WISE
Washington Internships for Students of Engineering

REDUCED FUNDING FOR AERONAUTICS R&D

By

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August 2000

This report was submitted to the American Society of Mechanical Engineers Int'l (ASME Int'l) to meet the requirements of the Washington Internships for Students of Engineering (WISE) for the Summer 2000 program

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About the Author

Kelly Goodyear is a senior at Lamar University studying mechanical engineering. The research for this paper was conducted through participation in the Washington Internships for Students of Engineering (WISE) program in the summer of 2000. The American Society of Mechanical Engineers (ASME) sponsored her internship.

The WISE Program

The Washington Internship for Students of Engineering program selects engineering students who have completed their junior year in a nation wide competition to spend ten weeks in a summer internship in Washington, D.C. The interns are exposed to a variety of public policy issues through discussions and frequent meetings with government officials, policy makers, lobbyists and other non-government individuals. These experiences enable the engineering students to learn how government officials make decisions on complex technological issues and how engineers can contribute to legislative and regulatory public policy decisions. In addition, each intern researches and completes a policy paper on a current engineering-related public policy issue that is important to the sponsoring society. The students work under the guidance of a prominent engineering professor. For more information about the WISE program, visit www.wise-intern.org on the World Wide Web.

Acknowledgements

The author would like to extend her deepest gratitude to the American Society of Mechanical Engineers for its support of her participation in the 2000 WISE program.

Additionally, the author would like to express her appreciation of Dr. Gilbert Brown, the WISE 2000 faculty-member-in-residence, Nelson Milder and Mary Legatski, whose support and guidance were invaluable.

Executive Summary

Federal funding of aeronautical research and development (R&D) has decreased steadily over the past years. The purpose of this paper is to explore the cause(s) of the decline in federal R&D support of aeronautics and the resulting repercussions for the nation if this trend is not reversed. The decline in federal funding for aeronautics R&D may be the result of one or more underlying factors, including the maturation of the aeronautics industry itself, the globalization of the industry, and more intense competition for limited federal R&D dollars. There are numerous possible repercussions, not only for the U.S. aeronautics industry but also for the nation as a whole, if funding for aeronautics R&D continues to decline. Several of these are discussed below including the effect upon U.S. competitiveness in aeronautics, national security implications, quality of life issues, decline in aviation safety, infrastructure integrity and quality of education.

There are steps being made by some of the concerned parties to ensure that the aviation industry survives its current slump. ASME International is coordinating an umbrella organization with representatives from several concerned groups including engineering societies. The coalition is currently drafting a position statement on the aeronautics "crisis" at hand. Also in the process of being established is a commission to evaluate the future of the United States aerospace industry.

There are several recommendations that can be made to help the future of the United States aeronautics R&D. A commission to determine the future of the aerospace industry is a necessary step toward a focused goal for the future. However, it is important that aeronautics role in the future of the aerospace industry is clearly defined and addressed by the commission. With a focused agenda, the aeronautics industry at least has something for which to aim; without a clearly defined target, there is no way to make a mark. The ASME-led advocacy effort is an important persuasive effort that should be followed through and supported at every level. It is important for the various concerned groups to cooperate with each other, because only through collaboration can their common goal be achieved. Also, on the research level, it is important for agencies to collaborate in order to make the most of their research efforts. The recent partnering between NASA and the FAA is a promising sign. Lastly, and probably most importantly, government funding for R&D has to be raised, overall. In the case of NASA, lowered funding for R&D forced the prioritization of NASA's R&D departments, consequently putting space R&D ahead of aeronautics.

Continued decreased federal funding of aeronautics R&D will severely injure the nation's well being. By conveying the need for continued funding for aeronautics R&D to policy makers, engineering societies can help reverse this possibly fatal trend.

Introduction

Federal funding of aeronautical research and development (R&D) has decreased steadily over the past years. Currently, funding for the aeronautics division of the National Aeronautics and Space Administration (NASA) represents less than five percent of NASA's total budget. The purpose of this paper is to explore the cause(s) of the decline in Federal R&D support of aeronautics and the resulting repercussions for the nation if this trend is not reversed.

Background

The National Advisory Committee for Aeronautics (NACA), the predecessor agency to NASA, was formed in 1917 to focus exclusively on aeronautics. Until the advent of the space race in the late 1950s, NACA and the Department of Defense (DOD) conducted the majority of aeronautics R&D.

With the establishment of NASA in 1958, NACA was dissolved. NASA assumed the lead role in developing the nation's aeronautics- and space-related technologies. Over the past four decades, federal funding for aeronautics R&D has been concentrated not only in NASA and DOD, but also in the Department of Transportation's (DOT) Federal Aviation Administration (FAA) and the National Science Foundation (NSF). Responsibility for aeronautics-related issues is so diffuse that, despite its name, most Americans do not associate NASA with anything but space exploration.

Over the past several years, however, overall funding for aeronautics R&D has declined. In fact, a recent article in *Aviation Week & Space Technology* [1] observed that "aeronautics has become NASA's stepchild."

[1] *Aviation Week and Space Technology*, Editorial, March 6, 2000.

Why the decline in federal funding of aeronautics R&D?

The decline in federal funding for aeronautics R&D may be the result of one or more underlying factors, including the maturation of the aeronautics industry itself, the globalization of the industry, and more intense competition for limited federal R&D dollars.

Industry Maturation

What is meant by a "mature" industry? Warning signs that an industry may be past its peak include diminishing technological opportunities, low return on research and technology (R&D) development, and a focus on reducing costs. In a report put out by the National Academies, it is stated that "aeronautics technology tends to be limited by ideas, not by basic physics."[2] Persons knowledgeable about the aeronautics industry[3] agree that new technological opportunities exist. There is, however, pressure to reduce costs.

Globalization

The aeronautics industry is also experiencing the effect of globalization. As companies expand across multi-national boundaries, fewer companies command larger pieces of the market share. In August of 1997 Boeing merged with McDonnell Douglas, making a single company that dominates the aeronautics industry in the U.S. Internationally, Airbus Industrie is itself a joint effort of France, Great Britain, Germany and Spain.

Increased Competition for Limited Federal R&D Funding

It does appear, however, that increased competition for limited federal R&D funding may play a greater role in the decline of aeronautics R&D than industry maturation or globalization. The NASA budget, which includes aeronautics R&D, is encompassed in the Veterans Administration, Housing and Urban

[2] Recent Trends in U.S. Aeronautics Research and Technology, The National Academies, 1999.
[3] Robert Pearce, NASA; Charles Heuttner, Office of Science and Technology Policy; Richard Obermann, Ph.D., Science Committee

Development and Independent Agencies (VA-HUD) appropriation. In addition to the VA, HUD and NASA, this appropriations measure also contains the budgets for the Environmental Protection Agency (EPA) and the National Science Foundation (NSF).

Table 1: Relative Budgets for VA-HUD Appropriations

	FY 2000 Appropriations	FY 2001 Recommended by the House
VA	$44,255,165,000	$46,849,667,000
HUD	$25,860,183,000	$29,967,030,000
NASA	$13,600,819,000	$13,713,600,000
EPA	$7,591,659,000	$7,150,888,000
NSF	$3,897,184,000	$4,064,300,000

Thus, aeronautics is competing for R&D funding against not only space-related interests, but also those of veterans, housing advocates, environmentalists and other scientists and engineers. The decline in R&D funding for aeronautics indicates that, in comparison to other disciplines, it is not a high priority.

Currently the legislation that affects the funding of aeronautics R&D is in many stages of completion. The VA/HUD appropriations bill, H.R. 4635, has passed the House, but is awaiting consideration in the Senate. The Transportation appropriations bill, H.R. 4475 (S. 2720), passed both the House and the Senate; but, in June, the Senate requested a conference. The Defense appropriations bill, H.R. 4576, went to conference in July and became public law, PL 106-259, on August 9, 2000.

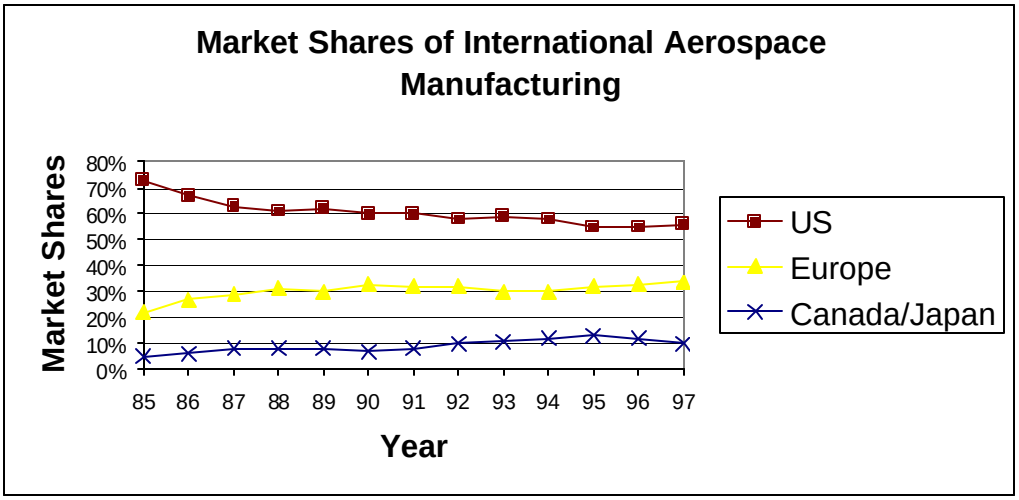
What are the possible repercussions of declining aeronautics R&D?

There are numerous possible repercussions, not only for the U.S. aeronautics industry but also for the nation as a whole, if funding for aeronautics R&D continues to decline. Several of these are discussed below including the effect upon U.S. competitiveness in aeronautics, national security implications, quality

of life issues, decline in aviation safety, infrastructure integrity and quality of education.

U.S. Competitiveness in Aeronautics

The U.S. has had, in the past, a dominating presence in the global aeronautics market share. The U.S. has provided a target for other countries to try and reach in order to compete.



Source: The National Academies, *Recent Trends in U.S. Aeronautics Research and Technology*

Figure 1: U.S. Holding of Market Shares in Aerospace Manufacturing

As seen in Figure 1, during the mid-1980s, the U.S. held 70 percent of the world aerospace market share; however, by 1997 it fell to 55 percent.[4] The year 1999 marked the first time that Airbus outsold Boeing in large commercial jets, holding 52 percent of the market share of orders.[5] Additionally, the National Academies' Committee on Strategic Assessment of U.S. Aeronautics found that although the demand for smaller regional commercial jet transport aircraft is growing, the two major suppliers of these regional jets are based in foreign countries. In the past,

[4] National Academies' Report.

[5] Statement on the Aeronautics Programs Within the National Aeronautics and Space Administration Fiscal Year 2001 Budget Request Prepared by the Aviation R&D Task Force of the Aerospace Engineering Division of the Environmental and Transportation Group, Council on Engineering, American Society of Mechanical Engineers, April 12, 2000.

partnerships between industry, NASA, DOD, and the FAA have been needed to accomplish large investments in new high-risk technologies.

In its recent statement to the Subcommittee on VA, HUD, and Independent Agencies, Committee on Appropriations U.S. House of Representatives[6], the American Society of Mechanical Engineers (ASME International) declared that it was not its desire that these government agencies share the cost of *commercial* aviation developments, as is the practice in other countries. Preferably, ASME would like to see NASA undertake "high-risk, potentially high-payoff"[7] R&D, which can eventually become the foundation for commercial endeavors.

Without increased federal funding of aeronautics R&D, the U.S. position in the global aeronautics community will continue to slip. After the launch of Sputnik by the Soviets in 1957, Americans felt the need to unite as a nation and go to the moon. During the 1960s, the competition with the Soviet Union was the driving force for the United States. Similarly, the Europeans now serve as severe competition in the aviation industry. This might be just the impetus the U.S. needs to resuscitate the aviation industry. The European Airbus Industrie group is in the process of introducing a large double-decker jumbo jet, currently called the A3XX, which could be in production as early as 2005. Among the A3XX's advantages over the Boeing 747 are its passenger capacity (555), range (over 400 miles farther), fuel capacity (almost 30,000 more gallons), and maximum takeoff weight (315,000 pounds more).

Table 2: Boeing 747 vs. New Airbus A3XX

	Boeing 747-400	**Airbus A3XX-100**
Seats	417	555
Range	8,380 miles	8,798 miles
Fuel Capacity	57,285 gallons	85, 900 gallons
Maximum Takeoff Weight	875,000 pounds	1,190,000 pounds

Source: *The New York Times*, "Airbus Industrie Is Considering a Very Big Bet", July 14, 2000

[6] ASME Statement.
[7] Ibid.

National Security Implications

National security is another area that will be negatively impacted by a continuing lack of aeronautics R&D. There is no capability that exists that is as reassuring and forceful as aeronautics. Aeronautics R&D directly impacts the nation's ability to wage war, since aviation is an integral part of the military defense. As unpleasant as it is to imagine, we have a responsibility as a nation to protect ourselves, and one of the most effective ways to do that is from the air. Aeronautics is the only capability that allows for the rapid projection of force over long distances. Airplanes establish a presence and an influence that cannot be matched by any other mechanism now or in the immediate future. Additionally, the use of planes in situations of national defense can successfully minimize American casualties by reducing the number of ground forces necessary and providing support from the air to those necessary ground forces. The U.S. has national and international commitments and responsibilities that can only be met with a strong aeronautics capability. A strong aeronautics capability can only be achieved through continued investment in aeronautics R&D.

Quality of Life Issues

Aeronautics has improved and can continue to improve the quality of life for Americans. From environmental concerns to cheaper commercial flights, aeronautics R&D seeks to change the way America flies. Without funding new advancements in the field of aviation cannot be made. In the last 30 years, as a result of aeronautics research, aircraft fuel efficiency has doubled and aircraft noise has decreased by a factor of 10.[8] The NSTC report lays out an "environmental compatibility roadmap", which provides a plan for reducing aircraft noise and emissions through new technology.[9] The roadmap outlines local air quality concerns, which include reducing the emissions of nitrogen oxides (NOx) and other pollutants that endanger the environment and public

[8] National Research and Development Plan for Aviation Safety, Security, Efficiency, and Environmental Compatibility, National Science and Technology Council, November 1999, Committee on Technology, Subcommittee on Transportation Research and Development.
[9] Ibid.

health, global change, which involves the reduction of emissions that affect the climate, and noise reduction. The expected results from these three activities are summarized in Table 2 below.

Table 2: NSTC Environmental Compatibility Roadmap Expectations

	2007	2022
NOx Reduction	70%[1]	80%
CO_2 Reduction	25%	50%
Noise Reduction	5 to 10 dB[2]	20 dB

[1] Relative to 1996 standard
[2] Reduced from 75 dB in 1997

The local air quality activity seeks to reduce the amount of NOx, and consequently improve local air quality and stop the progression of damage to the ozone layer, through advanced engine design and more efficient operations. The global change initiative attempts to reduce or possibly eliminate the emission of carbon dioxide through alternative fuels and more efficient operations. The noise reduction plan endeavors to lower the effect on local population by developing alternative options in engine systems, aircraft systems and operational procedures.

Dan Goldin, the Administrator of NASA, relayed in his statement to the Subcommittee on Aviation Committee on Transportation and Infrastructure that one of NASA's goals for the future is to decrease the time it takes a commercial passenger to go from "doorstep to destination".[10] He outlines the use of "smart", small airports that will facilitate transportation rates of two to three times faster than highway speeds. As it is now, trips less than 500 miles average a speed of only about 80 miles per hour. Sadly, none of these options for improving Americans quality of life will be possible without the support, through federal government funding, of aeronautics R&D.

[10] Statement of Dan Goldin to the Subcommittee on Aviation, Committee on Transportation and Infrastructure, May 16, 2000.

Decline in Aviation Safety

Aviation safety is an issue that must be constantly evaluated. Although it can be considered a part of improving the quality of life, it is important enough to evaluate separately. With expected increases in the number and frequency of flights, more accidents are predicted if changes are not made to the aviation safety field. The U.S. accident rate has remained unchanged and at a very low rate for the last 20 years. However, with the expected increase in air traffic, if nothing is done to re-evaluate aviation safety, there will be an increased accident rate and consequently an increase in loss of life. It is projected that within the next decade, if things remain unchanged, major accidents will occur on a weekly basis. With NASA's recent apparent emphasis on the space programs, federal budget limitations, and an increase of R&D assigned to the FAA, aviation safety efforts could be reduced.[11]

NASA Administrator, Dan Goldin, related NASA's commitment to safety in his recent statement to the House of Representatives, "We are focusing on enabling an unquestionably safe and environmentally friendly expansion of aviation that will dramatically improve this Nation's mobility for the 21st century."[12] In the future, aircraft will possess artificial vision, made up of a compilation of advanced sensors, digital terrain databases, accurate geo-positioning, and digital processing, which will combine to provide a three-dimensional picture of the terrain, any obstacles, the runway and impeding traffic.[13] All of these futuristic accomplishments are within the nation's reach with investment in aeronautics R&D.

Infrastructure Integrity

The backbone of the aeronautics industry is at risk of being shattered. Although total R&D funding in the U.S. has increased eight percent from 1999, 70.3

[11] ASME Statement
[12] Dan Goldin's Statement.
[13] Ibid.

percent of it will come from industry.[14] In past years, about half of the funding would have come from the federal government. R&D sponsored by industry tends to have an emphasis on near-term development, not basic exploration as does federally sponsored R&D. Therefore, the concern is that with R&D supported by industry instead of the federal government, the future of technology is at risk. In the National Academies' report it is said, "Once the position of the U.S. in aeronautics is lost, it will be exceedingly difficult to regain because of the difficulty in reassembling the infrastructure, people, and investment capital."[15]

Reductions in aeronautics R&D are occurring without a complete knowledge of the possible long-term repercussions. Additionally, these reductions are being made in an attempt to reduce near-term expenditures, again, without thought of what it might mean in the future. If aeronautics R&D funding continues to decrease, the time will come when the nation realizes that these reductions have done severe, long-term damage to aeronautical interests.

Quality of Education

Perhaps the most startling repercussion of reduced aeronautics R&D is the education aspect. Lack of funding for R&D programs means that not only will college students have less of a chance to study and develop new aeronautical technology, but also, as a result, they will be less prepared to function in industry. Which means that the industry will suffer a lack of competent employees. As a result, the industry will lose business, which causes the industry to cut back on employment. With a lack of available jobs, young people will stray away from aeronautical engineering, which only feeds the idea that funding is not necessary. There is a partnership between industry and academia for the development of new technologies. If the funding to these universities is cut, that partnership will be damaged.

[14] ASME Statement.
[15] National Academies' Report.

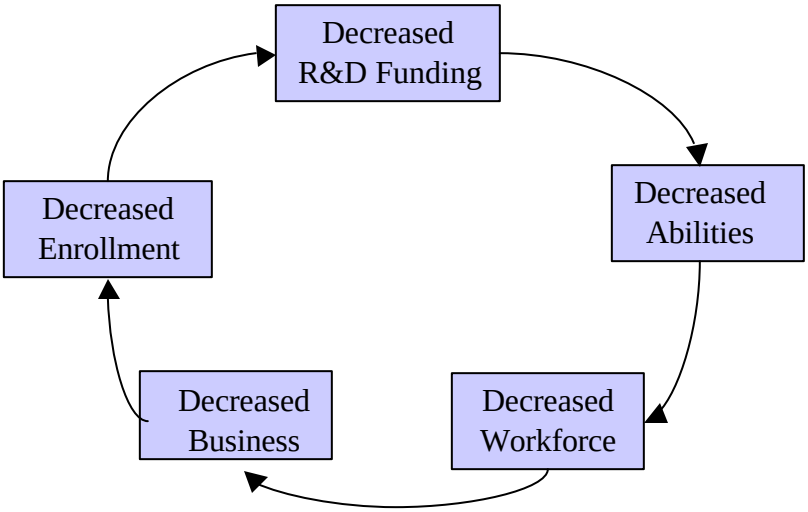


Figure 2: Cycle Caused by Reduced R&D Funding

In the previously mentioned statement, ASME expressed concern at the lack of support and promotion of aeronautics research and education. For the greater part of the last century, there was a partnership between American universities and American industry; American universities produced creative and skilled aeronautical engineers to work in American industry. However, this could be changing. De-emphasis of long-term aeronautics research is damaging U.S. universities' ability to sustain robust aeronautical engineering programs, and as a result, these affected universities are finding it progressively harder to contribute to improvements in aeronautics R&D. The nation needs the government to play a principal role in the support of university aeronautics education and research.

In addition, since aeronautics is not considered a growth industry, university graduates are increasingly attracted to high-paying new growth industries. Internet companies are attracting skilled aerospace industry personnel with information technology experience. Continued reductions in aeronautics R&D will result in the depletion of an appropriate personnel base that is necessary to sustain a healthy, competitive aeronautics industry that functions in the best interest of the nation. The knowledge and experience acquired by an engineer, for example, is lost if it is not passed along on the job to the next generation of

engineers. It is common sense that cutting edge R&D, especially aeronautics R&D, attracts young engineers and scientists. As a consequence, the more aeronautics R&D funding is decreased, the harder it will be to generate skilled new engineers and scientists.

Who are the key players in the public policy debate on aeronautics R&D?

As with most issues, there are groups that support the increasing of federal funding of aeronautics R&D and groups that oppose it. The discussion that follows outlines a few of the key players in the public policy debate surrounding the funding of aeronautics R&D.

Supporters

There are steps being made by some of the concerned parties to ensure that the aeronautics industry survives its current slump. ASME International is coordinating an umbrella organization with members from NSTC, NASA, DOD, DOT/FAA, and many more. The Aeronautics Research and Technology Coalition is comprised of representatives from 27 engineering societies with a membership of over 1,000,000 engineers and scientists from industry, universities, and government. The coalition is currently drafting a position statement on the aeronautics "crisis" at hand. Within the position statement are the coalition's concerns and their recommendations. The coalition's short-term goal is to influence Congress to grant no less than the President's FY 2001 Budget request for NASA's aeronautics research, which is a little more than $14 billion, an increase of 3.2% over last year. Among the long-term goals is the establishment of national aeronautics R&D policy to restore the U.S. to a position of world leadership in aviation. It is unclear exactly where aeronautics R&D fits in the domain that is called "aerospace"; this is unsettling to many concerned parties. Without a clear definition, aeronautics R&D can easily be lost among all the space programs.

Also in the process of being established is a commission to evaluate the future of the United States aerospace industry. A House amendment to the Defense Authorization bill[16] seeks to establish the Presidential Commission on the Future of the United States Aerospace Industry.

- House Amendment
  - Presidential Commission
  - 10 to 17 members appointed by the President
- Senate Amendment
  - Blue Ribbon Commission
  - 12 members total
    - 6 appointed by the President
    - 6 appointed by Congress

The proposed legislation to set up this commission has been passed through the House. The Senate amended the original bill, as well, seeking to establish the Blue Ribbon Commission on the Future of the United States Aerospace Industry. One of the main differences between the two of the proposed commissions is the appointment of the commission members. The House version states that the President shall appoint ten to 17 members. However, the Senate version says that there will only be 12 members, only six of whom will be appointed by the President, two by the Senate majority leader, two by the Speaker of the House, one by the Senate minority leader and one by the Senate minority leader. Obviously, the Senate is opposed to solely the President having the ability to appoint members to the commission. Such a distribution of representation should ensure a more universal commission that represents the views of many people, not just a select few.

Detractors

It is not surprising that there are people who oppose increased funding for aeronautics R&D; practically no one supports every issue. Those opposing are people who do not share the view that current funding levels for aeronautics R&D need to be increased, which are essentially those persons or organizations that feel that space research deserves the money. One of the arguments is that

[16] The Defense Authorization bill is H.R. 4205.

many things developed for the space program can filter down to aeronautics. However, this gives aeronautics less control over what is being researched. When budget cuts occur, agencies are forced to prioritize. In the case of NASA, when lack of funding hit, there were obligations to the International Space Station and other space programs that had to be met financially. Therefore, NASA had to prioritize. Aeronautics funding was cut. This is the wrong message to send out. Aeronautics is not less important than space. They are two different entities and both important.

Others opposing increased federal funding for aeronautics R&D are those who feel that the government is not and should not be responsible for funding the nation's aeronautics R&D. These people and groups quickly claim "corporate welfare" is being proposed and that industry should be responsible for funding all the aeronautics R&D for the nation. If industry were willing to invest in long-term basic exploration R&D, then support from the federal government would not be necessary. As it is, as mentioned earlier, industry spends its R&D money on near-term research, which does not include basic exploratory research that is so important to the nation's future.

What steps can be taken to reverse the decline in federal funding for aeronautics R&D?

In conclusion, there are several recommendations that can be made to help the future of the United States aeronautics R&D. A commission to determine the future of the aerospace industry is a necessary step toward a focused goal for the future. However, it is important that aeronautics' R&D role in the future of the aerospace industry is clearly defined and addressed by the commission. With a focused agenda, the aviation industry at least has something for which to aim; without a clearly defined target, there is no way to make a mark. Bringing together the concerned groups is an important persuasive effort that should be followed through and supported at every level. It is important for the various groups to cooperate with each other, because only through collaboration can

their common goal be achieved. Also, on the research level, it is important for government agencies to collaborate in order to make the most of their research efforts. The recent partnering between NASA and the FAA is a promising sign. Lastly, and probably most importantly, government funding for R&D has to be raised, overall. In the case of NASA, lowered funding for R&D forced the prioritization of NASA's R&D departments, consequently putting space R&D ahead of aeronautics.

The state of the U.S. aeronautics industry is in disrepair. One hundred years ago when flight by humans was first being attempted, no one would have guessed the impact that aviation has had on society. The American way of life has been, in many ways, defined by breakthroughs in aviation. Not only has it been made possible for people to stay in contact with loved ones around the world, but also aeronautics has insured a safe nation, by protecting the U.S. from hostile threat. With the help of the engineering community, by conveying the need for continued funding for aeronautics R&D to policy makers, this record of accomplishment can be sustained into the future.