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LOCAL AND NATIONAL IMPACT OF AEROSPACE RESEARCH AND TECHNOLOGY

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As Director of the NASA Lewis Research Center, I'll begin my discussion by telling you a little about our laboratory. From that vantage point I will show you how NASA Lewis fits into the national scene and what our impact has been at the national level. In particular, I'll discuss our three areas of activity: aeronautics, space, and energy. I will try to give you examples of the local and national impact of each of these areas. Finally, we will conclude with some issues as I see them in today's environment.

First let me point out that NASA stands for the National Aeronautics and Space Administration. We are an independent agency with an annual budget of about $6 billion, out of approximately $700 billion for the U.S. government as a whole. In aeronautics we do research and technology, working with industry as a team to provide the research and technology base. Let me emphasize that NASA does not do product development work in the aeronautics area - industry develops the final products.

On the other hand, NASA is charged with the total spectrum for civilian space: research, technology, and development as well as operations. Consequently, the space budget is considerably larger than the aeronautics budget - roughly 15 to 1.

NASA LEWIS RESEARCH CENTER OVERVIEW

The Lewis Research Center was created as an aircraft engine research laboratory in 1941. In the 1940's and 1950's, the laboratory made many contributions to aeronautics. Many of the features of today's gas-turbine engines were developed at Lewis. The first hydrogen-fueled rocket burned in the free world was pioneered at Lewis. And, of course, we provided technical support to the U.S. Army Air Force during World War II.

In 1948, after World War II, the laboratory was renamed the NACA (that is, National Advisory Committee for Aeronautics) Lewis Flight Propulsion Laboratory in honor of Dr. George W. Lewis, long-time NACA Director of Aeronautics Research. And in 1958, after Sputnik, the laboratory was again renamed the NASA Lewis Research Center. At that time our role was expanded to include not only aeronautical propulsion, but chemical rocket, electric propulsion, and space power technology to support the space effort.

Because of our expertise in the various disciplires associated with aeronautical and space propulsion, NASA was asked by Congress to assist the Department of Energy in certain areas. We now do research and technology in automotive propulsion, power conversion, wind turbines, solar cells, etc.

GROWTH AND LOCAL IMPACT

During the past 40 years, the NASA Lewis Research Center has evolved from a single research and technology laboratory in aeronautical propulsion to a multifaceted, highly technical Center involving many disciplines. About half of our staff of some 2700 civil servants are engineers and scientists, and about 1000 are skilled craftsmen and technicians supporting the engineers and scientists. Our budget is about $1/2 billion per year, 75 percent of which is research and development. Of our research and development monies, over two-thirds are awarded as R&D contracts to industry and universities. We pride ourselves on working with industry and academe as a team to establish the research and technology base in highly complex areas which address current national needs.

As far as the local impact is concerned, we contribute about $125 million per year to the local economy. Our employment impact in the local Great Lakes area represents about 7000 jobs. The NASA Lewis Research Center is the key government research and technology base in northeast Ohio.

AERONAUTICS

Let's now look at the research activities of Cleveland's Lewis Research Center and how they affect the local and national scene. Our research objectives in aeronautics involve the public, industry, and national defense. For the public we endeavor to provide the technology for safe, economical, and environmentally acceptable air transportation. For industry, we help to develop the technology base needed to retain our nation's competitive position in the international market place. And for the military, we do research necessary to maintain superior technology for U.S. military aircraft.

As an example of the fruits of NASA's research and technology programs in aeronautical propulsion, let us look at the improvements in fuel efficiency over the years. The first commercial turbojet-powered airplanes were introduced in the mid-1950's. Since that time, a 40-percent reduction in fuel consumption has been achieved through research and technology. With the national and world emphasis on energy efficient propulsion, we precipitated an additional 5-percent fuel savings by our engine research improvement program, which was started in the late 70's. Current research for more energy efficient engines could further reduce fuel consumption by about 18 percent. The concept of an advanced turboprop engine or gas-turbine-powered propeller promises an additional 33-percent fuel savings over advanced turbofans in the late 1980's. The turboprop-powered aircraft can be used by short-haul feeder airlines.

These accomplishments are remarkable when one considers that along with the development of the technology to reduce aircraft fuel consumption there has been equally significant reductions in engine emissions and noise. For example, the perceived noise level has been reduced from about 115 dB in the mid-1950's to less than 95 dB in the new aircraft engines currently being certified by the FAA. To give you some feel for reduction in noise level, 115 dB is equivalent to standing about 20 feet from a passing freight train. And 95 dB is about equivalent to road noise from your living room. The technology for these improvements has been gradually developed over the years, and most people do not realize that they are the result of extensive research started at Cleveland's Lewis Research Center working with industry and universities. Other research and technology projects for the future that I can only mention in passing include work for alternate fuels where we are investigating the combustion of fuels derived from petroleum, shale, and coal. We are looking at ways of conserving strategic engine materials such as chromium, tantalum, cobalt, and columbium where the United States depends on imports for over 90 percent of its supply. We have an extensive effort in materials and structures research for engine durability. These are just a few examples of our activities affecting the health of the aeronautical industry in this country.

SPACE

A second area of activity at Lewis involves space research and technology. NASA Lewis developed and manages the Atlas-Centaur launch vehicle. We are currently modifying the Centaur so that it can be used as a high-energy upperstage rocket to go from the near-Earth orbit to geosynchronous orbit with space shuttle payloads. We are involved in the research and technology for advanced chemical and electric propulsion. Our activities in chemical propulsion include very low-thrust rockets that will provide a mechanism for maneuvering large structures in space such as huge antennas for air traffic control, communications, and military applications. We have done extensive research and have developed the technology for ion thrusters, or so-called electric rockets, for space travel.

And finally, our space work includes research and technology for space communications. NASA Lewis Research Center was responsible for opening up the 14/12 GHz frequency spectrum for commercial satellites. This frequency spectrum, which is currently being used for commercial satellites, will be saturated in the mid to late 1980's. Both the Europeans and the Japanese are doing extensive research work at higher frequencies with the objective of capturing the space communications market. Our research at NASA Lewis concentrates on the 30/20 GHz frequency spectrum. We have worked with industry in doing studies of the potential markets for this system, and we have defined the key technology developments required to exploit this frequency.

Currently, we are developing the elements necessary for this technology, including very complex devices which would be incorporated in the satellite with an aim toward simple, low-cost ground terminals for the user. In effect, the communications satellite would be a big telephone switchboard or TV station in the sky, so that antennas so small they could fit in your briefcase will be feasible. This technology looks very promising and we are working with industry for the necessary developments. Our own TRW, for example, is one of the leading companies involved in this activity. We eventually plan to design and build experimental space flight hardware operated from a ground station at the Lewis Research Center.

ENERGY

Now for our third area of activity - terrestrial energy. Because of NASA Lewis' expertise in areas such as materials, bearings, lubrication, seals, combustion, aerodynamics, turbomachinery, and other disciplines, the Department of Energy has asked us to work with them in certain technologies. I mentioned that remarkable achievements have been accomplished in reducing fuel consumption for aircraft engines. If similar achievements could be accomplished in automotive propulsion, we would get tremendous reductions in the amount of petroleum we're burning. If you look at the percent of petroleum usage in this country, almost half is used by surface transportation whereas only about 6 percent is used for aviation. Therefore, we have a leverage factor of more than 5 times in fuel conservation, if we could accomplish similar technological achievements for automotive engines as have been made for aircraft engines. To this end, NASA Lewis, in conjunction with the Department of Energy, has embarked on two automotive engine programs with industry. We are working with the General Motors team, of Pontiac and Detroit Diesel Allison, and the AiResearch and Ford team. Our goal in automotive gas-turbine engine development is a 40-percent reduction in fuel consumption with virtually no pollution. The technical feasibility has already been established, so the emphasis is now on the -ilities - producibility, reliability, maintainability, affordability, and so on, with most of the emphasis on economic viability.

Here, one of the challenging technologies is in the potential use of ceramic materials in the turbine engine. Our program, which has stimulated innovative uses of ceramic materials, has, in turn, stimulated the U.S. ceramics industry. However, I should point out that the federal budget squeeze may terminate our entire automotive propulsion research effort. In the meantime, the Japanese have embarked on a broad ceramics research and technology program using extensive amounts of government subsidies. The Japanese government has committed about $60,000,000 over a 10-year period to ceramics research alone.

Another program in the automotive engine field is the Stirling engine research program. This technology resides mainly in Europe. We have a program with Mechanical Technologies, Inc., who is working with American Motors General and United Stirling of Sweden as subcontractors. The goals of the program are also to improve fuel economy and reduce emissions. Again, the results to date have been very promising. In fact, we installed a Stirling engine in an American Motors Spirit to demonstrate feasibility. In it we burned gasoline, diesel fuel, alcohol, and even Bacardi rum with good results.

We think that 9 to 10 years from now we could get exceptionally good fuel economy for a standard sized car using a gas turbine or Stirling engine. I should point out that an increase of only 1 mile per gallon in fuel economy for all the 120 million cars we have on the road would save over 300,000 barrels of oil a day.

Again, we have to worry about foreign competition. Foreign cars dominate the list of fuel economy leaders for the current 1982 model year. Only one American entry (and its engine is made in Japan) broke into the top ten. As a shocker, in 1983, about half of the cars sold in the United States will have foreign-made engines because of commitments already in place. The cost of this to the United State's economy will be about $5 billion in negative balance of trade and over 400,000 jobs. The United States is rapidly becoming a distributor rather than a manufacturer.

Wind turbine technology is another promising project that NASA Lewis Research Center has embarked on with the Department of Energy. We are the leader in horizontal-axis large wind turbines.

Recently we completed a "wind farm" - three wind turbines each rated at 2.5 million watts of electricity. These three wind turbines will provide enough electricity for about 3000 homes in the state of Washington. This "wind farm" is connected to the Bonneville electric power grid at Goodnoe Hills, Washington.

Our goal in wind turbines is to produce electricity that is cost competitive with that produced with fossil fuels. We think that large horizontal axis wind machines can probably produce electricity for less than 4¢ per kilowatt-hour if mass produced.

Wind turbines will not cure our energy problem, but they can make a contribution as a clean, renewable energy source. Utilities such as Hawaiian Electric, Pacific Gas and Electric, and Southern California Edison have already ordered wind turbines.

Because of the Lewis Research Center aerospace expertise, we have been able to contribute significantly to the development of the technology base for wind energy conversion. And, a new American industry is in place with a very promising future. All this has taken place in the 6 years since our initial research wind turbine of 100 kilowatts was designed and built at Sandusky, Ohio, in 1975. We think that further gains can be accomplished in the technology of wind turbines. Unfortunately, the current budget squeeze may eliminate further research in this very fruitful area.

Other energy projects, which I do not have time to detail, include standalone solar cell systems for entire communities, an electric energy storage system using liquids called REDOX, research on high-temperature turbines for stationary electric power generation, and a very promising project which would make possible the use of high-sulfur Ohio coal to efficiently generate both electricity and steam.

Now that I've described some of the aspects of our research and technology laboratory, let me briefly outline some of the tough issues that face us as a nation.

NATIONAL IMPACT AND FOREIGN COMPETITION

Let's start with our aeronautics industry, and discuss some aspects of its impact on the economic health of our nation. The aerospace industry in this country had over $50 billion in sales in 1980, employed over one million people, and has become the largest "positive" contributor to the U.S. foreign trade balance; that is, exports minus imports. In fact, the aerospace industry's positive balance of trade has increased from just $3 billion in 1970 to $13 billion in 1980. Each billion dollars of export in this industry represents about 40,000 U.S. jobs. This positive balance is mainly due to U.S. sales of commercial, transport-type aircraft. The U.S. enjoyed over two-thirds of the world's commercial transport market until about 3 years ago. In the last 3 years, however, our market share has dropped 20 percent because of European competition. The U.S. rotorcraft market has decreased 15 percent, and the commuter airplane market is now dominated by foreign manufacturers.

Our competitive position promises to become even worse in the future. It is the general practice for foreign governments to provide financial incentives for all phases of aircraft production and sales including research and development, tooling and fabrication, and attractive financing provisions. More than 20 companies in 17 nations, for example, are competing with U.S. industry for the growing worldwide market in general aviation. Brazil will sell you a general aviation airplane with almost nothing down and 7 percent interest on the loan. Our survival in the commercial aviation industry can only be accomplished by aggressive research and technology in the face of this stiff and expanding foreign competition.

In the aircraft propulsion industry, things are particularly bad. General Electric, for example, is cutting back on its aeropropulsion research and development programs because of the deteriorating profit margin in its commercial aircraft engine business.

Faced with less income and higher costs, U.S. industry cannot afford to fund research and technology over the long term (that is, 10 to 20 years) without government help. Industry's main concern is to survive and to make a reasonable return on its investment in the near term. The engines you will see in tomorrow's aircraft are the result of research and technology accomplished by NASA Lewis over several decades. But NASA's aeronautics budget has declined 17 percent since 1980 and further drastic reductions are probable in the next several years. The National Academy of Engineering has recently warned that the United States momentum in aeronautics is eroding. If this country fails to maintain and improve its technological capabilities in aeronautics, foreign competitors will seize greater portions of future markets.

Similar developments are evident in the space technology area. In the space portion of the NASA budget there are no new starts in fiscal year 1982. The space science program has declined 20 percent and space applications has declined 9 percent in constant dollars since 1980.

Our communications technology program at Lewis will be delayed or terminated, jeopardizing a $40 billion potential market by the year 2000. Our space technology has the potential for creating a truly integrated information system. Handling information constitutes over 50 percent of all activities of modern society. Through space technology we could employ new space communications frequencies, data processing and storage systems, in-orbit refurbishment, repair and checkout, orbit transfer systems, and operational and support centers in low Earth orbit to mention but a few possibilities. A passive approach to federal policy in this critical area will be a prescription for failure.

The European Space Agency has developed an expendable launch vehicle called the Ariane to compete with the Space Shuttle. It will be launched from French Guiana in South America. Commercial customers like INTELSAT have already contracted for launch on the Ariane. General Telephone's Satellite Corporation has also signed up to launch satellites on the Ariane from French Guiana. The Grumman Corporation of Bethpage is the Ariane marketing agent in the United States and is negotiating with several more potential U.S. customers. The United States no longer enjoys a monopoly on launch vehicles and, even when the shuttle becomes operational, there will be intense foreign competition.

The automotive area is even worse. Foreign imports of automobiles comprise about 25 percent of the U.S. domestic sales. The U.S. has become much less competitive in international markets, but the real danger is the inability to employ our own workers. The automobile industry employs directly or indirectly about 11 percent of the total U.S. labor force. In spite of alarming statistics, we have chosen not to aggressively pursue promising research and technology for the long term. Our gas turbine and Stirling engine programs have been curtailed drastically with a good chance of near-term termination.

The Arab nations will derive in the next 5 years about $2 trillion from petroleum exports and the United States will pay about $750 billion of this. In fact, the largest transfer of wealth that has ever occurred in civilization is now going on. $2 trillion is $2000 billion, which is almost equivalent to the gross national product of the United States generated by 100 million workers in a year's time. Yet, this country has chosen not to aggressively pursue research and technology to conserve petroleum.

As far as our military posture is concerned, the statistics are even more alarming. The Soviet Union launched 132 payloads into space in 1980 while the United States launched 16. The Soviets presently have over twice as many engineers and scientists as we do and they are turning them out at five times our rate. Still this country has chosen not to support its universities of higher learning by eliminating scholarship and research support for promising students. In fact, we're educating foreign graduate students almost at a greater rate than United States students. Some graduate schools in this country are two-thirds foreign students.

A recent Brookings Institute study shows that technology is the leading contributor to productivity. The declining technology base in this country has already taken its toll. The Bureau of Labor Statistics shows that the annual productivity increase of the U.S. worker from 1960 to 1973 was 3.4 percent, which is lower than in all other major Western trading nations. Most of these countries have an increase double that of ours, and Japan's increase is three times ours, 10.5 percent. Our one bright spot is agriculture.

None of us believe that the United States worker is inferior to the Japanese industrial worker, but the Japanese worker has the technology and capital at his disposal. If the United States wants to accelerate economic progress and increase productivity, an incremental investment in research is one of the best if not the best investment that can be made. NASA could be (and has been) a major contributor, but its budget is only 8/10 of 1 percent of our federal budget and is decreasing. In fact, the present purchasing power of the NASA budget is only about half that of the 1968 budget.

Almost as bad as the low level of funding has been the cyclic nature of funding for research in the United States. Funding for research increased during World War II, declined until Sputnik in 1957, and then increased until 1968 when a precipitous decline began. We now face another precipitous decline in research funding which could have disastrous effects on the future of this country. It is time that this country came to its senses and supported the vital research and technology necessary for our national economic health. Cyclic, inadequate funding is the road to disaster.