here today.

Senator BROWNBACK. Mr. Dietz, pull that microphone a little closer to you, if you will.

Mr. DIETZ. I also want to express our appreciation to you, Mr. Chairman, for taking the leadership to move this forward toward implementation. As in all activities, that is a key important part.

Kansas certainly is a key center for military, commercial, and general aviation activities, and employs many thousands of people, including the 13,000 people at Boeing and their families who are very directly impacted by the influence of the activity we are talking about today.

On behalf of the Boeing Company, I also want to acknowledge the tremendous effort by Chairman Walker and the members of the commission for the comprehensive report of great quality with great recommendations. After being here today, I can see his passion for this subject can only inspire such good output.

I also commend the Committee's initiative as reflected in today's hearing, in going forward with the implementation process.

I also commend Senator Allen and Senator Dodd for their strong support of aerospace technology, as reflected in the recently introduced legislation.

For the remainder of the time, though, I would like to address really two fundamental issues that are interrelated that come out of the recommendations in that report. And first is, and it is one we have been talking about from the very beginning, is that the Federal Government should increase significantly its investment in basic aerospace research, which enhances our national security, enables breakthrough capabilities, and fosters an efficient, secure, and safe aerospace transportation system. This is a high priority for Boeing.

Second, I want to address the commission's recommendation to effect the transformation of the U.S. air transportation system as a national priority. This must result in reducing door-to-door travel times for our citizens. Implementation of this recommendation is Boeing's highest aerospace research priority.

Mr. Chairman, the Boeing Company strongly supports the conclusion of the Aerospace Commission that an aggressive initiative by the Federal Government to invest in aerospace leadership would benefit the United States. There are broad public benefits. Many of them have already been spoken to—certainly Federal investment in our technology infrastructure, an advance of our test facilities, propulsion, fuel systems, fuel efficiency technologies, advanced materials and structures, safety and security-related technologies and environmentally friendly technologies that address noise, emissions, and cabin comfort, in the case of aircraft, and those technologies primarily related to subsonic and, in the longer term, perhaps supersonic flight.

A key step in maturing and improving advanced aeronautical technology is through the use of demonstrators and prototype units, and it is one of the ways you get a very quick feedback process in the work you are doing, and we would like to propose that it would be another avenue by which to make the return on investment, on our research investment, happen at a much faster pace.

Turning to a related key finding, and this is one I feel very strongly about, on the President's commission, is future industry productivity growth and gross domestic product that are directly related to an efficiently growing air transportation system. Aviation is highly dependent upon an airport and airspace infrastructure that does not meet future efficiency, capacity, and security requirements. When we talk about productivity, that is the way we bring this industry up to provide those jobs in the future that we have talked about. They are high-paying jobs, they are the kind of jobs that draw the interest of our students and our institutions, and upgrade the level of education in our institutions. And we be-

lieve that is really critical in terms of productivity for the future to create those jobs for the future, as well.

We support the recommendation of the Aerospace Commission on a national program led by the Department of Transportation with multi-agency participation. The goal of this initiative would be to define and develop a new air traffic management system to meet our long-term aviation, security, safety, and efficiency and capacity needs. And, of course, we have addressed competitiveness in this business, which means, we have to make this business such that we satisfy customer demand.

A national traffic management initiative should build upon current air traffic management and infrastructure initiatives, including the OEP. It should use a requirements-driven approach, and it should be highly integrated, using secure network-centric architecture to really enhance common situational awareness and ensure seamless global operations.

While not focused on space today, fundamental technology challenges in space should continue to be supported, as that is an important part of the whole activity within NASA, as well.

We believe that investment of public funds demands a return to the public, and I believe that I have outlined some of those in my submitted testimony, and that those benefits will go on into the future. As you rightly said in the very beginning, we are looking at a five-year plan, our competitor's looking at a twenty-year plan, and there are those in the world who look at hundred-year plans. We have really got to focus on a long-term stable investment, as well.

Finally, I would like to suggest that Congress engage as a full partner in this activity to maintain the implementation activity. In a year in which we celebrate the 100th anniversary of our pioneers, the Wright Brothers first flight, as well as a year in which we have had the loss of the Shuttle Columbia astronauts, we can pay no greater tribute to our aviation pioneers than to move forward in this activity and make great strides for the future that our future pioneers might be supported, as well.

Thank you, Mr. Chairman. I ask that my written testimony be included in the record, and I look forward to responding to questions.

Senator BROWNBACK. Without objection.

[The prepared statement of Mr. Dietz follows:]

PREPARED STATEMENT OF DENNIS DIETZ, DIRECTOR, MANUFACTURING RESEARCH AND DEVELOPMENT, BOEING COMMERCIAL AIRPLANES, WICHITA DIVISION

Thank you, Mr. Chairman and Members of the Committee. I am Dennis Dietz, Director of Research & Development for the Boeing Company's Wichita facility. I appreciate the opportunity to share Boeing's perspective on the importance of significantly increasing federal investment in basic aerospace research. I want to express my appreciation to you, Mr. Chairman, for your leadership on these issues. Kansas is center for military, commercial and private aviation. Thousands of employees and their families in Kansas, including Boeing's 13,000 employees, are directly impacted by the challenges we will address today.

On behalf of the Boeing Company, I also acknowledge the tremendous contribution of Chairman Walker and the members of the Commission on the Future of the United States Aerospace Industry. Their comprehensive report highlights the integral role aerospace plays in our economy, our security, our mobility and our values, and concludes that global leadership in aerospace is a national imperative for the 21st century. The challenge ahead of us is to work together to secure global aero-

space leadership by implementing the Commission's recommendations. I commend the Committee's initiative, as reflected in today's hearing, to begin the important implementation process. I also commend Senator Allen and Senator Dodd for their strong support of aerospace technology and their recently introduced legislation in this area.

For the remainder of my time, I will address two, interrelated recommendations of the Aerospace Commission. First, the Federal Government should significantly increase its investment in basic aerospace research, which enhances U.S. national security, enables breakthrough capabilities, and fosters an efficient, secure and safe aerospace transportation system. This is a very high priority for the Boeing Company. Second, I will address the Commission recommendation to effect the transformation of the U.S. air transportation system as a national priority. This must result in reducing door-to-door travel times of our citizens, and implementation of this recommendation is Boeing's highest aerospace research priority.

Aerospace systems protect us from those who would do us harm, and connect us to our loved ones across the country and around the globe. The Aerospace Commission observed that the aerospace industry is a powerful force within the U.S. economy, contributing over 15 percent to our Gross Domestic Product, supporting over 15 million high quality American jobs, while generating the largest trade surplus of any manufacturing sector.

There are a great many challenges affecting aerospace today. These include new national security threats around the globe, cyclical commercial aviation markets, the need for a more secure, efficient, environmentally-friendly and capable aviation system, and safer, lower cost and more reliable access to space—a challenge underscored by the recent Shuttle Columbia tragedy, to name but a few. Government and industry are both doing their best to deal with these issues and to respond to the needs of their stakeholders. Our nation needs to remain a leader in space, and investment is required to take our nation to a new level of safety, affordability and scientific research.

In our free enterprise economy, there is a proper role for government in each of these challenges. The Commission correctly defined government's role as recognizing the importance of aerospace leadership, creating a supportive policy framework, and increasing federal investment.

For national security, aviation system security, and civil space, the government investment role extends from funding enabling technology to procuring and operating systems. Let me note that The Boeing Company believes providing for the security of the air transportation system is a proper role of government, with resources coming from the general fund rather than the aviation trust fund.

For commercial products, the government role is properly limited to its historical role of supporting break-through, pre-competitive, fundamental research that has a longer time horizon—generally more than three to five years—than industry can support before it is mature enough to be considered for transition to product development.

Government, including NASA, the DoD, FAA and the new Department of Homeland Security, must continue to strengthen its partnerships so that the benefits of aeronautics and space technologies can be leveraged, transferred, and applied swiftly where they are needed to meet our economic and security needs.

Mr. Chairman, the Boeing Company strongly supports the conclusion of the Aerospace Commission that an aggressive initiative by the Federal Government to invest in aerospace leadership would benefit the United States. There are broad public benefits to be derived from federal investment in advanced test facilities, propulsion, fuel systems, and fuel efficiency technologies, advanced materials, advanced structures, safety and security related technologies, environmentally friendly technologies related to noise, emissions and cabins, and technologies related to subsonic and, in the longer term, supersonic flight. I understand the pressures on the overall federal budget in this time of national crisis. Nonetheless, I am disappointed that the FY 2004 NASA request for the Aerospace Technology Enterprise in the NASA budget continues the trend of declining investment in real terms for the future of America's aerospace leadership.

A key step in maturing and proving advanced aeronautical technology is to incorporate it into scaled, prototype flight demonstrators. Demonstrators are particularly valuable in that they provide a test bed to mature technologies that, in turn, maximize the potential for deploying technological advances to serve the nation's pressing aviation needs. High priority demonstrators, for example, are needed for technologies that greatly (1) improve overall performance efficiency and, thereby, reduce travel time and air transportation's impact on the environment: (2) enhance access and mobility to stimulate economic growth; and (3) improve our economic security by decreasing our dependency on fossil fuels through the development of alternative

fuel systems such as hydrogen. By focusing on a range of technologies that can be applied to demonstrators, a more significant and timely return on investment is achieved.

Turning to a related key finding of the President's Commission on the Future of the United States Aerospace Industry, productivity growth and our gross domestic product are directly related to an efficient and growing air transportation system. As I noted at the beginning, implementation of this finding is Boeing's highest priority for federal research investment.

Aviation system delays are projected to increase, creating a severe drag on economic growth in coming years. U.S. aviation system delays in 2000, as measured by the FAA, resulted in a $9.4 billion loss in U.S. economic activity.

The decline in air travel and system delays following 9/11 is temporary. Forecasters agree that growth in demand for air transportation ultimately will return to much higher historic levels, and will outpace available and currently planned capacity.

The U.S. economy will suffer without adequate government action to improve the air transportation system. Aviation is highly dependent on an airport and airspace infrastructure financed primarily by system users and controlled and regulated by the government. This infrastructure does not meet future efficiency, capacity, or security requirements.

The Commission concluded that the FAA's Operational Evolution Plan (OEP) is a necessary starting point, but insufficient for enhancing the U.S. air transportation system and maintaining global aviation leadership. The one billion dollar annual investment in the OEP will not produce sufficient capacity to meet long-term demand, nor will it take full advantage of technologies that can enhance the security of the overall aviation system. According to a DRI–WEFA study, if all projects envisioned by the OEP were completed on schedule, airspace delays in 2012 would be greater than in 2000, and the economic cost of delays between 2000 and 2012 would be an estimated $157 billion.

The Boeing Company strongly supports the recommendation of the Aerospace Commission for a national program office led by the Department of Transportation with multi-agency participation. The goal of this initiative is to define and develop a new air traffic management system to meet our long-term aviation security, safety, efficiency and capacity needs.

A national air traffic management initiative should build upon current air traffic management and infrastructure initiatives, including the OEP, use a requirements driven systems approach, develop a highly integrated, secure "network centric" architecture to enhance common situational awareness for all valid system users, and ensure seamless global operations. New and clearly identified funding for this initiative is needed. In light of current economic crisis and declining aviation trust fund revenues, the initiative should leverage investments and capabilities from non-traditional sources such as NASA, DoD, TSA, and DOT.

While I have not focused on space today, NASA aerospace research also contributes to safer, more reliable and lower cost access to space. President Bush told a mourning nation that our journey into space will continue despite the tragic events of February 1st. Fundamental technology challenges remain in the space flight arena, including lighter weight, lower cost airframes, propulsion, and health management systems. The FY 2004 NASA Aerospace budget proposals to address these needs should be supported, and necessarily will receive more emphasis when we better understand the causes of the catastrophic loss of Space Shuttle Columbia.

Mr. Chairman, the investment of public funds demands public benefit in return. I will close by citing some of the public benefits of federal investment in aerospace research. They include improving the quality of life for our citizens by drastically reducing the level of noise due to aircraft operations; reducing the congestion of the air transportation system; reducing the rate at which fossil fuels are consumed and greenhouse gases and other harmful gases and particulates are added to the atmosphere by aircraft; allowing for more rapid, cost-effective development of safer, lower cost, more efficient aerospace, automotive and energy producing products; enabling low-cost, safe, and low-emission propulsion systems; improving performance for operators, and in turn reducing costs to the flying public; reducing the aircraft accident rate by 50 percent over the next ten years; increasing the mobility of our population that, in turn, stimulates economic growth; and advancing flight, and with it, aerospace leadership.

Finally, Mr. Chairman, I congratulate the Congress for its willingness to consider the recommendations of the Aerospace Commission. I respectfully suggest that the Congress engage as a full partner in their implementation. This partnership will require a long-term view of the Nation's investment in aerospace technology and the return on that investment to the American taxpayer. Past investments have surely

improved the lives of all Americans. In a year in which we celebrate the 100th Anniversary of Flight and mourn the loss of the Shuttle Columbia astronauts, we can pay no greater tribute to America's aerospace pioneers than by securing America's economic and physical security with another century of aerospace leadership.

Thank you, Mr. Chairman. I look forward to responding to your questions and questions from other Members of the Committee.

Senator BROWNBACK. Thank you very much, and I look forward to our discussion.

Next will be Dr. John Tomblin. He is the executive director of the National Institute for Aviation Research at Wichita State University.

Dr. Tomblin, welcome.

STATEMENT OF JOHN TOMBLIN, PH.D., EXECUTIVE DIRECTOR, NATIONAL INSTITUTE FOR AVIATION RESEARCH, WICHITA STATE UNIVERSITY

Dr. TOMBLIN. Thank you, Mr. Chairman.

Senator BROWNBACK. And you might tell Senator Allen not everybody in Kansas is a Jayhawker, right? There are Wheatshockers and Wildcats and a lot of other——

Dr. TOMBLIN. That is correct.

Senator BROWNBACK.—a lot of other beasts, too.

Senator ALLEN. That is understood.

[Laughter.]

Senator ALLEN. Not everyone in Virginia is a Cavalier.

[Laughter.]

Senator BROWNBACK. Please.

Dr. TOMBLIN. Thank you, Mr. Chairman.

Mr. Chairman, Senator Allen, I appreciate the opportunity to share my observations and vision on the future of the United States aerospace industry with you today. My comments this afternoon will focus on the role of academia in partnership with government and industry and how that effective collaboration can contribute to the future of the United States aerospace industry.

The United States has been the world leader in aviation throughout the 20th century. Today, the aviation industry competes in a global economic environment that is far different from that in the past. New challenges to our leadership are arising from aircraft manufacturers in Europe, the Pacific Rim, and Brazil.

To address this competition, the Nation's research and development base for aircraft design and manufacturing must be expanded with support from the Federal Government in partnership with industry. It is only through research and the application of new technology that the U.S. will maintain its leadership position in aviation in the 21st century.

The mission of The National Institute of Aviation Research at Wichita State University is to conduct research, transfer technology, and enhance education for the purpose of advancing the Nation's aviation industries. Located in a cluster of aviation industries, which include Boeing, Bombardier-Learjet, Cessna, and Raytheon, the institute must be able to meet research, testing, and technology transfer needs of these industries as well as Federal agencies that support aviation and establish certification regulations for the industry.

The institute has established thrust areas that are of primary importance to the aviation research. They include aerodynamics, aging aircraft, composite and advanced materials, crash worthiness, icing, manufacturing, structures, and virtual reality.

Permit me to review only a few of those institute's success stories which involve forming a strong collaboration between industry, government, and academia.

One of our most successful partnerships developed as a result of the NASA AGATE program. I chaired the Advanced Materials Working Group of AGATE from 1994 until the program ended in 2001. During this time, the partnership between academia, industry, and government helped establish certification methods for composite materials that revolutionized the way in which composite materials are certified and used on aircraft. Through the joint collaboration, we were able to reduce the time and costs required for certification of new composite materials. This model of composite material insertion into applications and products has recently been adopted in commercial, transport, and military airspace as well.

In crash worthiness and safety, a 1995 survey revealed that the perceived lack of safety was the primary reason for the general public not wanting to travel in light airplanes. If general aviation is to grow significantly and become the alternative to the hub-and-spoke transportation system that the commission report envisions, perceived and real safety must improve.

The general public has come to expect crash safety in their cars and will likely demand the same from light airplanes. Furthermore, crash safety at aviation velocities has been demonstrated in race cars and in full-scale small airplane and helicopter tests. The automobile industry has accepted the unlikelihood of a zero accident rate and designed crash worthiness into its cars. Consequently, thousands of lives are saved each year. By designing crash worthiness into airplanes, aviation can see similar results.

The institute is currently working with the FAA, NASA, and the aerospace industry to develop and validate analytical tools necessary to incorporate crash worthiness features into aircraft during the concept phase of aircraft development.

In conclusion, I know we all agree the future of the aerospace is critical to our national security, transportation mobility and freedom, economic well-being, and quality of life for all Americans. The commission's sense of urgency to address the needs of the aerospace industry should not be ignored.

America's leadership in aerospace is becoming threatened. As many witnesses here have mentioned in the testimony today, a hundred years ago, Wilbur and Orville Wright flew the Wright Flyer and made aviation history for the United States. It would be historically appropriate if the world dominance of the United States aerospace industry could be assured for the next one-hundred years through new and dynamic Federal programs and policies, and stronger government, industry, and university interaction and cooperation.

I appreciate the opportunity to testify with you today. My prepared statement is more thorough and provides additional details. I would be happy to answer any questions.

[The prepared statement of Dr. Tomblin follows:]

PREPARED STATEMENT OF JOHN TOMBLIN, PH.D., EXECUTIVE DIRECTOR, NATIONAL INSTITUTE FOR AVIATION RESEARCH, WICHITA STATE UNIVERSITY

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to share my observations and vision on the future of the United States Aerospace Industry with you today. My comments this afternoon will focus on the role of academia in partnership with government and industry and how that effective collaboration can propel the future of the United States Aerospace Industry.

Aviation and the Global Economy

The United States has been the world leader in aviation throughout the 20th Century. America's aviation industry has designed and built commercial, general aviation, and military aircraft used around the world, with exports resulting in a net favorable trade balance. Today the aviation industry competes in a global economic environment that is far different from that of the past. New challenges to our leadership are arising from aircraft manufacturers in Europe, the Pacific Rim, and Brazil. For example, the commercial airplane industry must now compete against the European Union (13 countries). The balance of trade in the aviation industry has shrunk from $41 billion in 1998 to $26 billion in 2001. Furthermore, new foreign government-supported research and test facilities, particularly in Europe, are attracting business from United States aircraft companies because of availability, quality of results, rapid response, and low costs.

To address this competition, the nation's research and development base for aircraft design and manufacturing must be expanded with support from the Federal Government in partnership with industry. The need for federal support of new research and test facilities and equipment is as acute as it is for basic and applied research. It is only through research and the application of new technology in aerodynamics, materials and structures, and aviation safety that the U.S. will maintain its leadership position in aviation throughout the 21st Century.

According to the Milken Institute's report of July 1999, entitled *America's High-Tech Economy*, Wichita, Kansas ranks 19th in the nation among high-tech metropolitan areas because of the city's high concentration of aviation industry. Wichita is second in the nation among aircraft and parts metros on the same basis. Prior to September 11, 2001, Boeing, Bombardier-Learjet, Cessna Aircraft, and Raytheon Aircraft provided more than 43,000 jobs and a $2.1 billion annual payroll to the Kansas economy. The public is returning to commercial aviation as the only viable choice for long-distance travel, and both commercial and general aviation are expected to recover from the recent economic downturn.

While the four major aviation manufacturers dominate employment in south central Kansas, there are 1,800 smaller manufacturing shops in the 13-county region surrounding Wichita. In addition, economists estimate that there are 2.6 jobs outside aerospace for every direct job within aerospace.

Wichita State University and the National Institute for Aviation Research

Wichita State University (WSU) is located in the metropolitan setting of Wichita, Kansas and has partnered with local industry for the past 65 years. According to the National Science Foundation, WSU ranked seventh in the nation in aerospace research expenditures in 2000. The National Institute for Aviation Research (NIAR) was established on campus in 1985 to help address the aviation industry's research needs and has become a model for federal-state-industry-university partnerships.

NIAR is designated as a Kansas Technology Enterprise Corporation (KTEC) Center of Excellence, and is a partner in two FAA centers, the Airworthiness Assurance Center of Excellence and the Center of Excellence for General Aviation Research. The Institute was the recipient of the 2001 FAA Excellence in Research Award for its continuing contributions to aviation research, and its ability to partner with industry, academia, and government. NIAR, through its ties with industry, other universities, KTEC, and federal agencies provides an ideal focus for federal and state support to accomplish mutual goals for world leadership in aviation.

NIAR's mission is to conduct research, transfer technology, and enhance education for the purpose of advancing the nation's aviation industries. Located in a cluster of aviation industries, the Institute must be able to meet the research, testing, and technology transfer needs of these industries and the federal agencies that support aviation and establish certification regulations for the industry. With the assistance of an industry advisory board consisting of vice presidents of engineering of the local aviation manufacturers, NIAR has established thrust areas that are of primary importance to the industries, and plans to upgrade and expand its capabilities within these thrust areas. The thrust areas are as follows:

- Aerodynamics

- Aging Aircraft
- Composites & Advanced Materials
- Crashworthiness
- Icing
- Manufacturing
- Structures
- Virtual Reality

Partnerships With Industry and Government

Permit me to review some of the Institute's previous success stories which involved forming a strong collaboration between academia, industry and government. One of the most successful partnerships developed as a result of NASA's focus on general aviation. The Advanced General Aviation Transport Experiment (AGATE) was a NASA cost-sharing partnership with industry to create the technological basis for revitalization of the general aviation industry in the United States. The goal of the program was to develop affordable new technology as well as the industry standards and certification methods for airframe, cockpit and flight training systems for next generation single pilot, 4–6 place, near all-weather light airplanes. I was chairman of the advanced materials working group from 1994 until the program ended in 2001.

During this time, the partnership with academia, industry, the FAA, and NASA helped establish certification standards for composite materials that revolutionized the way in which they are certified and used on aircraft by creating a series of composite material databases. Through these shared databases, a manufacturer can select an approved composite material system to fabricate parts and perform a smaller subset of testing for a specific application. Through the joint collaboration of two government agencies, the FAA and NASA, we were able to reduce the time required for certification of new composite materials by a factor of four and the cost of certification by a factor of ten. This model of composite material incorporation in applications and products has recently been adopted in the commercial transport and military aerospace industry as well.

Typically, each company desiring to use a composite material in a product design must conduct a qualification process for the material in order to verify its properties and characteristics. Even for identical material systems, each company usually selects a different "customized" qualification process leading to a very detailed and expensive procedure for each company. This cost increases further as other procedures must be established for structural testing, manufacturing control and repair procedures.

Thus, most programs are limited to using materials previously qualified for other programs which leads to using older, out-dated material and not taking advantage of the latest technology and material advances in the industry. A solution to this problem, as witnessed by the AGATE program is to establish a national localized center for composite material validation and quality assurance.

It is also worthwhile to note the paradigm shift that occurred as part of the AGATE program. Typically, one would think it better to spend federal research and development funding on larger commercial or military programs to advance the state-of-the-art. However, from collaboration with industry, government and academia, the AGATE program was able to achieve a paradigm shift by spending fewer research dollars in the general aviation market and applying the technology to large commercial transport and military programs. This is the case of small aircraft technology "spinning up" into large, complex aircraft designs and providing more cost-effective ways to achieve advanced performance as well as reduced costs. The application and transfer of these advanced technologies are easier and faster in the general aviation and business jet community than in the large transport and military community.

Currently, Raytheon Aircraft Company is applying these advanced composite technologies on a new line of business jets, one of which is already certified and being produced. Cessna Aircraft Company, even in the present economic hardship of the aerospace world, announced at the National Business Aircraft Association meeting in September that it would be producing three new business jets. Using new technologies in applications that improve product performance and safety is essential in the 21st century's global market.

Another important research area in the aerospace industry is aircraft crashworthiness. In a 1995 aircraft market survey, analysts determined that safety is the primary concern among of general aviation aircraft pilots and passengers. For pilots, the level of safety offered by the aircraft was said to be the primary decision factor when purchasing a light airplane. For potential pilots (the "latent market" for airplanes and flight services), a lack of safety was the primary reason for not piloting

light airplanes. And for potential passengers, a perceived lack of safety was the primary reason for not wanting to travel in light airplanes. The respondents of this survey were not given a definition of the term safety; they were allowed to use their own definition in formulating their response. Even though there were nearly as many concepts defining safety as there were people surveyed, safety can be broadly categorized into two areas. The first is control and minimization of factors that cause accidents, or accident prevention. The second is control and minimization of the factors that cause injury once an accident occurs, or injury mitigation. Designing for crashworthiness addresses this second category of safety.

Customer concern over the safety of general aviation aircraft is warranted, to some extent. Although declining, the accident rate of general aviation aircraft remains relatively high and the average number of general aviation accident-related fatalities remains significantly higher than other forms of air transportation. If general aviation or air transportation is to grow significantly and become the alternative to the hub and spoke air transportation system that the Commission report envisions, perceived and real safety must improve. The latent market (people interested in general aviation but not currently using it) will not participate without a stronger perception of safety. The general public has come to expect crash safety in their cars, and will likely demand the same from light airplanes.

Furthermore, crash safety at aviation velocities has been demonstrated in racecars and in full-scale small airplane and helicopter tests. While many of the improvements in overall safety should come from accident prevention through such areas as enhancements in the airspace infrastructure, flight systems, training, etc., the automotive experience has shown that privately owned and operated vehicles will continue to crash. A zero accident rate is not likely. The automotive industry has accepted this reality and designed crashworthiness into its cars; consequently, thousands of lives are saved each year. By designing crashworthiness into light airplanes, general aviation can see similar results. NIAR is currently working with the FAA, NASA and the aerospace industry to develop and validate the analytical tools necessary to incorporate crashworthiness features into aircraft during the concept phase of development.

One of the most successful crashworthiness stories occurred just three months ago in Texas where a pilot in a Cirrus Design SR22 lost control of his aircraft mid-flight due to an aileron failure. Typically, this would have resulted in a fatality but instead resulted in an uninjured pilot who was able to walk away from the crash. Using a ballistic recovery parachute, which is a relatively new technology for small aircraft and was developed in a partnership with the FAA and the NASA–SBIR program, the pilot was able to safely deploy the parachute over an unpopulated area and turn an otherwise fatal event into an unfortunate accident.

In-flight icing also has a significant impact on the safety, operation, development and certification of helicopters and fixed-wing aircraft. In addition, icing hampers the operation of Unmanned Aerial Vehicles used for commercial and military applications. Recent accidents, such as the American Eagle ATR–72 in Roselawn, Indiana, in October 1994, and the Delta Connection (Comair) Embraer 120, near Ida, Michigan, in January 1997, which resulted in 97 fatalities, show that icing continues to be a serious safety concern. In fact since 1986, more than 300 fatalities have been attributed to icing-related airline accidents. Furthermore, the costs associated with aircraft design, testing and certification for icing are very high, especially for general aviation aircraft manufacturers. These costs are typically in the range of $5 to $10 million for a business jet aircraft. Research is needed to enhance aircraft safety and to reduce aircraft icing design and certification costs.

Wichita State University is currently one of the leading universities in the U.S. in aircraft icing research and continues to collaborate with government and industry to enhance aircraft safety and utility and to provide industry with the tools needed for reducing aircraft development and certification costs. During the last 20 years, researchers at WSU have been conducted more than 18 collaborative icing research programs involving NASA, FAA and the aviation industry. A number of these research efforts were in direct response to the 1997 NASA Aviation Safety Program, of which the goal is to reduce the aviation fatal accident rate by a factor of 10 by the year 2022. Collaborative icing research programs have resulted in a number of products ranging from aircraft ice protection systems, databases for aircraft design and certification, aircraft test methodologies, simulation tools for aircraft design, and pilot training aids.

As noted in the Commission report, human factors research must be a continued consideration. The Institute is presently focused on investigating ways to improve maintenance documentation available to personnel. Maintenance errors have been identified as a major contributing cause in approximately 12 percent of major aircraft accidents. The perception was that maintenance manuals are laden with er-

rors. However, results from a study funded by the FAA Airworthiness Assurance Center of Excellence (AACE) showed that airline companies adequately provide valid and appropriate content. The problem lies in the cumbersome way in which the material is presented. Manuals should be prepared in a more "user-friendly" format, allowing ease in finding the relevant technical documentation and improved sequencing of information for complex maintenance procedures. Technical writers must be familiar with how aviation maintenance is performed in order to effectively describe complex procedures.

One of the unexpected outcomes the human factors research program was the development of an education program to offer an Associate of Arts degree specializing in *aviation* technical writing. This new program at Wichita State University is designed to provide students with special aviation training so they can better understand how to effectively communicate maintenance instruction in the manuals. The program was created through a joint effort of WSU, the Wichita Area Chamber of Commerce and the Wichita Area Technical College (WATC). Local aviation manufacturers including Cessna, Raytheon and Bombardier, supported the program through research and program development that designed the curriculum and coursework.

In another collaborative effort, the Institute and Boeing Commercial Airplanes—Wichita Division are currently in the process of completing research on the effects of manufacturing defects on composite nacelle structure. This program was successful in reducing the cost of repairs and improving the first pass yield. It has also provided a substantial database for assessing damage that occurs in the fleet.

A relatively new quality assurance inspection technology has been investigated in the research and appears attractive for in-process manufacturing inspection. Further research aimed at facilitizing the technique for use in aircraft production may result in a small business opportunity for producing associated equipment.

Another important area that requires serious investigation is the current aging aircraft problem. Economic and market conditions of present-day airline companies are requiring the use of commercial and military airplanes far beyond their original design life expectancies. The general aviation fleet consists of more than 215,000 aircraft, of which more than 25,000 are over 50 years of age and are still flying and being resold. This aging airplane concern is being amplified as more airline companies use aged aircraft and rely on standard inspection practices for a guarantee of airworthiness assurance. NIAR recently opened a new laboratory that will focus on the integrity and aging aspects of small airplanes in commuter service. With funding through the FAA Airworthiness Assurance Center of Excellence and in partnership with several original equipment manufacturers and airline companies, this new laboratory will explore aging concerns in the commuter aircraft fleet and establish guidance to ensure that current maintenance programs of small general aviation airplanes are providing acceptable levels of continued airworthiness.

Commission Report on the Future of the Aeropsace Industry

In conclusion, I know we all agree that the future of aerospace is critical to national security, transportation mobility and freedom, economic well-being and quality of life for the American people. The Commission's sense of urgency to address the needs of the aerospace industry cannot be ignored. America's leadership in aerospace is becoming threatened.

On December 17th, 1903, the brothers Wilbur and Orville Wright flew their Wright Flyer from level ground under engine power alone and made aviation history for the United States. It would be historically appropriate if the world dominance of the United States Aerospace Industry could be assured for the next 100 years through new and dynamic federal programs and policies.

I would like to thank you for the opportunity to testify today. I would be happy to answer any questions you might have.

Senator BROWNBACK. Thank you, Dr. Tomblin.

Let me ask both you and Mr. Dietz at the outset here. Let us run the clock for ten minutes. Are we doing today what we need to on making the research to marketplace connections that we have in the past in the aviation industry? You mentioned that you worked the materials working group up until—I cannot remember the date you said it ended, but are we doing today what we need to to make those transitions from the research to the marketplace?

Dr. TOMBLIN. It is funny you ask that question, because what we did in the AGATE program was kind a paradigm shift to what usu-

ally is done. If you look at commercial, military, and general aviation, and you want to apply technology, most people would say start at military, then to go commercial, and then go to general aviation, that it works down. But what we found, that it was more effective to work from essentially—saying general aviation is the bottom—going from the bottom up, because I can get a new technology implemented faster on general aviation models that turn over year after year after year, rather than commercial transports that have very few models. And military aircraft have greater models, but, unfortunately, some of that technology does not transfer into Federal policy and regulation, so it cannot be used cost effectively like the general aviation industry, because then they have to go redo some of the research to actually get it into Federal policy and regulation.

Senator BROWNBACK. So do you feel like we are doing what we need to in the match between Federal research and getting this to the marketplace today, or is it—I mean, this is a model program that you are talking about, and that one has worked well. Are we doing that enough? Are we doing it across the board sufficiently?

Dr. TOMBLIN. I think we can do more by—I think Mr. Bolen mentioned it—as some of the certification methods. Currently, when I go to a general aviation manufacturer and we have a new technology that we want to implement, they have to consider cost, risk, and certification time. And that new model, they have customers, 300 airplanes already sold, and unfortunately, the new technology has to earn its way onto the aircraft. So that is unfortunate, because a lot of times that technology gets old and it is not implemented, because——

Senator BROWNBACK. What do you mean "it has got to earn its way onto the aircraft"?

Dr. TOMBLIN. By cost and risk reduction and certification time.

So if I was going to implement, let us just say, my expertise, a composite material technology, like we did in the Raytheon Premier 1. We had various parts of that aircraft that we could have put it on, and only one part made it because of the new application and the technology. They would not bet the whole aircraft technology on that specific technology.

Senator BROWNBACK. Mr. Dietz, same question. Are we doing the partnership right that we need between the government and the private sector to get this research utilized as rapidly and as well as possible?

Mr. DIETZ. I am in the transition business, so I understand that word, and that is a very, very important word in our business. The problem, as both the gentlemen have alluded to is the timing and the fact that it does have to make itself pay, from a financial standpoint. And it goes back to the basic research. The basic research has to be out in front of the applied research and the actual transition on to the product.

Senator BROWNBACK. Well, let me put it a little differently. Were we much better in the past at getting the information and the help and the research, or were we just much bigger investment from the government in this basic research to be able to use it in the private sector in the past then we are now?

Mr. DIETZ. I think there are two answers to the question. I think one answer to the question is, yes, there was, I think, in some cases in the past, a more steady and predictable research activity that was out in front. The other thing I think needs to be recognized, we are talking very significant material properties from the materials/processes historically used in building airplanes. We are now working with materials and matrixes of those materials that are whole new materials systems. They create all new challenges for the structures they are used in. And, therefore, the ability to create the basic research that is substantial enough to transition to a product is a greater jump than it has been historically because of significant changes.

It goes back again to changing that productivity model. We cannot just make incremental improvements to the same old process, and it is time we have to make step-function improvements, and that is driving some of these new material, process and system changes.

Senator BROWNBACK. Ed, did you have some comment on this? Mr. Bolen?

Mr. BOLEN. Well, I think when we looked at this from the commission, one of the things that we saw as somewhat of a historical shift. I think we felt that 30 years ago a lot of the goals of the space program, the military, the civil aviation, were roughly the same. We wanted to fly a little bit further, we wanted to fly higher, we wanted to fly faster. I think what we have seen more recently is that the end goals of some of our different disciplines are different.

The military, for example, is now very interested in stealth technology. That is not something that spins off well to the commercial side.

Senator BROWNBACK. I am particularly interested in that.

Mr. BOLEN. The commercial side—no, I mean, the commercial side is very interested in flying quieter and flying cleaner. Well, that is not to say the military does not care about it, but that is certainly not their first priority. That is not how we have set it up. So I think we have had a divergence of goals so they do not naturally—the technology does not naturally flow back and forth as well as it could.

But I think we do have—certainly with the general aviation community and NASA, I think we learned through the program, the AGATE program that was discussed, we did learn that collaboration and cost sharing was very, very helpful. But I do not think you can ever have too much collaboration communication.

What we need to do is have the industry talking to NASA about the type of basic research, pre-competitive level research, that we need done. Then let the companies themselves try to take those products and make them marketable, but also working with the FAA to know that, hey, if we got this technology——

Senator BROWNBACK. It could be certified.

Mr. BOLEN.—could it be certified? And we do not know that. And so I think what we need is—we have got better communication now, but we need to have all the Federal agencies talking to each other, and we need to have industry involved, and I think that is a fundamental part of the commission report at every level—better

Federal coordination, better industry involvement and interface with the government.

Senator BROWNBACK. Mr. Dietz and Dr. Tomblin, Mr. Bolen mentioned about propulsion systems. And I take really from what you are saying is that at the root of all this is the engine of it, and we need most to focus there. Would that be correct, Mr. Bolen, in summarizing your comment on propulsion?

Mr. BOLEN. Yeah, I think history is pretty clear on that from a civil aviation standpoint. If you go back to the comments that Chairman Walker made about space, the propulsion systems in space are there, as well. It is figuring out how to get someplace reliably, quickly, cleanly. All of those things matter. And I think propulsion research is at the heart of that. That is the engine. And we can certainly build the aerodynamic systems around that.

Senator BROWNBACK. Do you agree that that is really where we need to focus, that most of the effort will be in that propulsion system?

Dr. TOMBLIN. I agree that, like Mr. Bolen said, the aircraft is usually built around the engine. If you look in the commission's report, they mention the number of aircraft companies, and of new aircraft companies that hopefully will revolutionize their world with their cost and their speed. Those aircraft are essentially built around a new engine.

Senator BROWNBACK. Mr. Dietz?

Mr. DIETZ. I do not know I would characterize that all the research needs to be focused around propulsion. I would agree——

Senator BROWNBACK. Well, I am not—and I am not saying that, either, but I am just saying that your dominant area—you have always—you have got a number of parts in that plane, but your dominant focus right now really needs to be that propulsion——

Mr. DIETZ. Propulsion is certainly needs to be a key item, from the standpoint of we continue to need greater efficiencies but, at the same time, have to handle the noise, the emissions, and the other aspects that go along with that. So, yes, it creates some special challenges that certainly need to be addressed and will continue to make products more competitive.

Senator BROWNBACK. Mr. Dietz, you mentioned, too, about the systems, whereby air traffic systems—I think Boeing's done quite a bit of investment in the air traffic systems. Do you feel like that the current system in this country, air traffic system, is an antiquated one that really needs to have a lot more focus? And, if so, we will be able to have a much more efficient, be able to land more aircraft, takeoff more aircraft per airport?

Mr. DIETZ. I will go back to what I said was our highest priority, and that is the door-to-door travel time for our citizens. If you can make it convenient and low cost for people to travel, and they feel safe and secure in doing that travel, you will have more demand for travel, and this research can provide the enablers. And, therefore, we feel it is a really critical element of this initiative to provide that whole infrastructure of the transportation system that creates the environment for air transportation.

Senator BROWNBACK. Let me ask you this. If—and I have had some discussions with Boeing and some other people about, now you have to go to a Point A and then to B to where your final des-

tination is. You are not going the most direct route, and there are issues of safety. But if you could go directly from Point A to B, instead of Point A to C and then to B in the process, how much travel time could we take off of flights going middle of the country, from the East or West Coast to the middle of the country, or—how much time are you talking about if we just use current technology and did it very safely, though, in a safe way?

Mr. DIETZ. The point-to-point, obviously, eliminates congestion in the hubs. And so that, in and of itself, creates some opportunities to make a more manageable airspace. So that is certainly an element of the capacity. But the other part of the capacity is managing that capacity, as well, dealing with the human factors that air traffic controllers and others have to deal with in managing that and really linking all the elements of the system together to where it is a truly network-centric type of operation.

Senator BROWNBACK. Like how much could we cut off the travel time from Washington National to Kansas City if you had a more efficient air traffic system? Just to make it personal.

[Laughter.]

Senator BROWNBACK. Just for example. I am calculating, here, my weekly commute.

Mr. DIETZ. Well, obviously, if it is a direct flight, the whole issue with door-to-door time is how soon do you have to get to the airport ahead of time, what kind of security issues do you have to deal with at the airport, what kind of issues does congestion in the airport deal with leaving on time and arriving on time? So it is a little difficult to speculate——

Senator BROWNBACK. Just the air travel from once we take off to once we land?

Mr. DIETZ. I believe the air travel would be relatively the same.

Senator BROWNBACK. Okay. Is that the case of most that is point-to-point, and the hubs——

Mr. DIETZ. Obviously, as you talk about longer distances, the ability to go point to point versus through a hub now enables you to stop the whole landing/takeoff pattern and the whole wait time in the airport and everything else, so that is when you begin to really affect the travel time, is by eliminating that stop in between.

Senator BROWNBACK. Senator Allen?

Senator ALLEN. Thank you, Mr. Chairman, and thank you, all three gentlemen, for your insightful testimony. It is great to hear the various perspectives. And, Mr. Dietz, thank you for your support of the measure that Senator Dodd and I are introducing. And it is good to hear your views. There are different aspects of this, not just funding just across the board, there is focus on aircraft noise, fuel efficiency, emissions, research and development for civil supersonic transport which will necessarily be a function of propulsion if you are going to get up to supersonic. Sure, you can do the aeronautic aspect of it or the avionics and so forth, but you need to have the engine, whatever the propulsion system is.

We do have rotor-craft research and development, as well, not something brought up here, scholarships for those who are studying in masters degree programs, and aeronautical engineering, weather, air traffic management—it is very important. And I have seen at NASA–Langley how some of the ideas on noise and better

air traffic management and how they are working, that they—take O'Hare Airport; it is not theory how the noise pattern or the amount of noise, areas affected by noise, would be reduced—as well as better air traffic management, because it is getting more and more crowded. It is not just commercial aviation. It is general aviation, as well. And all of these, I think, are very important, and we have to increase our funding there and work in collaboration with the private sector, with colleges and universities, as well as a variety of governmental organizations, whether it is NASA, whether it is FAA, whether it is the Department of Defense.

Dr. Tomblin, let me ask you this question. You summarized your remarks. In your written testimony that I was reading before, and you alluded to it, that the aviation industry today competes internationally. We have been talking about that and competition and how that is important and that it is different than it was in the past. Could you share with us or discuss with us the differences that you see, as far as that competition? And also, in doing so, could you share with us any observations you may have where others outside of the United States do a better job somehow than we do, and can we learn from that, or does it really matter?

Dr. TOMBLIN. I think that a lot of the people that have testified here today have touched on this. And my experience in dealing with this actually comes personally. I mean, doing some consulting with foreign aircraft companies.

And as Ed mentioned and Dennis mentioned, too, I see the United States industry, when I personally look at it, having a five-year vision. They have a five-year vision out. What changes is that I see the global competition having the hundred-year vision. And they will send a research product back that is ready to go to market—they will send it completely back—that, in my opinion, is totally new technology—back to the drawing board to get more cost out and greatly affect the performance when they already have a superior product to anything we produce. So that worries me, that not only do they have this step, but they are making this step-function approach. So that we still have the leadership now, I think, but it is becoming threatened if we do not do something.

Senator ALLEN. Now, is that a function of corporate strategy or the? As you say, well, we look at it for five years, they look at it a hundred years.

Dr. TOMBLIN. And I think it is——

Senator ALLEN. Is that governmental? Is that corporate? Or is it?

Dr. TOMBLIN. I think it is—personally, I see it as corporate. I mean, they have the money to throw into the research and development, where our companies do not put that much basic research funding in, not as much as, like, the—like you see from the automobile industry.

Senator ALLEN. Well, I cannot recollect which one of you—I was going through the testimony. Maybe it was Mr. Bolen, or maybe you, yourself, pointing out where NASA's value is, is the basic research, and then the private sector comes in and figures out how to adapt that research to some commercial value.

Now, it is not as if what—NASA's research would not have any application. Much of it will. But sometimes you get adaptations of utilization of that research, basic research, which maybe it is some-

thing that has nothing to do at all with aeronautics. But, nevertheless, if you have that predictability and stability in research and development funding, and it is not going to be a year or two-year fight—businesses will say, "Oh, gosh, I worry about the quarterly shareholders report or the annual report," let us say. If we have a plan that is clear in here, our goals in the supersonic transport is going to be not five years, that is 20 years, but regardless, if we have that credibility and stability of funding, rather than just fussing and fighting every appropriations year, that might—would you all think that could help in the private sector in your long-term vision, as opposed to saying, "Gosh, we have done this. We have got to turn around and get some bang for this research"?

Mr. BOLEN. Yeah, I think that would be extraordinarily helpful, to have some certainty in the process. You have talked about nano-technology, for example. Well, if private-sector companies can be aware of what NASA is doing in nano-technology, they can think to themselves, "Well, if they get this, what would we do with it? How would we market it? How would set up? What would the production facilities look like?" And if you know that it was not a basic research program that was subject to starts and stops, if you knew it was going to go on year after year, and you could make an assessment taking the funding out of the issue and getting down to the technical equation——

Senator ALLEN. Right.

Mr. BOLEN.—then you can build a business plan that says, you know, "Four years from now we want to be able to position our company to take advantage of nano-technologies. Here is how we would do it. We would take that basic research, we would turn it into this product. Here is how we would certify it." It would change the world an awful lot. So it would be extraordinarily helpful to have predictability in terms of the research programs and not have to go to the ups and downs of not knowing program starts and stops.

I also wanted to point out, when you had asked a question earlier about the foreign competition, I think one of the things that we do here in the United States is that NASA does its research and then it is available to everybody. In Europe, they often do their research on a type of cost-sharing program with a company, and then that—it becomes proprietary to that company, that European company. So the U.S. companies cannot take advantage of European basic research, but European companies can take advantage of U.S. NASA research after a very short period of time. And I think, you know, that is an example of how other countries, other regions, that are interested in a long-term aerospace industry are looking at it.

Senator ALLEN. Mr. Dietz?

Mr. DIETZ. I would just add, again, going to the stability, I believe that is a critical issue in the whole thing. If you know you have got a program that is planned, it is funded, it is not going to be chopped off, corporations can then do parallel research to start the application and driving the costs down and all the things it takes to put it in a product development program at the same time. Furthermore, you do not have the problems of staffing up, staffing down, and trying to retain those skills.

We talked about the effect on our universities and institutions. One of the ways that you drive very high priorities in the institution is to turn out very well-educated people who see a long-term commitment that they know will be there when they graduate and can go into the industry. So I think in a lot of ways that long-term stability has a positive effect on what we do.

Senator ALLEN. Thank you.

Dr. Tomblin? It seems like you want to say something on this.

Dr. TOMBLIN. I would just like to reiterate what Mr. Bolen said. That was probably one of the great successes of AGATE, is this cost sharing and knowing the funding was going to be there. The industry worked with the universities and with the government organizations, and we did not just stop when the final report came out, when the technology was in a report. Being an academic person, you know I love to write journal papers, and a lot of those journal papers, unfortunately, no one reads but other academics. So the nice thing about this program was that it took an academic study and turned it into an FAA policy and turned it into a part on a plane. That was the nice thing about that program.

Senator ALLEN. Well, I think you all have given us the insight we need. What we need to do, Mr. Chairman, is not just listen to a journal report or read it, we need to take action on the variety of comments that have been made here, all very insightful.

And I am one who is competitive, but this competition is not just business competition. This is important for the jobs of the future, for national security. The same applies in nano-technology, where if we do not make the proper long-term investments there, the Europeans and the Japanese will be ahead of us. And that is a $1 trillion economic benefit there which has applications across all sorts of disciplines and fields.

So count me as one of your allies. But mostly count me as an admirer of each and every one of you all and all our witnesses today. We are going to work hard together for the future, which is important for our jobs, for our economy, and our security.

And, Mr. Chairman, I want to thank you. Thank goodness we have your leadership making sure that this Congress pays attention to this vital issue for our country.

Thank you, Mr. Chairman.

Senator BROWNBACK. Thank you. Thank you, Senator Allen. I want to thank the panelists.

And would just note that as we conclude the hearing, we will leave the record open for the requisite number of days so you can submit further statement if you would like, but I leave this hearing uneasy. It is like we are celebrating a hundred years, a hundred years ago, the Wright Brothers took off Kitty Hawk. We had that short flight with lots of successes along the way, broke the sound barrier here, the first people on the moon, the space shuttle program, the things that we have done, and yet I am uneasy that we are losing the edge. I mean, I guess that is the cumulative of what I am hearing from everybody here, is we have not lost it yet, but if we are turning around and looking back, they are gaining on us. And we have not developed necessarily the strategy that takes us on forward to the next century of American dominance in the aero-

space industry, which I want to see it be. And you have provided us good thoughts and good food for thought.

We have several legislative vehicles that will be looked at. It was mentioned here today, the Allen–Dodd bill. There will be some view towards funding for research efforts. And please feel free to contact our office—others, the Committee—about where you think the best placement of effort and sources would be so that we can be secure in moving forward and maintaining the lead in this very, very vital field for our economy, for our future, for our safety and our travel, and also for our security.

Thank you for coming. Thank you for traveling here. Thank you all for attending.

The hearing is adjourned.

[Whereupon, at 4:30 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. ERNEST F. HOLLINGS,
U.S. SENATOR FROM SOUTH CAROLINA

The United States has long enjoyed a preeminent position in the aerospace industry. This position is now being challenged by Europe and other countries. Aerospace technology is not just a economic issue, but also one of national security. We must continue to pursue the development of new aerospace technology in order to maintain our global leadership.

Today's hearing is to examine the National Aeronautics and Space Administration's (NASA) aeronautical research activities. We will hear about research and development's critical role and how the application of advanced technology is critical to this nation's economic competitiveness. The U.S. Aerospace Commission Report called for proactive government policies and long term public investment to address this issue. The Honorable Robert Walker the Chairman of this commission and other witnesses will discuss what is needed to enhance our current R&D initiatives.

I am pleased to announce that I am currently working on legislation that implements much of what we will be discussing in this hearing. I want to significantly increase this nation's investment aerospace research engineering and development. I want NASA to develop new technologies that will reduce environmental issues such as pollution and noise. I want to ensure that America has a well trained cadre of aerospace engineers by offering scholarships and fellowships in aerospace education programs. Finally, I want to improve the coordination of aviation and aeronautics research programs between NASA and the Federal Aviation Administration. These additional investments are necessary to maintain our competitive position in aviation safety and technology and ensure our nation's aviation security.

I look forward to our panels' testimony.

Thank you Chairman Brownback.