Where are the forest fires on Earth?
Where are blight or other diseases attacking forests and agricultural crops?
Where are mineral and oil resources likely to be found?
Where is the pollution of air and water occurring?
Where are the fresh water resources on Earth?
Where is urban growth occurring, and how is it impacting on the environment?

Today, for the first time in the history of this planet Earth, we have the tools to find answers to these and other vital questions because mankind has begun to get information that will fit into the first global inventory of resources.

There is nothing new about having a picture of a portion of the Earth taken from high above it.

What is new is the fact that today cameras and other sensors are providing single pictures that provide more information than formerly could be gleaned from up to 1000 photographs taken from an aircraft and laboriously matched together into a mosaic.

ERTS-1 (Earth Resources Technology Satellite 1), launched on July 23, 1972, from Vandenberg Air Force Base, California, is orbiting Earth at an altitude of 570 miles, and is returning high-quality pictures and other data on the condition of the atmosphere and the oceans, agriculture and geology, and man and his fellow creatures.

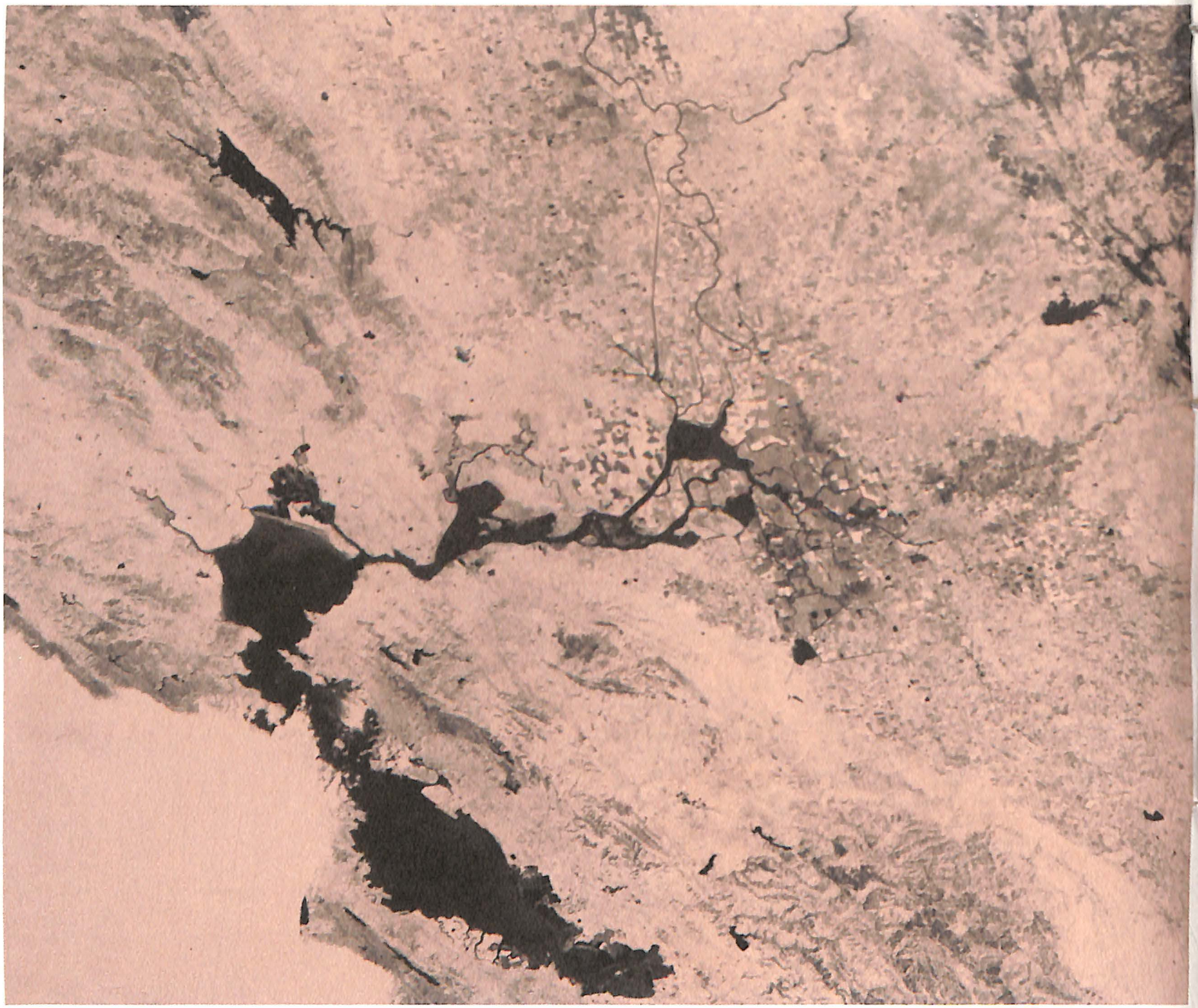
In its near-polar, sun-synchronous orbit the 1,965-pound NASA spacecraft circles the globe every 103 minutes, completing nearly 14 orbits daily. Every week it surveys more than 42 million square kilometers, sending back images of the Earth's surface that are 115 miles square. Thus the entire globe, with the exception of some areas near the poles, is covered every 18 days.

In addition, a data collection system aboard the satellite is gathering signals from 150 automated platforms at as many ground stations in various remote areas of North America. This environmental information — measurements of air pollution, rain and snow fall, rate of stream flow and other physical occurrences — then is relayed through telemetry to NASA ground stations.

At NASA's Goddard Space Flight Center at Greenbelt, Maryland, nearly 10,000 color, black and white, and digital tape images will be processed every week for ERTS experimenters.

The latter include some 300 scientists in 37 countries. Domestic U.S. investigations are being funded by the National Aeronautics and Space Administration and the user agencies, which include the Departments of Agriculture, Commerce, Interior, the Environmental Protection Agency (EPA), and the U.S. Army Corps of Engineers, as well as regional, state and local organizations.


Serving Mankind —
EYES IN
THE SKY



ERTS-1 spacecraft last summer made this composite photo of the San Francisco Bay area from an altitude of about 570 miles. Notable geographic features include San Francisco Bay (lower center), foothills of the Sierra Nevada Mountains (upper right) and Tomales Bay (far left). Rolling fog and sediment in the bay are shown at lower left.

Canada, Brazil and Mexico are involved in extensive cooperative Earth resources projects involving ERTS and NASA Earth observation aircraft.

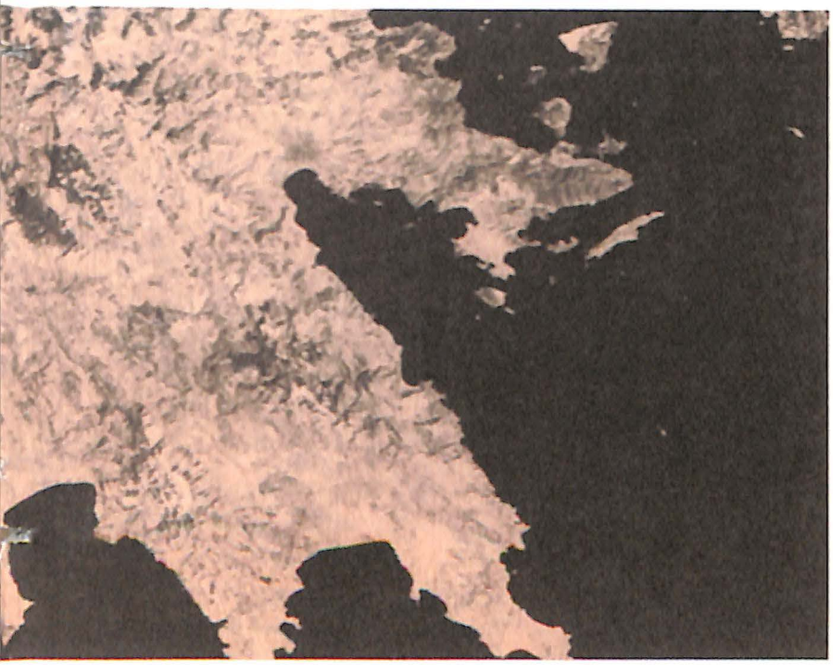
ERTS-1 has a design life of one year. The second satellite in the series, ERTS-2, is scheduled for launching late in 1973.

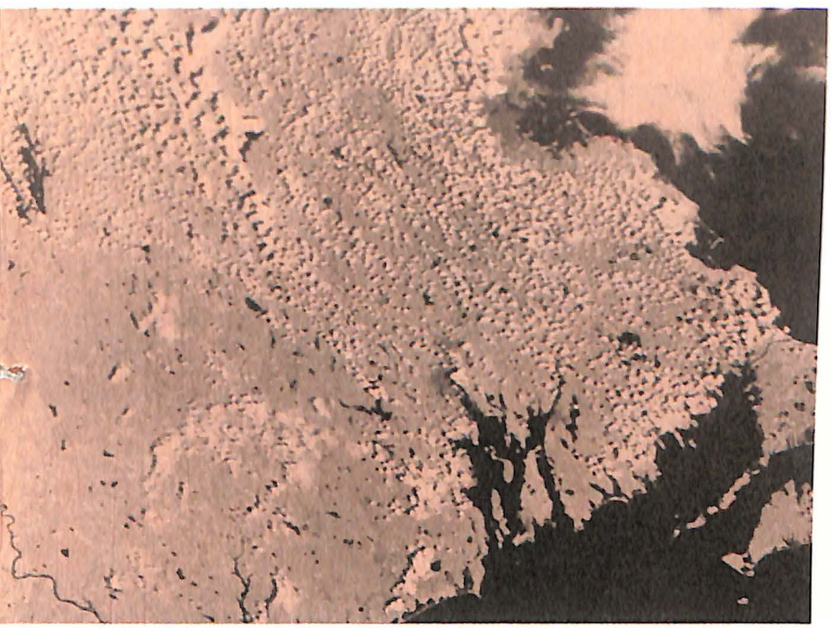
The ERTS satellite, for which General Electric's Space Division, Valley Forge, Pennsylvania, is prime contractor, is similar in design to the Nimbus weather satellites, for which GE was also spacecraft contractor. It is 500 pounds heavier than the last Nimbus launched, however, and is 10 feet high with a five-foot-diameter ring to carry its payload. With its solar paddles extended, its span is 13 feet.

• *Payload* — The payload includes a Return Beam Vidicon (RBV) Camera subsystem, developed by RCA's Astro-Electronics Division, Princeton, New Jersey; a Multispectral Scanner (MSS), from Hughes Aircraft Company, Culver City, Calif.; and the aforementioned Data Collection System (DCS), equipped by specific investigators.

• *RBV* — This subsystem contains three cameras, each of which operates in a different spectral band. They all operate on visible wavelengths and, therefore, operate only during daylight. They are aligned to view the same 100-nautical-mile-square portions of the Earth's surface. A failure in the spacecraft power supply system made it necessary to shut down the RBV after launching. NASA plans to turn on the subsystem later in this year, however. In the meantime, excellent pictures are being received from the MSS.

• *MSS* — The Multispectral Scanner is a line-scanning device which uses an oscillating mirror to continuously scan the surface of the Earth perpendicular to





TOP: Details of a ERTS-1 photograph show a large part of Greece, including the Gulf of Corinth (upper left corner), and the Corinth Canal, connecting the Gulf with the Sea of Crete, to the right. *BOTTOM:* Another picture shows an area of New England, including Boston (upper right), Narragansett Bay (lower right center) and Connecticut River (lower left corner).

the spacecraft's direction of flight. It images portions of the surface approximating those of the RBV images in several spectral bands simultaneously through the same optical system.

• *DCS* — This system consists of the Data Collection Platform (DCP), satellite relay equipment, ground receiving site equipment, and a ground data processing system. Data from the platforms is relayed by ERTS to ground stations whenever the spacecraft can mutually view any platforms and any one of the three principal ground stations — Goddard; Fairbanks, Alaska; and Gladstone, Calif.

The ERTS-1 was put into orbit by a McDonnell Douglas Delta launch vehicle.

Breakthroughs Anticipated

The first ERTS and its follow-on systems should provide vast benefits in a wide range of disciplines:

• Agriculture — Planning of land use; range management; identification and control of crop diseases; improved irrigation.

• Geology — Study of glaciers and volcanoes; earthquake fault systems; identification of terrain features indicating oil and mineral deposits.

• Hydrology — Detection of water pollution trends; taking inventory of surface water in lakes, reservoirs and rivers; determining snow levels; and predicting flood potentials and the location of water reserves.

• Oceanography — Observation of environmental sea-surface conditions related to fish location; sources of pollution; behavior of major ocean currents; storm-caused changes in shorelines; better charting of sea conditions; ice field observation and iceberg warnings.

• Geography — Production of a constantly updated map showing natural and man-made changes in the Earth's surface of interest to urban planners, the transportation industry and others.

Specific Goals

NASA says some "near-term" objectives of the ERTS domestic program are to:

• Develop a geologic and soil feature map of the United States

• Develop an agricultural map of the United States

• Study vegetation damage from highway construction in Maine

• Get information on the dynamics of Lake Pontchartrain, Louisiana

• Determine the ability to observe control measures for pink bollworm infestation of cotton in the Imperial Valley of California

• Study land use in the great urban "megalopolis" stretching from Boston, Massachusetts, to Richmond, Virginia

• Inventory timber resources in selected forests in the United States

• Study the ecological changes taking place on the U.S. East Coast

• Get information needed to plan protection of tidal marshes

• Acquire comprehensive information on use of public lands in the western United States for grazing purposes

Foreign scientists have proposed other experiments planned for ERTS:

• Detection of potential locust breeding sites in southwest Saudi Arabia

• Snow surveys to assess the risks of spring flooding in Norway

• Land use and soil erosion in Guatemala

• The hydrologic cycle of the Santa River basin in Peru

• Winter monsoon clouds and snow cover in Japan

• Survey of a variety of resources in India

Nations with participating scientists include Australia, Brazil, Canada, Chile, Colombia, Ecuador, France, West Germany, Greece, Guatemala, India, Indonesia, Israel, Japan, South Korea, Mexico, Norway, Peru, Republic of South Africa, Switzerland, and Venezuela. Each nation will fund its own experiments.

Key is 'Signatures'

Much of the early analysis of images from ERTS-1

is directed toward getting sequential information—"signatures"—on surface features such as plants, soil and water.

All earthly matter—animal, vegetable or mineral—absorbs, transmits or reflects visible and invisible lightwaves. Each object in its own way thus reacts to all energy coming from the Sun.

The ERTS program, providing the capability to sense radiation in a variety of wavelengths, heightens the possibility of identifying every feature in a given area. The more spectral bands employed, the more complete and reliable is the identifying response pattern, or "spectral signature," radiated by an individual resource.

Many scientists, especially ecologists, have hailed the advent of ERTS as a major event of the Space Age.

In Congressional testimony earlier this year, Dr. Robert N. Colwell, Associate Director, Space Sciences Laboratory, University of California, Berkeley, an ERTS-1 investigator and expert on remote sensing of farm, forest and range resources, stated:

"Agriculturists, foresters and range managers deal primarily with *renewable* natural resources, including agricultural crops, timber, forage and livestock. If such resources are wisely managed they can provide mankind with a sustained yield of food and fiber not merely for a few generations to come but perhaps, as some resource managers claim, 'in perpetuity.' If, however, these resources are not managed wisely, man's very survival may soon be threatened."

Interior Biggest ERTS Customer

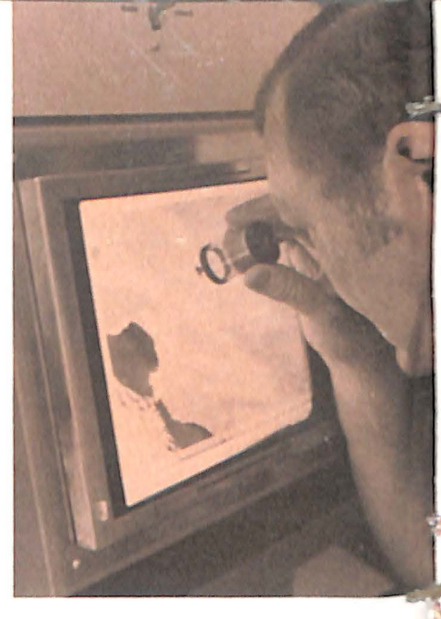
The Department of the Interior, through its EROS (Earth Resources Observation Systems) program is the largest single recipient and user agency of data from the ERTS mission, as well as that from NASA aircraft.

With an eye to the forthcoming ERTS program, Interior began in 1964 to research the testing of applications of a broad spectrum of remote-sensing data from aircraft and spacecraft. Early studies in cartography, geography, geology and hydrology were sufficiently encouraging so that in 1966 the Department established the EROS program as a departmental effort under the management of the U.S. Geological Survey.

In addition to the Survey, nine other Interior bureaus are participating: the Bureau of Indian Affairs, Bureau of Land Management, Bureau of Mines, Bureau of Outdoor Recreation, Bureau of Reclamation, Bureau of Sport Fisheries and Wildlife, the Bonneville Power Administration, National Park Service, and the Office of Trust Territories.

The EROS program managers submitted to NASA 70 experiment proposals for the ERTS-1 satellite; 40 were accepted. They fall into five categories: cartography; geology, mineral, and land resources; water resources; marine resources; and geography, human and cultural resources.

The Department also is building a $5-million EROS Data Center, to be completed by the spring of 1973, at Sioux Falls, South Dakota. This center will be a national repository and dissemination agency for data from ERTS satellites and other remote sensing equipment.



Dr. Arch Park, Chief, Earth Resources Survey Program, Office of Applications, NASA Headquarters, examines detail of ERTS-1 photo on color enhancer machine. The ground processing facility, at NASA's Goddard Space Flight Center, Greenbelt, Md., also gathers environmental information from Earth-based platforms which is collected aboard the satellite and then relayed back.

He went on to say, "Since the face of the land looks to the sky, it often is the 'bird's eye' view as obtained from an aircraft, together with the 'God's eye' view as obtained from a spacecraft which will best provide the resource manager with the information that he needs."

Military Spinoff

The ERTS subsystems borrow heavily from research done years ago for military surveillance from aircraft and spacecraft.

These pictures made for defense purposes remain top-secret. Some indication of their high resolution can be gleaned, however, from the pictures taken in the mid-sixties by NASA's Lunar Orbiter satellites, using the same camera system carried by military satellites earlier.

One Orbiter photograph taken from about 100 miles altitude shows a boulder only 15 feet in diameter. Nearby it also disclosed a three-foot-wide trail apparently created when the boulder rolled down a hill.

It is reasonable to believe that current military surveillance pictures have even better resolution, and that at least some of this enhancement has been passed on to the civilian space program. However, it is doubtful that the ERTS or other civilian camera systems will be pushed to their full potential in terms of resolution, the concern being that other nations might then regard them as being in effect additional military "spy" systems.

Attitude Control

Regardless of the quality of the cameras, the quality of the pictures returned by ERTS-1 obviously would suffer if the "Cameraman" did not hold steady.

To ensure stability, GE's Space Division developed a precision stabilization and control system called the Attitude Control Subsystem. It is designed to stabilize the spacecraft in orbit in regard to the three axes of pitch, roll and yaw. Thus, ERTS-1 can look continuously at the Earth's surface with a pointing accuracy within 0.4 degrees vertically (about the pitch and roll axes) and within 0.6 degrees of the velocity vector (about the yaw axis).

ERTS-1 has electronic "horizon scanners" for "eyes," a computer for its "brain," and mechanical flywheels and jets for "muscles." GE designed them into an integrated system to keep the satellite balanced in every direction at all times.

Improvement of Life

The ERTS program—like the Skylab program to be undertaken next year, and the Space Shuttle system, to be operational by the end of this decade—represents a new emphasis in the U.S. space effort on improving life on Earth. The technology needed for space exploration, both manned and unmanned, has now been well developed. Now the main objective is to utilize that technology for the benefit of all; hence, the deepening concentration on Earth-orbiting, downward-looking spacecraft.

The ERTS program, the other projects referred to, and the rest of NASA's effort can be carried out for a *total* annual budget over the next six to eight years of about $3.4 billion—less than one-thirtieth of the amount we will be spending each year on direct social and environmental programs.

What will we gain from the Earth resources satellites?

The eventual dividends are impossible to predict. However, a study group established by the National Academy of Sciences has stated: "The potential economic benefits to our society from space systems are enormous . . . (They) may amount to billions of dollars per year to many diverse elements of our industry and commerce and use to the public. In some areas it is possible to predict these benefits with accuracy; in others we can estimate within broad but conservative limits."

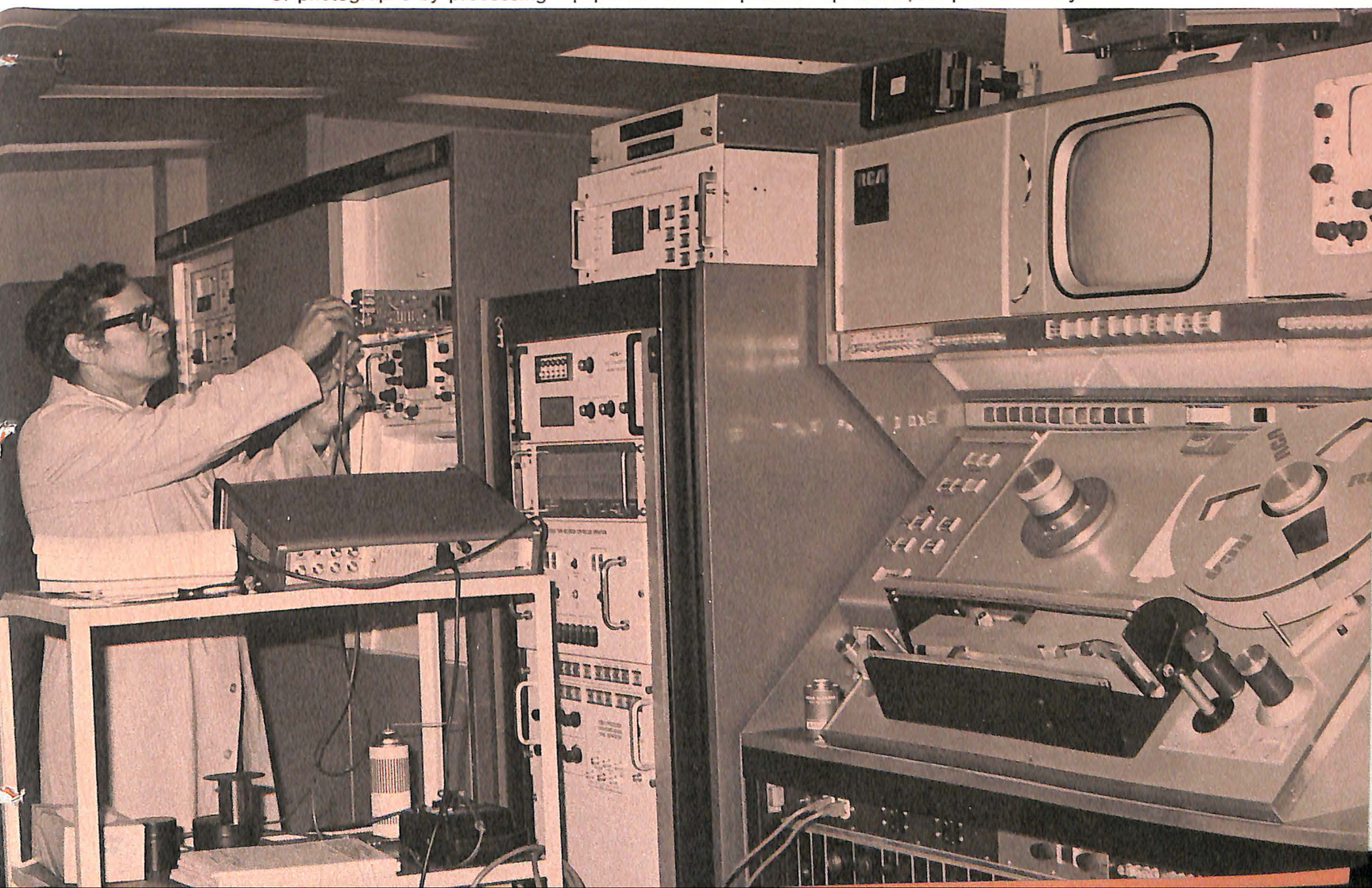
The U.S. Department of Agriculture estimates that in the area of U.S. agriculture and forestry *alone* the utilization of satellites will yield savings on the order of $3 billion a year. These would come from reduced crop losses due to satellite-derived weather and related data, satellite detection and monitoring of crop diseases and forest fires, and orbital information assisting in the assessment of optimum harvesting times, probable size and quality of crops, and so forth.

Dr. James C. Fletcher, Administrator of NASA, stated recently: "We have made our new program for the Seventies relevant to the needs of modern America. Our new ERTS . . . is an excellent example. Much of what we hope to learn in Earth orbit and at the planets in this decade will help protect the environment of spaceship Earth."

Fred Hoyle, the British scientist and futurist, has observed that one of the major gains from space exploration thus far was the first photograph of Earth from deep space. He believes that mankind was profoundly affected by this dramatization of the tininess and the fragility of Planet Earth and the limitations of its resources, and that in fact the present worldwide concern over environment, ecology and depletion of resources dates from that photograph.

It now appears that the space program, having thus alerted us psychologically to the hazards of our Earthly situation, will provide us with a crucial weapon for overcoming those same perils.

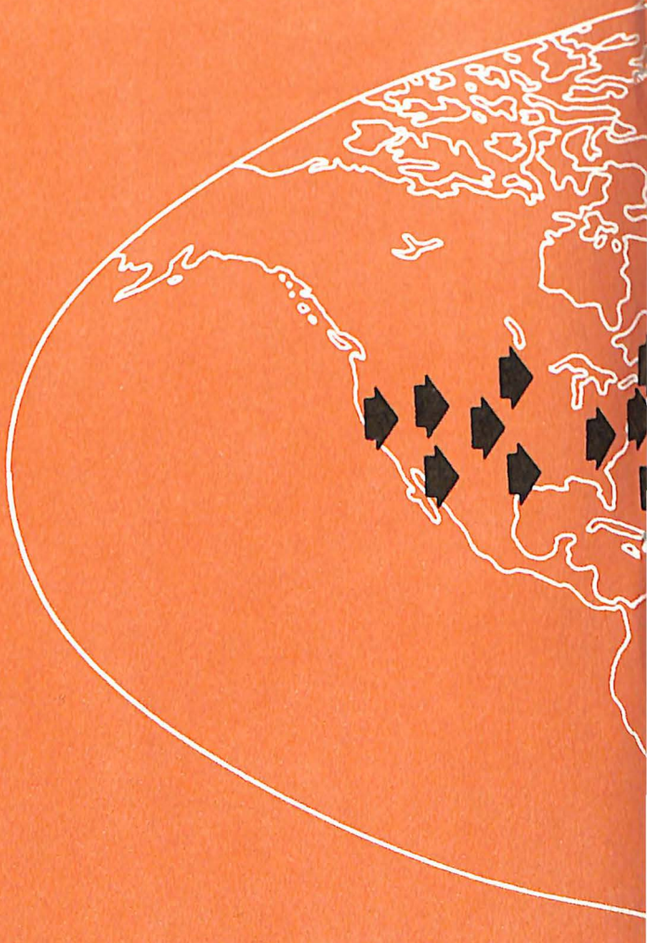
Goddard Space Flight Center technician makes adjustment on computer used in receiving ERTS-1 data. Information will be readily available to more than 300 subscribers in form of photographs by processing equipment that can produce up to 300,000 photos weekly.



Technology and Trade—

'A Place of Honor in History'

By AMBASSADOR WILLIAM D. EBERLE
The President's Special Representative for Trade Negotiations



The aerospace trade balance has been going steadily up as the national trade balance has gone from surplus to deficit. Further, the industry has been a member of the $2 billion export club for six years, and last year qualified for the $4 billion club.

This proves that when it comes to technology, America still leads the way, and has every right to demand a trade policy that permits the aerospace industry to keep and expand its lead. President Nixon supports that kind of trade policy.

My job is to relate the general to the specific — the general complex of trade policy problems to the specific interests of industry. If this industry were less eager to export and more afraid of imports, I would state the same thing. Trade policy is different from other aspects of foreign policy: it stands or falls on the ability and willingness of specific domestic interests, such as the aerospace industry, to understand and support it.

Trade policy is now and always has been a local as well as an international issue in the United States. And this is just as true now in Japan and in Europe. The foreign policy objective of the Nixon Administration is to see the construction of a new global economic superstructure to go with the political superstructure the President has built in his first term. It will be an appeal not just to governments, but to business and trade interests in all the major trading nations.

Talking to the representatives of 124 governments at the annual meeting of the International Monetary Fund and the World Bank recently, the President said, "We must set in place an economic structure that will help and not hinder the world's historic movement towards peace. We must make certain that international commerce becomes a source of stability and harmony rather than a cause of friction and animosity."

To this end the President has pledged himself to nothing less than "a total reform of international economic affairs." A thorough-going reform of a monetary system is a key objective, of course. But so is a thorough-going reform of the trading and investment system as well.

When somebody in Washington talks about monetary reform and trade "negotiations," just remember the objective is to improve both the monetary system and the trading system. The trade negotiations that lie ahead of us will be of an entirely different order from anything in the post-war years.

Treasury Secretary Shultz, at the same meeting of the world bankers, spelled out in considerable detail the principles underlying the President's new policies. Just let me capsulize a few to show how dramatic is the change that the President has in mind.

First the President said, "We can all agree that the health of the world economy and the stability of the international economic system rest largely on the successful management of domestic economies."

The big trading powers — Japan, Europe, and the United States — share in common a set of domestic problems: the need to maintain growth and employment while curbing inflation. The President's new policies start with a recognition that we share these problems *in common*, and how we manage them will determine the state of the world economy.

Second, the President recognizes that each nation will approach its domestic problems in different ways. So, as Secretary Shultz put it, we need "a new balance between unity of purpose and diversity of execution." To that end the President envisions a common code of conduct designed to protect an open international economic system from the very diverse measures nations will take to meet their domestic economic problems.

The heart of that code of conduct must be a system for "prompt and orderly adjustment" to prevent what the President called an annual "invitation to a monetary crisis." Part of this code must be a recognition, in the President's words, of the fact that "there is no heroism in a temporary surplus, nor villainy in a temporary deficit."

We must think what international agreement to this proposition will mean. "Surpluses in payments," as Secretary Shultz said, "are too often regarded as a symbol of success and of good management rather than simply a measure of the goods and services provided from a nation's output without current return." So it has been for centuries since the mercantile governments of Europe started measuring their success in terms of the gold they could hoard. An agreement among nations to submit persistent balance of payments surpluses to international disciplines symmetrical to those now imposed on persistent deficits would be an historic breakthrough in international cooperation.

The heart of the code of conduct the President seeks, however, will be the technical agreements that give day-to-day substance to the need for a system of "prompt and orderly adjustment."

Trade gets equal billing in the new system that the President envisions. "Our monetary and trading systems are an interrelated complex," Secretary Shultz said, and we envision some direct links between the work of the General Agreement on Tariffs and Trade (GATT) and the International Monetary Fund. One possibility will be to legitimatize across-the-board tariff surcharges or taxes on imports in case of extreme balance of payments emergency, rather than the present hodge-podge system of quotas and special, bilateral voluntary restraint agreements. It may be, after all, that the tariff in extreme cases is preferable to these jury-rigged substitutes when all other means of "prompt and orderly adjustment" have been exhausted.

Finally, the President envisions devising ways and means of internationalizing the safeguards all trading nations must have to protect those who face abrupt dislocations as a result of our common pursuit of open trade policies. Here again the technicalities are formidable. In general, when we talk of multilateralizing safeguards we do not mean trying to impose uniformity; we do mean to create a system that preserves "diversity of execution." What we hope to add is the obligation to consult beforehand on the imposition of safeguards, to provide for termination of those safeguards when not needed, and to offer ways and means for other nations to take actions that make imposition of the safeguards unnecessary.

Here in microcosm we have an example of what the President means when he says he seeks an era of negotiations to replace an era of confrontation.

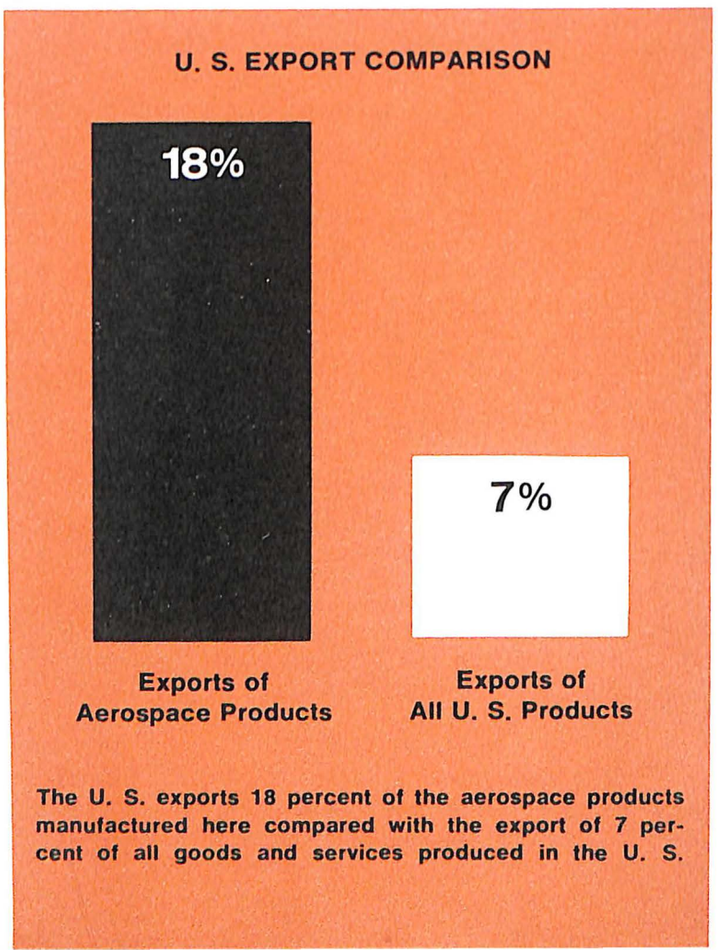
What do all these generalities have to do with the aerospace industry?

The short answer is that what is good for trade is good for the aerospace industry. About 18 percent of AIA members' production is exported. That compares with 7 percent of all the goods and services produced in the U.S. More important, the aerospace industry is exporting advanced technology, not raw materials or products entering a stage of obsolescence. Unless one believes that this nation faces the prospect of becoming a second-rate center of technological innovation, one must agree that what is good for trade is good for this industry.

But you will want to put the proposition the other way round, I'm sure. You will argue that what is good for the aerospace industry is good for trade. Here are two situations which appear to me to be major worries of the aerospace industry:

- First, the decline in federal spending for technological research, and its effect on your exports;
- Second, the subsidies foreign governments give to your competitors, and the effect they have on trade prospects.

Advanced research — and the ability to sell it abroad — account for the tremendous contribution the aerospace industry has made to our trade balance. But trade policy alone cannot determine the level of federal spend-



ing on research. It's not a big enough tail to wag that dog.

Something more than balance of payments arguments is needed to restore the level of research expenditures. I subscribe wholeheartedly to the proposition that the United States must remain the world's most exciting center of technological innovation. Take that away and you take away one distinguishing and irreplaceable feature of our culture, one that gives us a right to claim a place of honor in the history books. This, not the balance of payments, is the best argument — if it can be proven.

Many people do not understand how profoundly federally-sponsored research has affected the rate of technological innovation in our society, and the trade benefits that spring therefrom. The spin-offs that have taken place within corporations, and in universities, too, far exceed the list of patents that can be traced directly to that research. But the evidence remains to be presented in a way that will make the nation sit up and take notice. If this could be done, it would be a real service.

The second worry — the subsidies foreign governments give to your competitors — is a very tough problem. Perhaps the toughest problems in devising a new international economic order will be, in the words of Secretary Shultz, to "harmonize countries' practices with respect to taxation of international trade and investment, the granting of export credit, and the subsidization of international investment flows."

These issues dramatize the two sides of the trade policy problem.

On the one hand, how can this nation make our exports more competitive, given the restraints of our own domestic laws and policies?

On the other hand, how can we make the international trading system fairer, given the restraints of policies in other countries?

There are some dangerously easy answers to these questions. We could, for example, decide to divide up the world into exclusive trading blocs, each major trading power, Japan, Europe and the United States, being assigned a backyard to trade in.

The trouble with this easy-sounding answer, of course, is that such a trading world would quickly change the shape of international politics, as well as international trade, with the certain result that we would have confrontation and not negotiation. There are very few, if any, parts of the world today where people are willing to see their countries serve as the backyards of any great power. This is underscored by the statements of Latin Americans concerning themselves and their future.

Alternatively, the U.S. could decide to match subsidy with subsidy in a great escalation of government intervention in trade. Comparative advantage, then, would be measured in terms of the degree of support available from government treasuries. This, too, of course, would lead inexorably to a succession of confrontations, rather than a succession of negotiations. And the U.S. would have to learn to cultivate practices in world trade that we would never tolerate in trade here at home.

Finally, we could decide simply not to trade in competition with those who follow different business and taxation policies from our own. This, perhaps, would lead to the most exclusive trading policy of all.

There simply isn't any easy answer to the problems Secretary Shultz mentioned — the problems of "harmonizing" the trading practices of different nations when it comes to matters like taxation and financial incentives and subsidies. The only way to achieve a fair international trading system is to make a habit of negotiations over the whole range of problems that trade involves.

Hopefully, this means to purge the system of subsidies that are designed purely and simply to gain trade advantage, whether they be subsidies to industry or to agriculture. The U.S. is already doing this, in bilateral talks with Japan and the Common Market and in the major multilateral forums, particularly GATT. We seek to preserve and expand the notion that comparative advantage must be determined by technological innovation, entrepreneurial skill and productivity, not by subsidy.

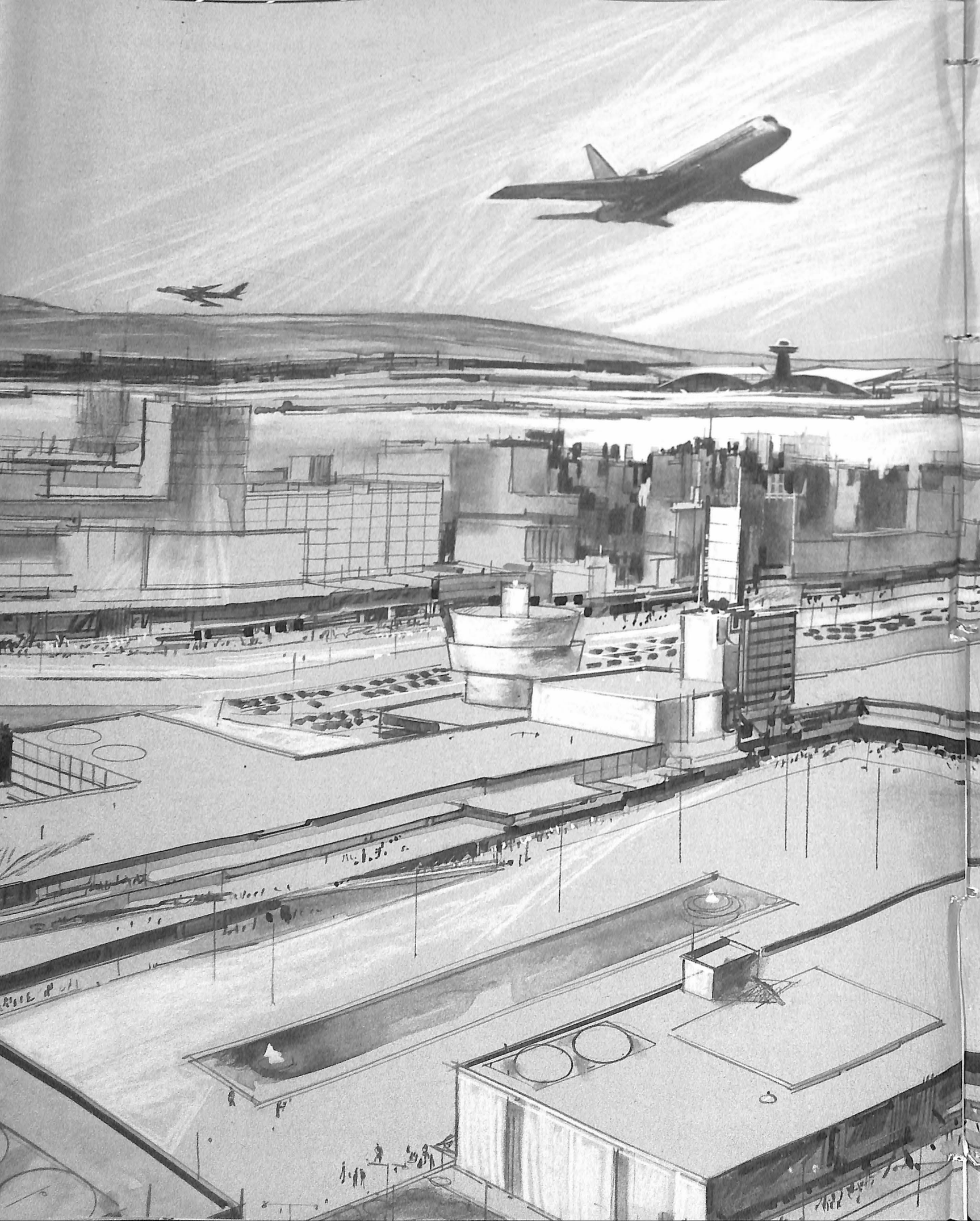
The stage is set now for the most elaborate series of trade negotiations ever undertaken among nations. These negotiations will become a permanent feature of our relationship with Japan and Europe. They will have to weather the storms of the expansion of the Common Market, of the design of a new monetary system and, no doubt, of countless events we cannot now foresee. There will be more participants in these negotiations than ever before. I sincerely hope, for instance, the Congress will be an active participant from the beginning, and industry must work with us as closely as possible.

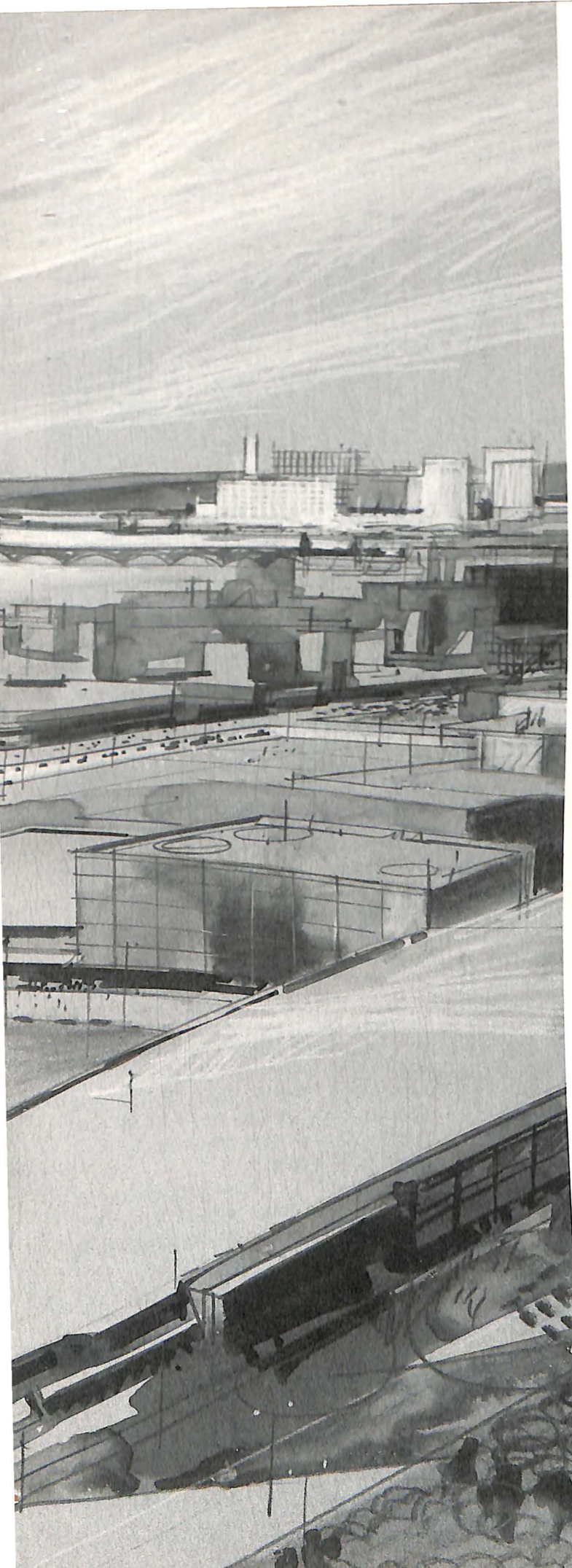
Success will depend in large part on whether industry, not just in the United States, but in Europe and Japan as well, sees in the generalities of trade negotiations a reflection of the efforts to help with its particular problems. This is particularly important in the United States where only about four percent of our corporations are seriously interested in exporting. Your trading skills are not broadly shared in our economy, nor will they flourish if the rest of the economy fails to appreciate them.

I suggest that when it comes to adapting our policies to making exports more effective that the aerospace industry take the leadership in such matters as illuminating the real role of federally sponsored research in maintaining the pace of innovation throughout our economy . . . not just in your own industry but in others as well.

And when it comes to designing a new and fairer international trading system, we must work together to devise ways and means of harmonizing our policies with those of our major trading partners and to convince our own countrymen that their standard of living is bound to suffer if the U.S. cannot devise a new and fairer system.

The President has given us a clear sense of direction. He has weighed the options — the easy sounding options — and favors a system designed to preserve real comparative advantage and not the false comparative advantage of competitive subsidies and exclusive trading blocs. There are already some signs that our trading partners are willing to follow this lead. We must do everything we can to make sure that American industry, the Congress, and the American people are no less willing.





THE AIRPORT IMPACT-
Positive Economics

Last week, a worker at the Seattle-Tacoma Airport picked up his paycheck, stopped for some groceries on the way home and, while he made his car and furniture payments, his wife went out to buy a new dress and have her hair done.

This rather ordinary, everyday scene illustrates the way in which aviation touches the lives of an entire community, not just those who work in it or use it. It is the source of a great deal of economic activity in any community it serves.

The Air Transport Association, through its regional committees of airline public relations people, has under way a program that is showing these local communities just how much aviation does touch their lives. These committees are preparing economic impact studies of their local airports and distributing them widely throughout the area.

This is an important program for aviation because it is what the industry can do now to describe the beneficial aspects of aviation in such a way that they will be meaningful to everyone, whether they use the airlines or not. It is talking about aviation in terms of dollars, jobs, drug stores, supermarkets, banks and the many other aspects of ordinary daily community life.

It is a good thing for the industry to do at any time but it is especially important now for aviation because aviation has been coming under increasing attack from several groups of critics.

Aviation is telling its story in a positive way, and a series of economic impact studies is the basis of it.

The program began in South Dakota. The industry wanted to demonstrate to the governor of the state that air transportation was indeed useful to the state, and that because of air transportation four manufacturing companies had located within the state. These companies created 2,000 new jobs that, at that time, represented 12 per cent of the total manufacturing work force in the state.

The current program is to develop economic impact studies at each one of the 23 major hub cities in the U.S. with the aid of regional public relations committees made up of airline employees located in these cities. A major hub is defined as a city which develops at least one per cent of the total air transportation passenger enplanements. These are obviously the biggest cities, starting in New York and working down through Las Vegas.

The basic tool used by the local committees in making their study is a workbook prepared for them by the ATA public relations staff called: "How to Measure the Impact of Aviation on the Local Economy." This workbook is basically a series of questionnaires designed to help the committee members get the right kind of information from the right sources. The most important is the questionnaire that is distributed to aviation employees in the area. Some committees have surveyed only airline employees while others have gone to all employees at the airport.

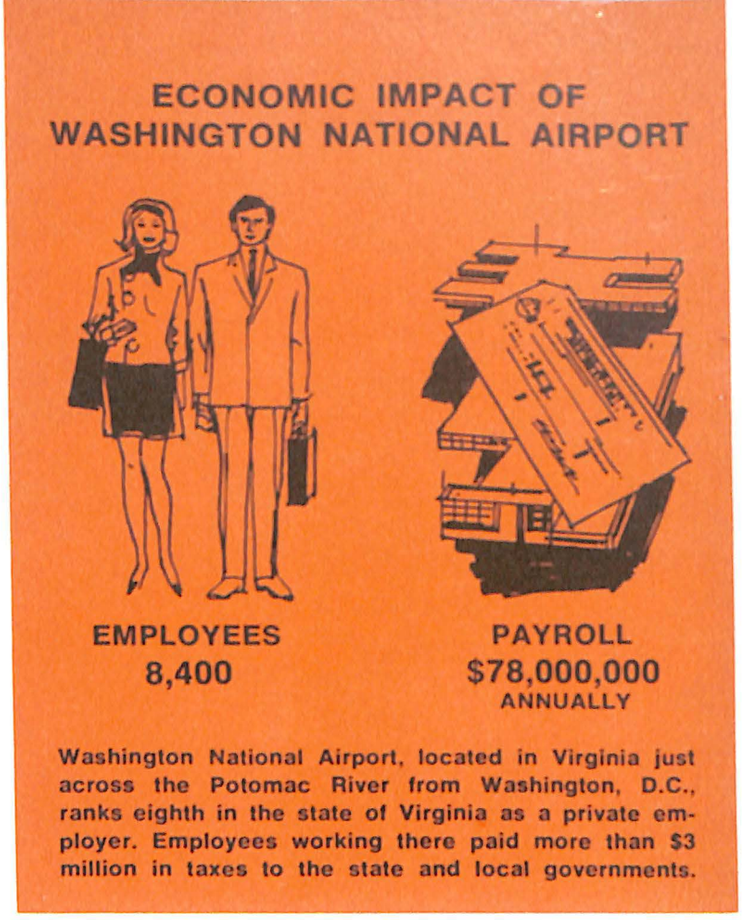
These employee questionnaires are the base upon which the whole story is built. They find out how much each employee makes, how many people he supports, how much his home is worth (or how much he pays in rent) and how many automobiles he owns. From this data, it is possible to determine how much aviation employees in an area spend on groceries, health care, recreation, clothes, furniture, and most important, taxes of all kinds.

Most committees also ask employees for their zip code, or other means of locating them, so that the economic impact of aviation can be pinpointed even more precisely than just to a metropolitan area.

Other questionnaires in the workbook seek such information as how much the scheduled airlines themselves are spending in the area and at the airport for such things as landing fees, airport rentals, fuel, goods and services, taxes and construction. Tourism, convention and business travel is vital to many cities and the studies pinpoint how many people, through this kind of activity, are indirectly dependent on air transportation for their livelihood.

Other kinds of information that are included in the study are: how much airlines spend to promote the area as a tourist destination, and, if the information is available, how profitable is the airport. Not many people realize that major airports are big and usually highly profitable businesses.

What have these studies shown about the economic impact of airlines and airports? In short, that aviation is much more important to the economic life of a community than anyone had thought. For instance, Los Angeles International Airport is the largest employer at a single location in the entire Los Angeles area. Moisant Field holds the same relationship to the entire state of Louisiana and in Kansas City one of the airlines serving the city holds this distinction.



These are just a few individual examples of the major impact of aviation on its market area. But in every city surveyed so far the results have been the same — the airport and the airlines that serve it are indispensable to the economic health of the area.

Here are some examples:

WASHINGTON NATIONAL

The first study completed after South Dakota was of Washington National Airport. With a payroll of 8,400 employees earning more than $78 million annually, Washington National ranked eighth in the state of Virginia as a private employer. In terms of employment at a single location, the airport came in third. To the state of Virginia alone, National meant 5,607 people living in the state employed and making over $54 million each year. This average annual wage of $9,649 was $2,751 more than other employees were making, on the average, in all private industry.

Another important indicator of the importance of National is the tax revenue it generates for the state. Employees working there paid, in one year, more than $3 million in taxes to state and local governments.

Also important as a stimulant to local economies is the purchases from local merchants of goods and services by the airlines and the airport and its concessions. In the Washington area, local businessmen benefited by more than $22 million annually because of airport-generated business. Added to this is the business generated by the tourists and convention travelers who enter the Washington area through National. In one year, 16.8 million visitors and another 674 conventions came to Washington, and spent $531 million. Much of this business came by air.

PITTSBURGH

The Pittsburgh study found that almost 50,000 people in Southwestern Pennsylvania were either directly or indirectly employed in air transportation or travel-related industries, such as firms providing direct support and services to aviation and hotels, travel agencies and restaurants. Of these, 5,900 actually worked for the airport or airlines. These 50,000 people represented approximately 5 per cent of the total work force in the Pittsburgh labor market area. Their payrolls of some $288 million annually also represented about 5.3 per cent of the area's total payrolls.

CHICAGO

A survey of airline employees in Chicago resulted in a very impressive map showing how many of them live in each county and congressional district in the Chicago area. It also indicates how much people living in those areas earned, how much they paid in taxes and the value of their homes or amount of rent paid.

The survey revealed that the 23,900 airline employees working for 29 scheduled foreign and domestic air carriers received more than $272 million annually in salaries, for an annual average income of $11,395. Including the employees themselves, this income supports some 72,000 people, including 44,000 adults and 28,000 children. The homes owned by these employees — about half were homeowners and half renters — had a total value of almost $400 million and the rent paid by the rest came to about $1.7 million each month.

KANSAS CITY

In Kansas City, not only is aviation an important industry, but, also, the largest private employer in the entire area is one of the scheduled airlines serving Kansas City International. The total direct and indirect employment there totals 22,000 persons, 13,615 of whom work for the airlines and in airport-related jobs. The payrolls for these 13,615 employees comes to $132 million, of which $118 million is paid by the airlines themselves.

In addition to employment and payrolls, the airlines and the airport also contribute to the local economy through purchases of goods and services which amount to $42 million annually. The airlines and airport businesses also pay the city $4.8 million each year for landing fees and rentals and payroll taxes come to $3.4 million annually. In addition to this impact, the airlines bring tourists and other visitors to the area who spend some $285 million each year in the area.

NEW ORLEANS

Moisant Field, or New Orleans International Airport, is a $121 million bonus to the New Orleans area. Aviation activity there contributes $77 million annually to the area's economy through $33.6 million in wages and salaries, $35.3 million in purchases of supplies and services and $8.3 million in capital expenditures. The $43.9 million in indirect spending is from conventioneers and vacation and business visitors.

DENVER

In Denver, Stapleton International Airport was found to be an asset of $148 million to the area's economy. Of this, $145 million went for employees salaries and another $3.7 million came from airport revenues from airline rentals and landing fees. Added to this is the vast amounts of money spent by tourists and business travelers coming to the state. At least $150 million is estimated to be spent by air travelers to Colorado every year.

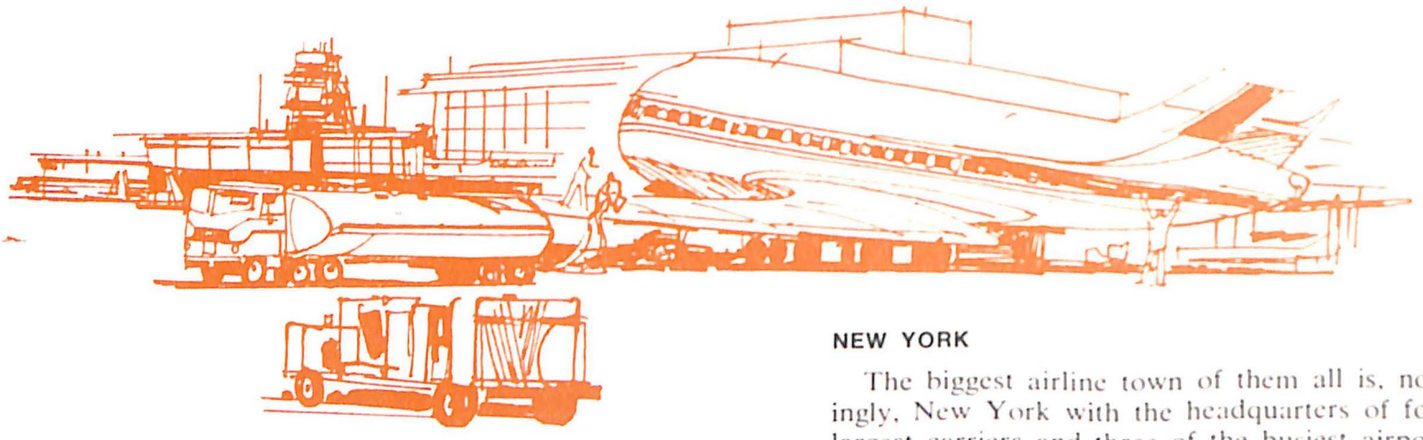
SAN FRANCISCO

The San Francisco/Oakland Bay Area is richer by at least one billion dollars per year because of San Francisco International, Oakland and San Jose airports. Almost 30,000 Bay area residents make their living at SFO alone and another 2,600 work at Oakland. The SFO employees earn over $322 million annually and these payrolls support, at least in part, some 68,000 persons.

Another $322 million is added to the area's economy by airline and airport concession expenditures, taxes, fees and local advertising. This total of $644 million that the airlines, the airport and their employees contribute to the area is also "recycled" to create another dollar of income and thus, the total economic impact of the airports comes to more than $1.3 billion per year.

LAS VEGAS

Las Vegas is, of course, very much an airline town — the spending of the tourists and conventioneers that the airlines bring there is what keeps the Las Vegas economy alive. This spending comes to about $187 million



per year. Added to this is the payrolls of the employees of the airlines and the airports which come to another $13.7 million. Also important, but very difficult to measure, is the employment and payrolls of the thousands of hotel, casino and restaurant workers who depend to a major degree on airline passengers for their livelihood.

LOS ANGELES

As one of the biggest commercial and private aviation centers of the nation, Los Angeles has three large and very important airports — Los Angeles International, Ontario International and Van Nuys. These three airports and their employees and airlines are worth some $3.6 billion to the area. Payrolls to employees account for $1.6 billion, purchases from local businesses for goods and services, $290.9 million, local taxes $26.4 million and spending by air visitory another $1.7 billion.

At LA International, there are over 37,000 employees earning some $450 million annually and the airlines serving this airport account for 78 per cent of these employees and pay 85 per cent of the total payroll.

ATLANTA

Another airport that ranks high as an employer is Hartsfield Atlanta International Airport which is the largest private employer in the entire state of Georgia with 17,541 employees and an annual payroll of almost $210 million. Airline and airport spending, visitor expenditures, local media advertising brings the total impact of the airport up to around $345 million.

This economic bonanza also, like most big city airports, pays its own way financially and does not cost local taxpayers anything. As a matter of fact, for the year ended September 30, 1971, the airport had a surplus of revenues over expenses of $4.3 million to use for future airport improvements.

SEATTLE-TACOMA

The Seattle-Tacoma International Airport contributes some $486 million per year to the Puget Sound Region — or more than $1.35 million per day or $56,250 every hour of every day. The biggest chunk of this is accounted for by airline and airport concession purchases of more than $306 million per year for supplies, food, fuel and taxes. The next biggest item is payrolls for the more than 7,000 people working at Sea-Tac — approximately $100 million annually. The rest goes for capital improvements, airport landing fees and space rentals at the airport.

NEW YORK

The biggest airline town of them all is, not surprisingly, New York with the headquarters of four of the largest carriers and three of the busiest airports in the nation. To New York and neighboring New Jersey, aviation has an impact that approaches $7 billion — once the entire aviation and the visitor and convention industry that is so closely tied to it is taken into account. Payrolls for the almost 78,000 people who work for that airline and the airports comes to almost $1 billion. Spending by tourists who come by air adds another $1 billion, and spending by the airlines and airports for goods, services, office space, etc. is another $2 billion. Once all of this impact is added up and the multiplier effect — that each dollar put into an area's economy generates yet another dollar of income — is taken into account, the economic impact of aviation on New York comes to an astonishing $7 billion.

These studies are, however, just the first step in a whole series of steps aimed at measuring the impact of the entire aviation/aerospace industry on the economic life of communities. The next step is to expand the city studies to include aerospace employment — to show that not only do people work at the airport or for an airline but many others are also busy making aircraft wings, or altimeters for aircraft cockpits or aircraft seats, or any one of the other millions of pieces that make up a commercial jet transport.

For any large city, the number of people engaged in aviation and aerospace manufacturing is bound to be considerable. On a state basis, the numbers will be even more impressive and summarizing the impact of aviation on cities into state-wide reports will be yet another step in telling the aviation story.

The city and state-wide reports use the "macro" technique of showing the impact of aviation — that is gathering all of the data into a collection of big numbers and displaying it on as large a scale as possible. The opposite approach is the "micro" study in which a community and its people are studied in detail from sociological as well as economic standpoint to show how aviation affects their lives. This might also be called the "Middletown" approach as it will be patterned after the famous study of a midwestern city by Robert and Helen Lind in the nineteen-twenties. ATA is now in the process of picking a city that is small enough in order to get a real "feel" for it but still large enough to have good air service. This city will be the subject of a real in-depth look at just what aviation means to its citizens.

The airport studies, the expanded state studies and "Middletown" are just a few of the ways in which the aviation industry can show communities and the people in them that strong, healthy airline, airport and aerospace system is in the best interest of, not only the nation, but of themselves as individuals.

AIA

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Aerojet-General Corporation
Aeronca, Inc.
Amphenol SAMS Division
The Bunker-Ramo Corp.
Avco Corporation
The Bendix Corporation
The Boeing Company
CCI Corporation
The Marquardt Company
Murdock Machine & Engineering
Chandler Evans Inc
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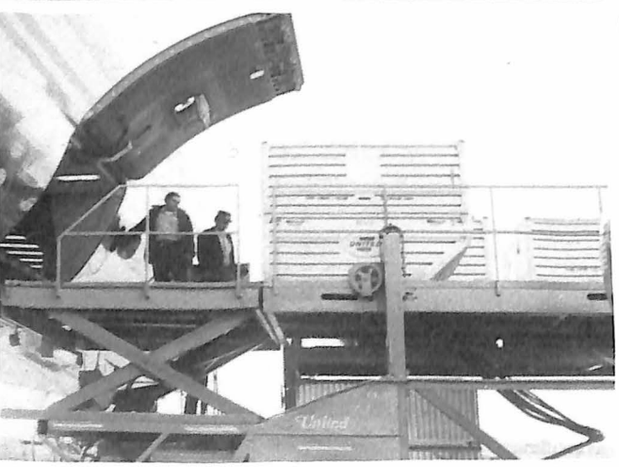
AEROSPACE INDUSTRIES ASSOCIATION
1725 De Sales St., N.W., Washington, D. C. 20036

RETURN REQUESTED

Airport employees make significant contributions to their local economies. See *The Airport Impact—Positive Economics*, Page 12).



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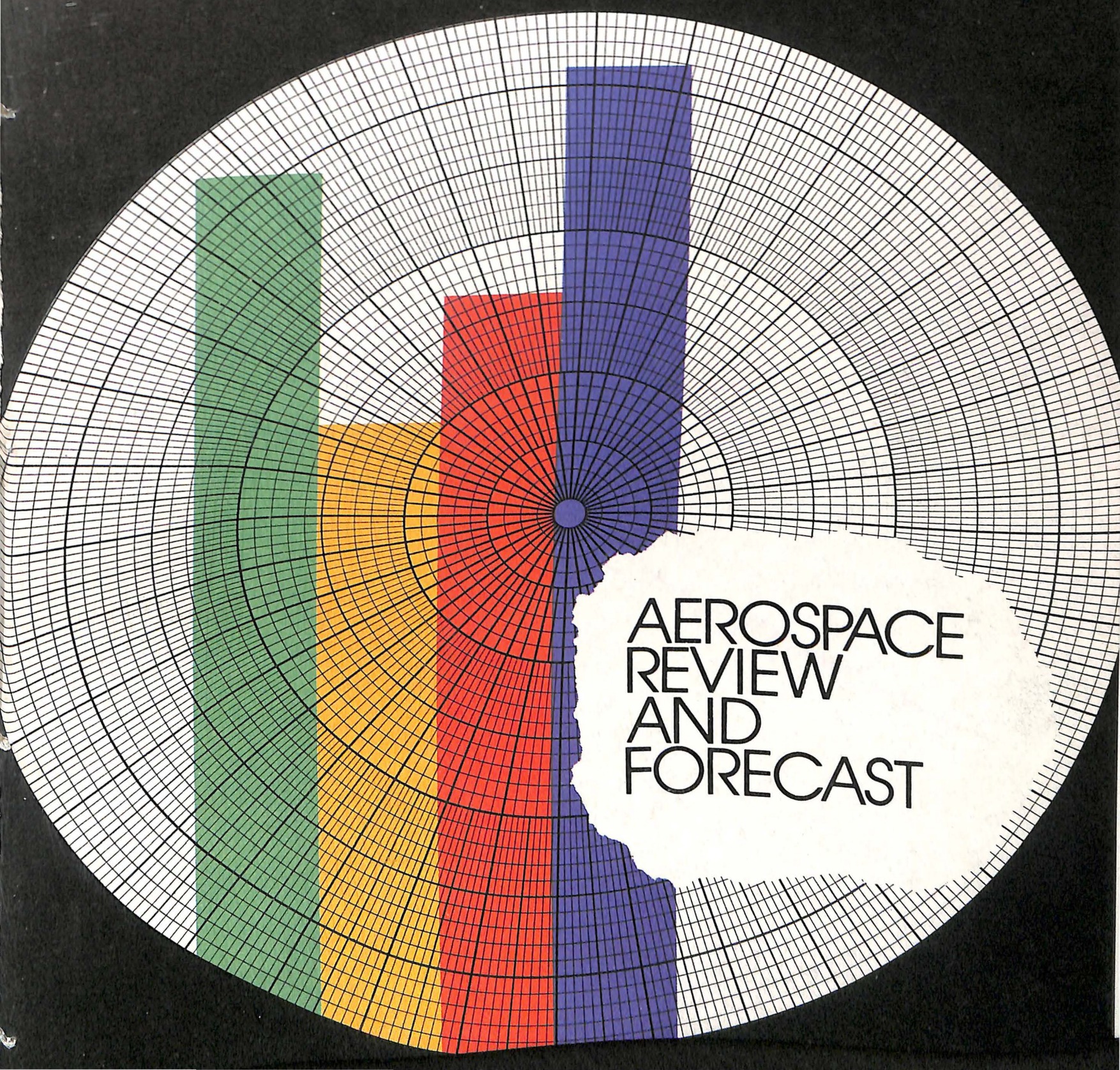
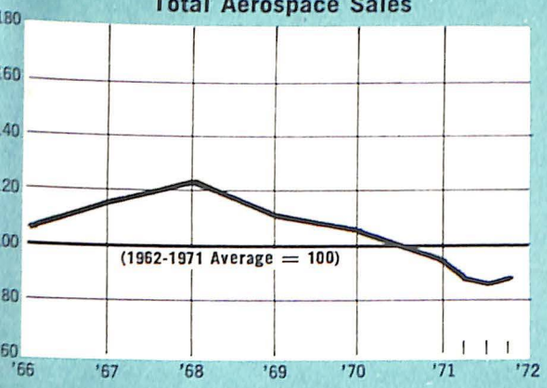


AEROSPACE REVIEW AND FORECAST

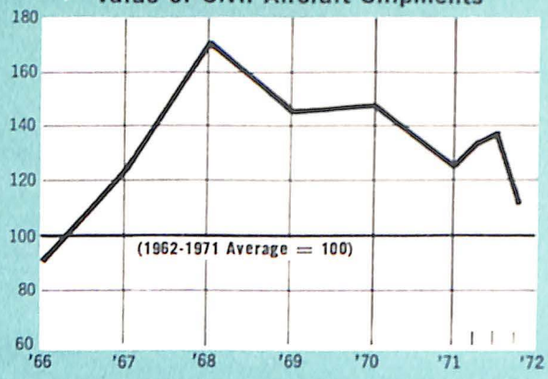
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

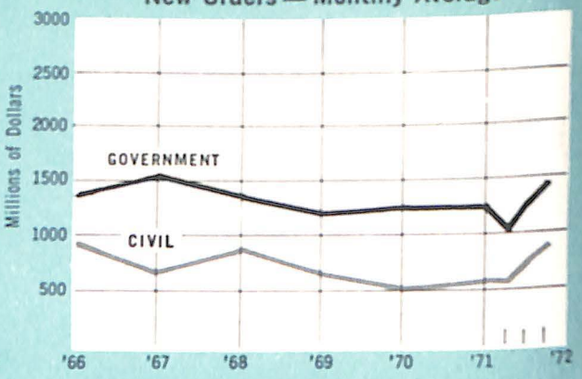


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1962-1971 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	23.5	3rd Quarter 1972	22.9	20.4	21.0
	Billion $	Quarterly	5.9		4.8	5.4	5.4
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,240	June 1972	1,704	777	2,135
Aircraft	Million $	Monthly	733	June 1972	1,223	551	1,683
Missiles & Space	Million $	Monthly	507	June 1972	481	226	456
Aerospace outlays: Total	Million $	Monthly	1,147	June 1972	1,192	1,157	1,882
Aircraft	Million $	Monthly	665	June 1972	696	722	938
Missiles & Space	Million $	Monthly	482	June 1972	496	435	944
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,057	Sept. 1972	1,388	855	1,004
Aircraft	Million $	Monthly	631	Sept. 1972	722	529	523
Missiles & Space	Million $	Monthly	426	Sept. 1972	666	326	481
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	270	Oct. 1972	283	146	305
Expenditures	Million $	Monthly	277	Oct. 1972	204	212	213
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	22.7	3rd	24.4	25.0	26.7
U.S. Government	Billion $	Quarterly	13.6	Quarter	13.5	14.6	15.3
Nongovernment	Billion $	Quarterly	9.1	1972	10.9	10.4	11.4
EXPORTS							
Total (Including military)	Million $	Monthly	204	Nov. 1972	293	299	312
New Commercial Transports	Million $	Monthly	59	Nov. 1972	79	55	79
PROFITS				3rd			
Aerospace — Based on Sales	Percent	Quarterly	2.6	Quarter	2.2	2.9	2.3
All Manufacturing — Based on Sales	Percent	Quarterly	4.9	1972	4.1	4.5	4.2
EMPLOYMENT: Total	Thousands	Monthly	1,286	Oct. 1972	937	933	937
Aircraft	Thousands	Monthly	699	Oct. 1972	515	503	505
Missiles & Space	Thousands	Monthly	144	Oct. 1972	90	93	94
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.48	Oct. 1972	4.35	4.69	4.72

* 1962-1971 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

HIGH TECHNOLOGY AT THE CROSSROADS

By KARL G. HARR, JR.,
President, Aerospace Industries Association

The first article in this issue of *Aerospace* magazine briefly covers statistical highlights of the aerospace industry for 1972. It presents such key economic barometers as sales, profits, employment, exports and backlog of orders.

The important question, of course, is just what do these figures mean in the long range?

The basic clue is not hard to find. In the long range—or even in the intermediate future of the aerospace industry—everything hangs on one fundamental question: "What is the will of this country with respect to technology?"

There are clear indications that the Administration strongly believes that continued U. S. technological superiority is an essential underpinning of our national economy, our security and our capacity to solve social problems.

In other elements of our society—in Congress, in state and local governments, in news media, in private organizations—there are varying and often sharply split attitudes regarding support of the steps necessary to maintain this superiority. Which viewpoint prevails will go a long way toward shaping the future not only of aerospace, but of all other high-technology industries as well.

In oversimplified terms the debate proposition might be stated: "Be it resolved that we should (should not) continue efforts toward technological progress."

When the proposition is amplified and broken down into its components, and the tradeoffs and alternatives are raised, it becomes much more complicated and susceptible to considerable media, public and even political confusion.

Employment, tax revenues, our balance of trade position, national security and a place in the forefront of international progress in many fields—progress that will move ahead at full steam, with or without us—are important. It follows, then, that the capability to produce competitively superior, high-technology products, such as new generations of commercial transport aircraft, is of vital importance. The development, production and sale of just one new model commercial air transport, for instance, may involve hundreds of subcontractors, suppliers and vendors and thousands upon thousands of employees in almost every state in the union.

As noted, however, technological progress, with all its obvious implications to the nation, is opposed by certain elements of our society which are determined to deny the essential link between technological advance on the one hand and economic well being and national security on the other. For reasons of their own they pursue a course designed to stifle technological advance, not realizing or deliberately ignoring the fact that technological progress, economic stability and national security are inextricably linked and mutually interdependent.

It follows that if we sacrifice technological superiority for the future we must be prepared to pay an unacceptable price in economic progress and national security.

This must not happen.

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Official Publication of the
Aerospace Industries Association of America, Inc.

PRESIDENT • Karl G. Harr, Jr.
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EDITOR • Gerald J. McAllister
ASSOCIATE EDITOR • Jean Ross Howard
ART DIRECTOR • James J. Fisher

CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

Publication Office: 1725 De Sales Street, N.W., Washington, D. C. 20036

AEROSPACE REVIEW

1967

1973 FORECAST

Aerospace industry sales in 1973 are expected to decline to $22.5 billion compared to $23.5 billion in 1972. The anticipated decline will result from a lower level of sales to the government.

Sales to the Department of Defense are expected to decrease to $12.7 billion in 1973 compared with $13.8 billion in 1972.

Space sales will decline to $2.9 billion in 1973 from $3.0 billion in 1972.

Commercial aerospace sales are expected to increase between 1972 and 1973 from $4.8 billion to $5.0 billion. The increase expected is in delivery of jet transport aircraft and in general aviation.

Non-aerospace sales in 1973 are expected to remain at $2.4 billion.

Employment in the aerospace industry is expected to decline only slightly between December 1972 and December 1973 from 917,000 to 913,000.

AND FORECAST

Aerospace industry sales, for the first time since 1968, increased in 1972 to $23.5 billion, a 5.9 percent gain over sales of $22.2 billion in 1971. An 11.6 percent increase in commercial aerospace sales was reported in 1972, reaching an estimated $4.8 billion, compared with $4.3 billion in 1971. This increase reflects a significant increase in deliveries of helicopters and general aviation aircraft.

Major aerospace sales areas include:

- Total aerospace sales to the Department of Defense in 1972 were $13.8 billion compared with $12.6 billion in 1971.
- Military aircraft sales increased to $8.1 billion in 1972 compared with $7.4 billion in 1971. These figures include both procurement and research and development funds.
- Missile sales to the Department of Defense (which also include research and development) increased from $4.7 billion in 1971 to $5.2 billion in 1972.
- Space sales continued to decline in 1972 to $3.0 billion, compared with $3.2 billion in 1971.

Non-aerospace sales declined, with $2.4 billion in 1972 compared with $2.5 billion in 1971. These sales represent work by aerospace firms in such fields as urban transportation, pollution control, marine sciences and water desalination.

- Utility and executive aircraft sales increased from $321 million in 1971 to $500 million in 1972 (55.8 percent), and units delivered showed an increase of 23.2 percent.
- Civilian helicopter sales increased from $69 million in 1971 to $95 million in 1972, a gain of 37.7 percent.

BACKLOG

Total aerospace backlog at the close of the first half of 1972 was $24.7 billion compared with $23.9 billion at the end of 1971. It is anticipated that the backlog at the end of 1972 will be $25.0 billion.

The backlog of commercial transport aircraft decreased from $7.8 billion to $7.1 billion between December 31, 1971 and September 30, 1972.

EXPORTS AND IMPORTS

Aerospace exports declined for the first time since 1964. They dropped from $4.2 billion in 1971 to $3.9 billion in 1972, a 6.6 percent decrease. The major reason for the decline was military aerospace exports, which declined 23.8 percent from $1.1 billion in 1971 to $854 million in 1972.

Imports of aerospace products in 1972 were valued at $500 million, a 34.0 percent increase from $373 million in 1971.

PROFITS

Aerospace industry profits (as a percentage of sales after taxes) are expected to increase from 1.8 percent in 1971 to 2.2 percent in 1972.

EMPLOYMENT

Employment in the aerospace industry declined slightly from 924,000 workers in December 1971 to an estimated 917,000 in December 1972. Despite this continuing drop, the aerospace industry remains the nation's largest manufacturing employer.

Production workers in the aerospace industry dropped from 448,000 in December 1971 to 444,000 in December 1972, a 0.9 percent decrease. Employment of

scientists and engineers is expected to continue to decline to 157,000 compared to the peak of 235,000 in 1967.

During 1972, production workers made up 48 percent of total employment, scientists and engineers accounted for 17 percent, technicians 7 percent, and the remainder were in administrative, clerical and maintenance categories.

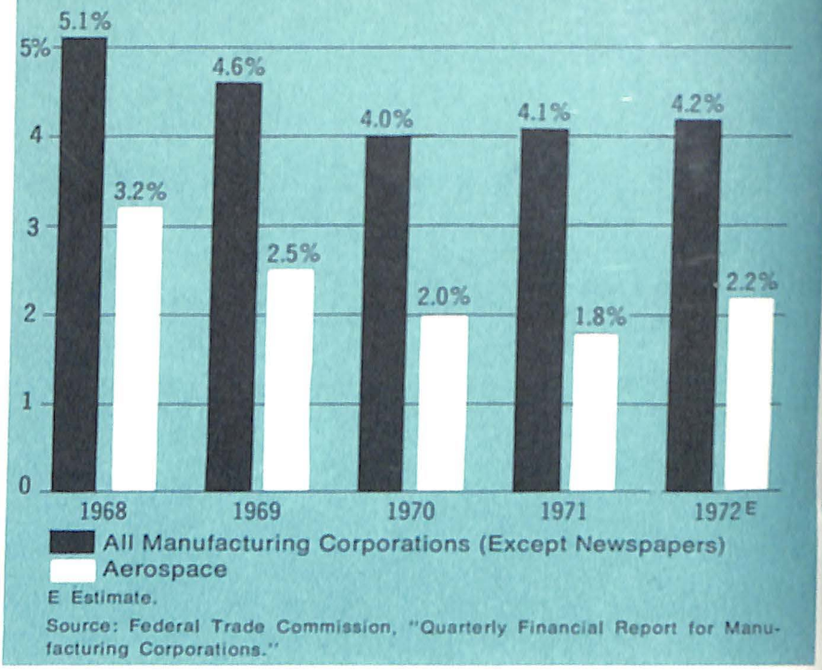
EARNINGS AND PAYROLL

Weekly earnings of production workers in the aerospace industry rose from $176.64 to $189.39 between 1971 and 1972 as average hourly earnings increased from $4.32 to $4.56 in the same period. Total industry payroll increased slightly from $10.1 billion to $10.3 billion in spite of the decrease in employment.

HOURS

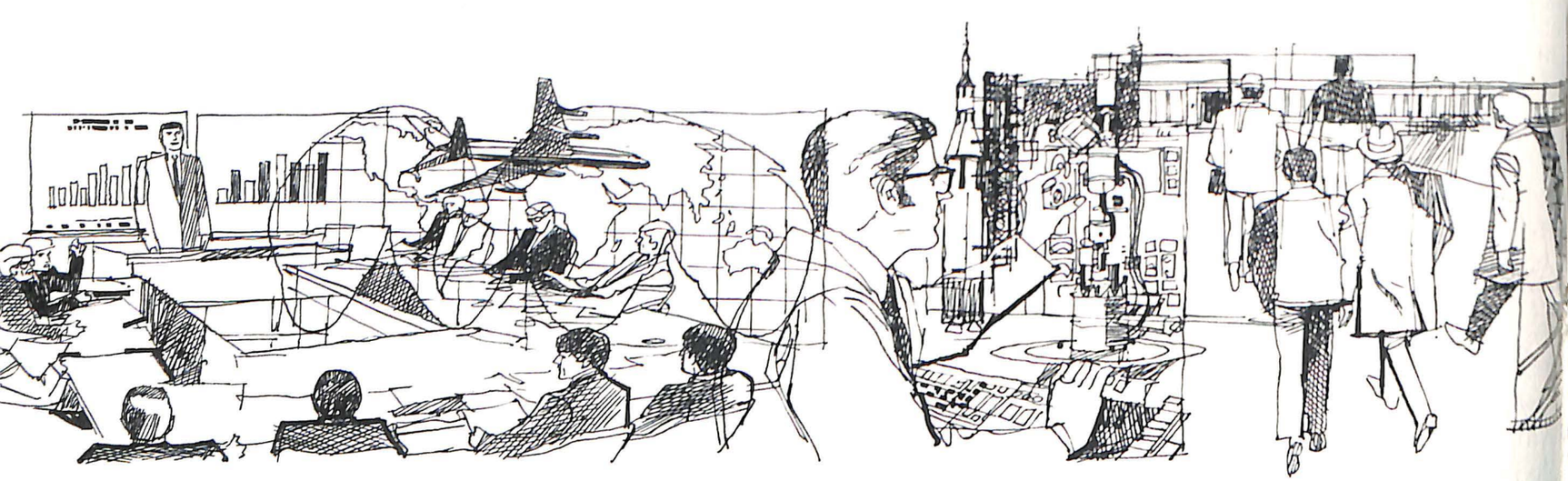
Average weekly hours in the aerospace industry increased from 40.9 in 1971 to 41.6 in 1972. Overtime increased from 2.3 to 2.8 hours in the same period.

NET PROFIT AFTER TAXES AS A PERCENT OF SALES
AEROSPACE AND ALL MANUFACTURING CORPORATIONS

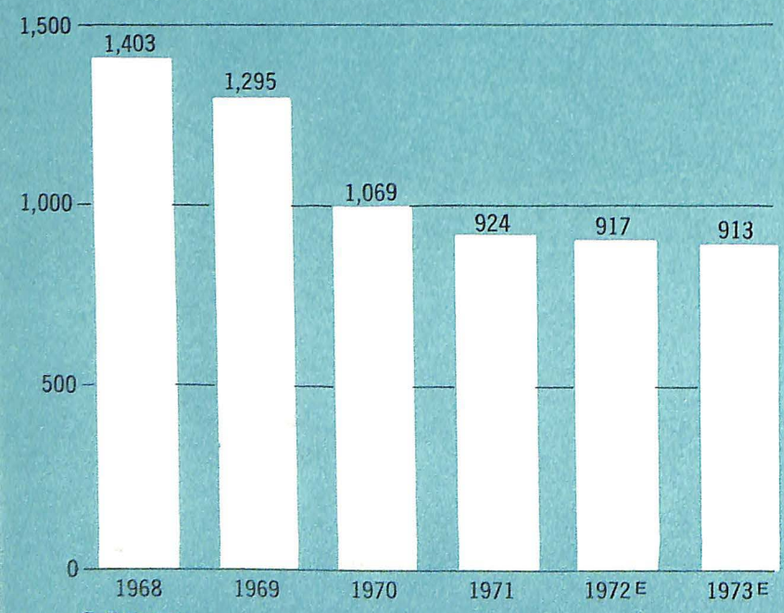


E Estimate.

Source: Federal Trade Commission, "Quarterly Financial Report for Manufacturing Corporations."



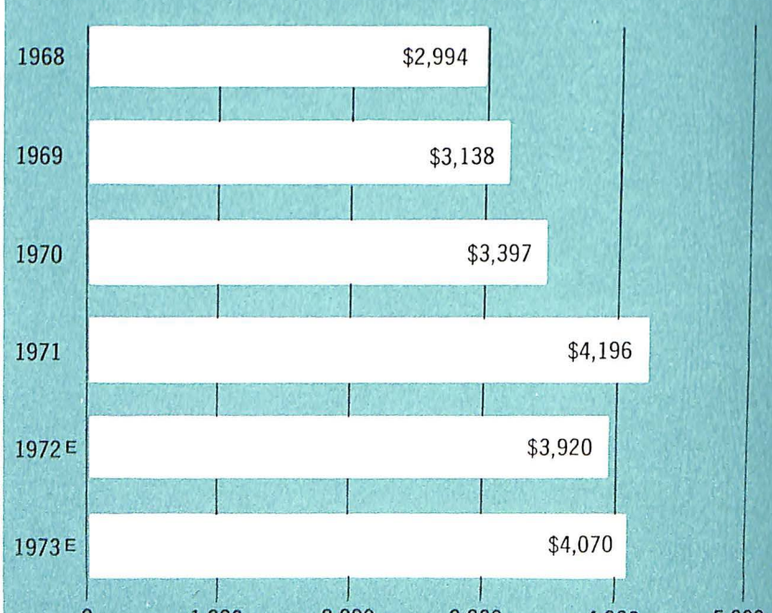
AEROSPACE EMPLOYMENT
(IN THOUSANDS)



E Estimate.

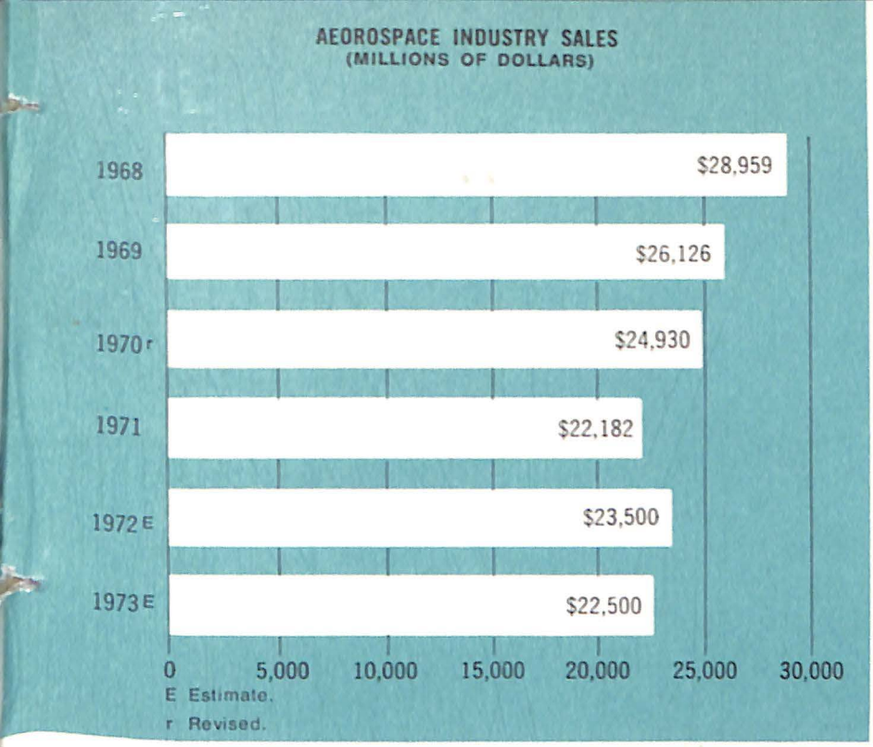
Source: Aerospace Industries Association, based on company reports and Bureau of Labor Statistics data.

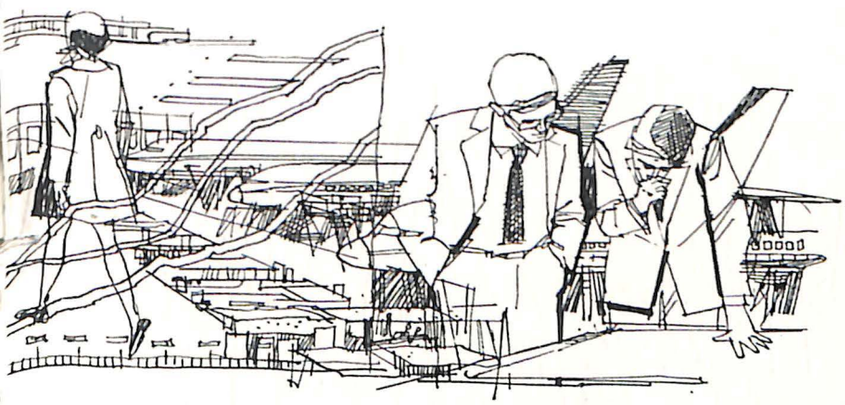
EXPORTS OF AEROSPACE PRODUCTS
(MILLIONS OF DOLLARS)

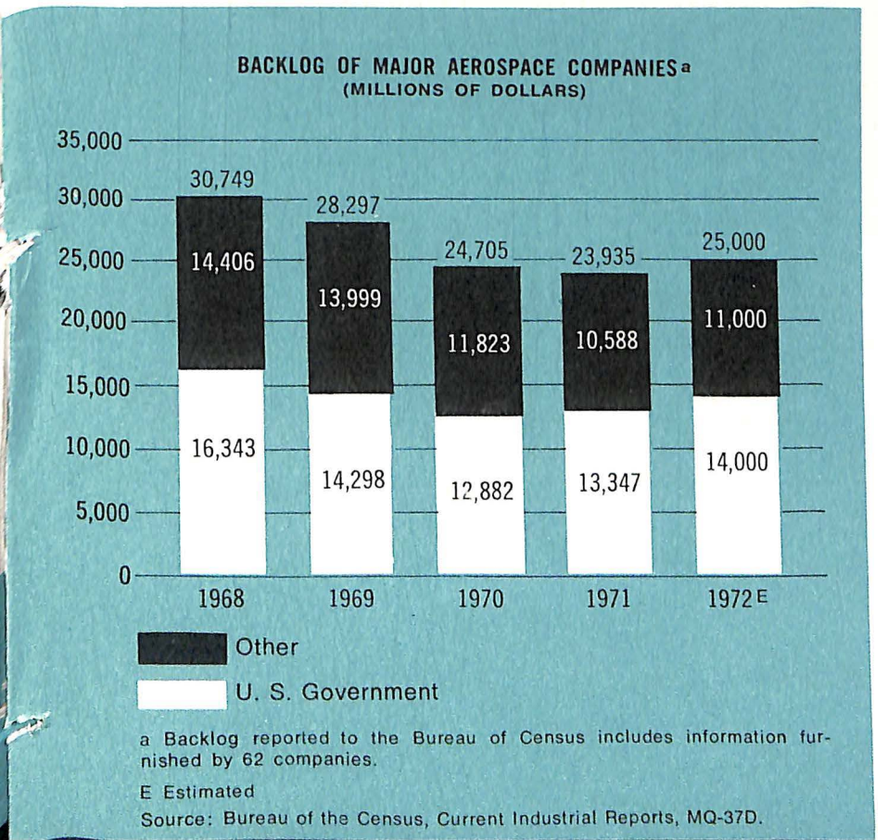


E Estimated.

Source: Bureau of the Census, FT 410 and FT 135.







A Proposal — TRANSPORT AIRCRAFT FINANCING

At a news conference sponsored by the Mid-East Region of the Aviation and Space Writers Association, Karl G. Harr, Jr., president of the Aerospace Industries Association, emphasized the need for a new formula to achieve joint government-industry financing for the development and production of commercial transport aircraft.

Because of the long lead-time necessary to develop and produce new transport models, both the costs and the risks are more than a manufacturer can bear, he said. The traditional method, total funding by private capital, can no longer meet the challenges from foreign aircraft producers who are supported by their governments and who often combine resources via consortiums.

Mr. Harr noted that some new device is needed to enable the United States to continue to compete favorably in the international high-technology marketplace, most notably with respect to modern transport aircraft. He commented favorably on the efforts of Mr. Secor Browne, former Chairman of the Civil Aeronautics Board, to develop a government authority that, if approved, would provide Federal guarantees of private loans (up to $3 billion) where necessary to assure the production of such aircraft.

Mr. Harr pointed out, however, that in the view of the aerospace industry such support of production would leave one basic problem unsolved—meeting the huge outlays required for the research, development and pre-production phase. That phase may encompass five years before a new model is certificated for airline use. The industry thus favors a broadening of Mr. Browne's proposal to provide government participation in this phase. This may include loan guarantees or direct loans with government and industry sharing the financial risks.

As outlined by Mr. Harr, support to the manufacturing industry would be governed by certain restrictions, among them being that eligible projects must:

- Incorporate significant improvements over existing aircraft or aircraft engines in design and construction.
- Meet the reasonably predictable needs of the public for efficient, economical, and environmentally compatible air transportation.
- Be capable of competing with or be superior to comparable aircraft or aircraft engines, if any, manufactured substantially outside the United States.
- Not directly compete with another aircraft or engine offered by another U.S. manufacturer and funded with private resources.
- Satisfactorily fulfill the requirements of air carriers, as demonstrated by the placement or stated intention for placement of a quantity of orders judged sufficient by the Authority to demonstrate reasonable expectation of an adequate market; or in the case of financial assistance for prototype development, have reasonable expectation of fulfilling an airline requirement, as demonstrated by acceptability to the airlines.

"This is a financing plan," said Mr. Harr. "This is not a subsidy. It *would* provide the means for an American manufacturer—and his subcontractors, suppliers and vendors —to be the producers of the next generation of a specific type of advanced transport aircraft rather than competitors abroad."

Elimination of

AIRCRAFT EMISSIONS

AIRCRAFT EMISSIONS

AIRCRAFT EMISSIONS

AIRCRAFT EMISSIONS

AIRCRAFT EMISSIONS

Vanishing smoke plume in this McDonnell Douglas DC-9 is visible evidence of progress in airline program to modify the JT8D engine powering the short and medium haul DC-9 and the Boeing 737 and 727. The airplane's engines have had their combustion chambers modified during overhaul to eliminate the smoke plume shown in photo at left.

For several years there has been a growing public concern about ecology—the relationship between man and his environment. One of the most popular targets of those concerned about the atmosphere is the engine—either internal combustion or jet turbine. These are the engines that power much of the modern world.

There can be no argument with the proposition that man should do all he can to take care of his environment. If controls over engine emissions are necessary, then obviously realistic controls should be established and enforced.

Meantime, the man in the street stands confused in the midst of the considerably heated controversies that have characterized environmental issues. Emissions have especially been subject to emotion and much misunderstanding.

It is apparent, for example, that many critics of emissions do not know that man is not the prime producer of the emission materials for which engines are being criticized.

The problem of public understanding—or lack of it—is well illustrated by a recent statement by a legislator, as published in the *Congressional Record,* versus the findings of a recent scientific study. The legislator said: "Autos account for nearly two-thirds of all carbon monoxide in our air, more than one-half of hydrocarbons and two-thirds of nitrogen oxide."

The scientific study says that nature produces 15 times more nitrogen oxides, 10 times more carbon monoxide and 6 times more hydrocarbons in any given period of time than do all of man's activities.

The Clean Air Effort

Although manufacturers of engines and the vehicles they power have been working for nearly two decades to produce quieter, more efficient engines with reduced ecological impact, federal action to establish deadlines for meeting fixed anti-pollution standards is of more recent date.

Public concern about the atmosphere and the quality of the air we breathe led Congress to pass the Air Quality Act of 1967. One cause was the growing public awareness that with the introduction of turbine-engine aircraft in the late 1950s there were visible exhaust plumes from the engines and more noticeable exhaust odors at airports.

The Air Quality Act directed the Department of Health, Education and Welfare to make a study which, when submitted in mid-January 1969, concluded, among other things, that:

An article entitled *"What The Quiet Is All About,"* in the July 1972 issue of this magazine, discussed the great strides that have been made in reducing the noise of commercial aircraft operations, particularly on and near major airports. The following article looks at aircraft engine emissions from the standpoint of what is the problem and what is being done about it. *—Editor*

- Reduction of particulate emissions from jet aircraft is both desirable and feasible.
- Further research is needed to define more precisely the present and probable future nature and magnitude of all other air pollution problems associated with aircraft activity in the United States and to identify needs for control measures.

The HEW report of 1969 led Congress to pass a stringent "Clean Air Act" in 1970. This Act was amended in 1972. The 1970 Clean Air Act directed the Administrator of the Environmental Protection Agency (EPA) to "establish standards applicable to emissions of any air pollutant from any class or classes of aircraft or aircraft engines which in his judgment cause or contribute to or are likely to cause or contribute to air pollution which endangers the public health or welfare."

The operative phrase is ". . . or are likely to cause or contribute to air pollution which endangers public health or welfare."

In doing its job the EPA established standards for various forms of emissions. Different standards were set for several categories of aircraft engines according to size (pounds of thrust). EPA also established various dates for meeting the standards, ranging from January 1, 1974 to January 1, 1979, depending on the category of engine and the type of emission.

Who Pollutes with What?

The most common complaint is that internal combustion and jet turbine engines emit exhaust gasses containing four components that are considered pollutants.

The first standards that must be met under the Clean Air Act, as amended, apply to particulate emissions—visible smoke from engines—particularly aircraft turbine engines.

In 1965, aircraft and engine manufacturers and the airlines began a program to eliminate the smoke plume. A program to re-work many of the engines already in service was begun in 1970.

It was in March of that year that a meeting was held by the Secretaries of Health, Education and Welfare and of Transportation with representatives of 31 airlines. A schedule for retrofitting the JT8D with reduced smoke combustors was developed and voluntarily accepted by the airlines. The focus was placed on this model engine because it powers more commercial aircraft than any other engine—aircraft that serve the short- and medium-haul routes and, therefore, make many more takeoffs and landings than do the transcontinental and international jets.

By the end of September 1972 more than 90 per cent of the 3,000 engines that power the McDonnell Douglas DC-9 and Boeing 737 and 727 transport aircraft in the commercial airline fleet had been modified. This year the program will be completed. New engines coming into use and those planned for the future will put out no smoke plumes.

Standards to be met later would control the emission of gaseous components. These are:

- Carbon monoxide which in a confined space, such as a closed garage or a tunnel, can bring on a headache and can even kill if the concentration is great enough.
- Oxides of nitrogen which can have an adverse effect on plants and other organisms.
- Unburned or partially burned hydrocarbons which react with the oxides of nitrogen in the presence of sunlight to produce what is commonly known as smog.

(Aircraft turbine engines also produce carbon dioxide, water and oxides of sulphur in negligible amounts. The jet fuel does not now and never has had enough compounds of lead to produce measurable lead emissions.)

Often overlooked is the fact that nature has its own disposal system. For example, fungus in the soil in the United States alone has the capacity to consume more than double the amount of carbon monoxide produced by all the vehicles and factories in the world.

One of the problems is that non-scientific critics are prone to equate *weight* of emission products with *danger*.

They miss the point.

If automobiles in the United States produce 40 million tons of carbon monoxide in 1980, as predicted, that *weight* is not a valid measure of *harmfulness* throughout the country. The important factors are *concentration* and *toxicity*.

In fact, looking across the complete spectrum of air pollutants it now is estimated that motor vehicles account for only about 10 per cent of the *potentially* harmful emissions produced by man, and jet aircraft account for about *one* per cent. In other words, traffic congestion and pollution are a classic cause and effect, and even so, pollution is limited to those areas where a concentration of vehicles, the geography and climatic conditions conspire to produce a concentration of emissions which are "likely to cause or contribute to air pollution which endangers the public health or welfare."

Saying that automobiles produce 10 times as much pollution as aircraft is not to say that this is a serious ecological problem. Automobile manufacturers, under an effort begun years ago, have done much to reduce the emission of the three common pollutants—oxides of nitrogen, hydrocarbons and carbon monoxide. And further reduction is on the way.

But the question is, how big an offender is the automobile?

If, for example, we apply the even more stringent 1976 automotive pollution control standards to other activities of the average car owner we find that:

- The vegetation in the car owner's back yard, just in the process of growing and decaying, would give off as many hydrocarbons as his automobile.
- If he burns one log in his fireplace he'll have used up his daily allotment of carbon monoxide production.
- If he is using oil heat, he is limited to three gallons of oil each day, which will last about eight hours, or he'll be over the limit in oxides of nitrogen produced.

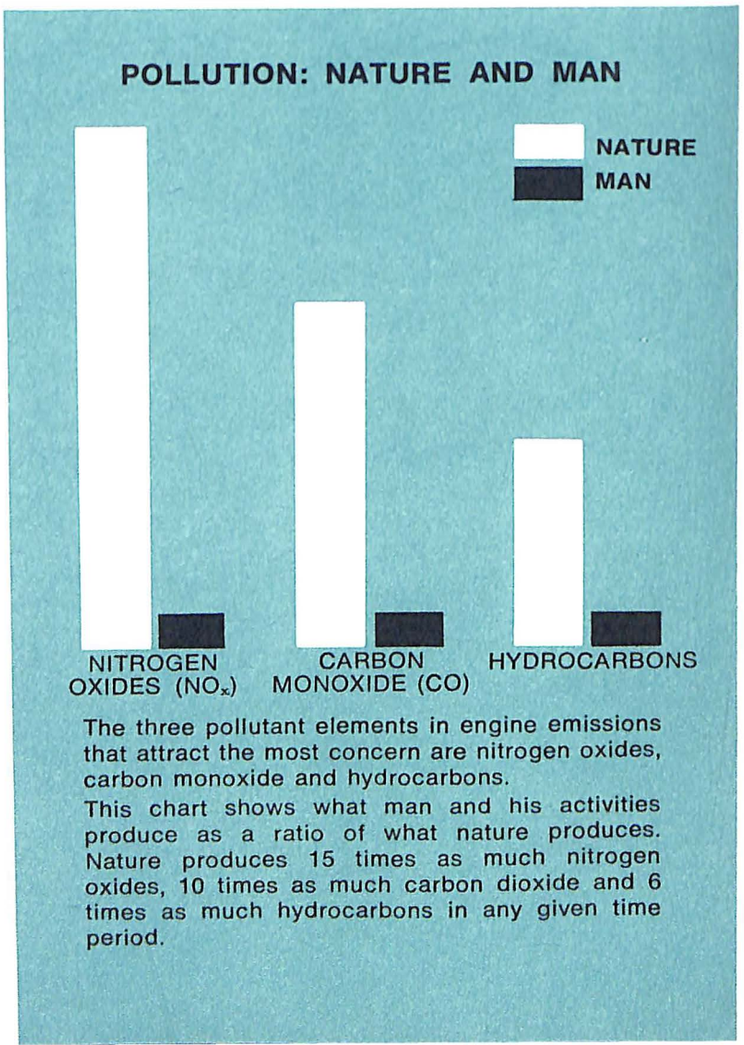
This suggests that if the standards for engine emissions, now and in the future, are examined against the rational criteria of *concentration* and *toxicity* they may lend themselves to some realistic adjustment.

A recent report by the Chrysler Corporation states: "The fact is that years of research, involving millions of people in hundreds of community studies, and in laboratory studies, have not developed any evidence showing any threat to health from average ambient levels of automotive emissions."

But, back to the airplane.

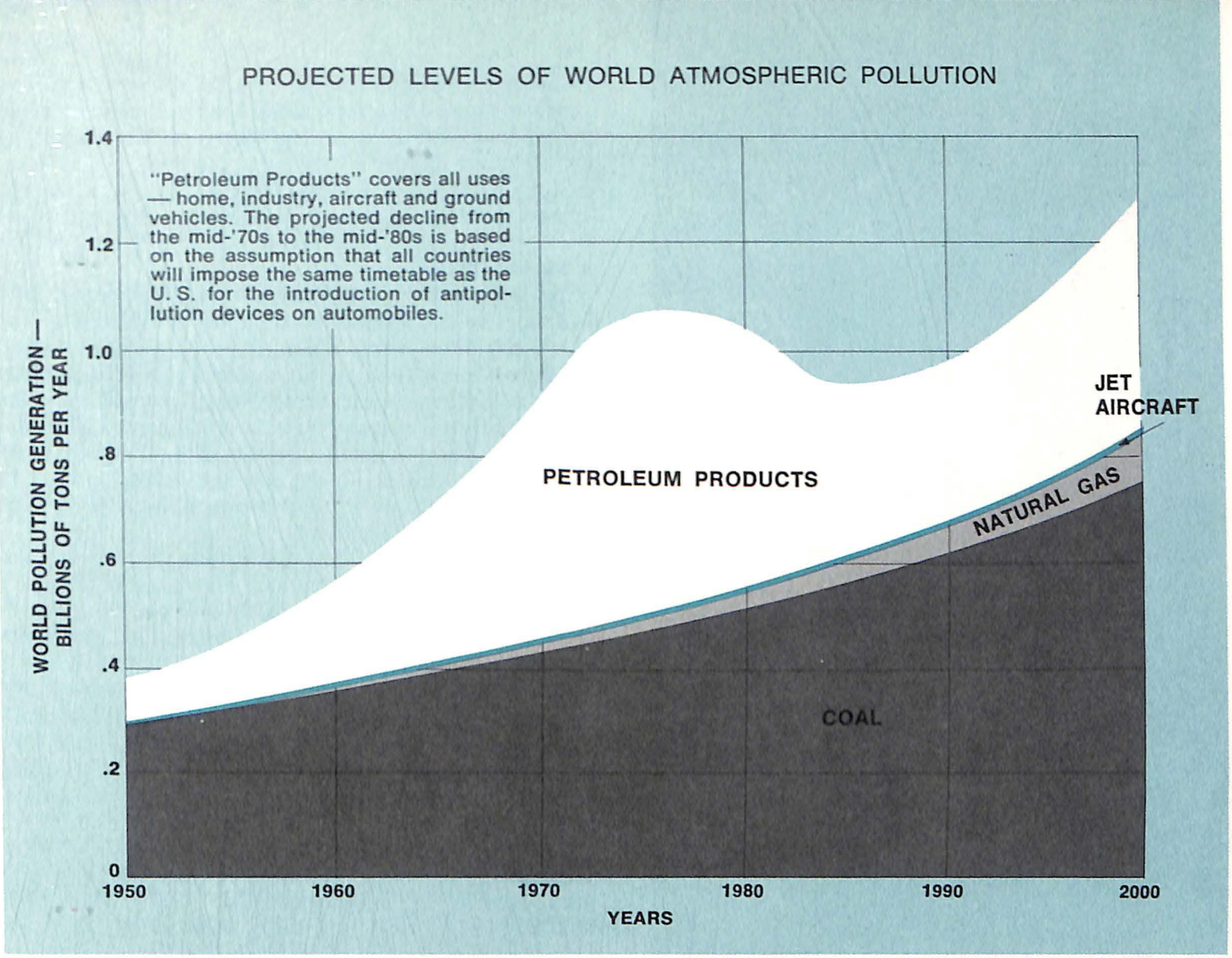
As a point for re-emphasis, it is not a question as to whether air pollution should be monitored and controlled, but that aircraft engine emissions are not now significant polluters and will be even less so in the future.

The basic concern of lawmakers and those who must establish aircraft standards and enforce them is focused on the areas encompassing major airports, such as those



The three pollutant elements in engine emissions that attract the most concern are nitrogen oxides, carbon monoxide and hydrocarbons.

This chart shows what man and his activities produce as a ratio of what nature produces. Nature produces 15 times as much nitrogen oxides, 10 times as much carbon dioxide and 6 times as much hydrocarbons in any given time period.



at New York, Washington and Los Angeles. Studies have shown that the level of air pollution in suburban or urban areas surrounding major airports is no greater than the background of pollution produced within those same areas. In fact, London's Heathrow Airport actually provides an improvement in air quality over the general background pollution in surrounding areas.

And in the case of the Los Angeles International Airport, a sampling site east of the airport showed a higher concentration of carbon monoxide when the wind was from the east (toward the airport) than when it was from the west (across the airport). In other words, man's activities in areas outside of but near airports probably contribute more pollution than do the activities on the airports.

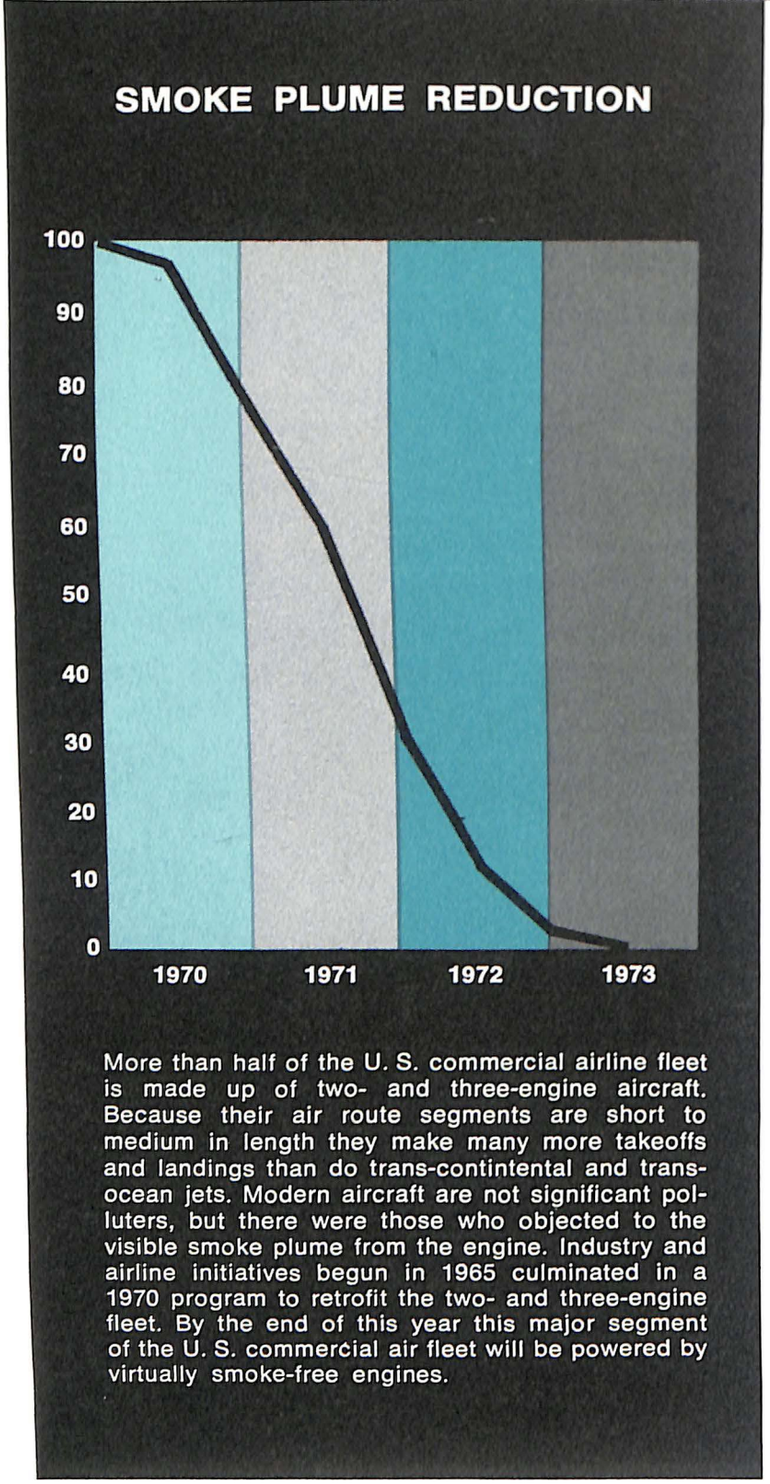
It is because of findings such as these that two scientific consultants, who provided much of the information on which the proposed aircraft emission standards are based, do not support the standards as they now stand.

Over the years industry has achieved much, but there has been little public recognition of this fact. Since the Clean Air Act was passed, earlier on-going efforts by the scientific and technological communities have been stepped up. They have been gathering the facts that are essential to a reasoned, unemotional and informed approach to identifying the nature and the scope of the air quality problem, and to arriving at recommended solutions.

Contrary to certain popular assumptions of the late 1960s, findings now indicate that:

- There has been a marked improvement in air quality in communities of all sizes, according to a recent study made for the Council on Environmental Quality.
- There is no evidence that prolonged exposure to average street level concentrations of engine emissions, even in heavily populated urban areas, is a threat to health, except possibly under infrequent and unusual combinations of weather—temperature inversion and a lack of wind.

All industry would agree that where controls are needed they should be imposed. The important point is that any controls should be tailored to meet the standards that *scientific* evidence shows to be necessary to protect public health and welfare. The people who make engines and the people who use them, as is the case with scheduled airlines, long have been concerned about their responsibility to man and the environment. They have done much and are doing more every day. But the standards imposed to control emissions must require only what is really necessary or there can be unwanted, unnecessary and costly penalties to our dynamic economy as well as to the manufacturers, the



More than half of the U. S. commercial airline fleet is made up of two- and three-engine aircraft. Because their air route segments are short to medium in length they make many more takeoffs and landings than do trans-contintental and trans-ocean jets. Modern aircraft are not significant polluters, but there were those who objected to the visible smoke plume from the engine. Industry and airline initiatives begun in 1965 culminated in a 1970 program to retrofit the two- and three-engine fleet. By the end of this year this major segment of the U. S. commercial air fleet will be powered by virtually smoke-free engines.

fuel producers, the people who buy and operate surface and air vehicles, and even the people who ride in them.

A Look At The Proposed Standards

The Aerospace Industries Association, utilizing the talents of member company experts, has conducted a thorough study of the proposed federal regulations designed to control air pollution from aircraft and aircraft engines.

The AIA study concentrated on aircraft gas turbine engines. Without going into the voluminous scientific and technical details in the study, some resulting comments are:

At most, the contribution of aircraft emissions to air pollution at and near major airports is small and reduction in pollutant level achieved by controlling aircraft emissions would not significantly alter the situation. The sites where the airplane contributes by itself to hydrocarbon levels that are predicted to exceed the air quality standards are almost always near the ends of runways. In these locations it is doubtful that the public would have access except inside airplane cabins, and even then the exposure times would not be of the lengths specified in the standards.

The AIA strongly recommends that the implementation dates of any emissions standards be related to engine certification dates, rather than the date of engine manufacture. This would be analogous to the application of standards to the "model year" of automobiles. By targeting the effective date of any standards to the certification date a given engine can be designed from the outset to comply with any applicable emissions standards and all subsequent production units of that engine will meet the standards.

On the other hand, the requirement that all engines of a given design, manufactured after a specific date, meet applicable emission standards is expected to result in substantial cost increases in the engines manufactured after these effective dates.

For engines already certified and in production such a cost impact may in many instances result in prohibitive unit engine cost increases because these costs can only be shared by a relatively small and declining production base. The net effect might well be the premature end of the production runs of some engines.

In view of these and other considerations the AIA recommends that the proposed 1976 standards for new aircraft gas turbine engines be made applicable to new engines certified on or after January 1, 1976, and the effective dates on any proposed standards for subsequent years also be based on engine certification dates.

In view of all of the efforts that have been and are being made, and the fact that the engines other than the JT8D, which already is well along in the retrofit program, largely are older engines it is recommended that a smoke emission retrofit requirement not be imposed. Many of these engines will be phased out during this decade. Therefore, any smoke emissions concerns associated with these engines gradually will be eliminated without incurring the high costs associated with providing them with low smoke combustors.

The proposed EPA 1979 emission standards require another substantial reduction in the oxides of nitrogen emitted, coupled with the extreme reductions in both carbon monoxide and total hydrocarbons emissions. Experience to date has indicated that these combined reductions in pollutant levels cannot be met in any practical device available today. Obviously there must be a period of thorough and costly research leading to the development of new design and construction techniques.

In summary:

1. The supporting data presented by the EPA does not justify the overly restrictive aircraft engine exhaust emission standards currently proposed.
2. The large development effort and expense required to retrofit in-use Class T2 engines for smoke reduction is not warranted by the small benefit to be gained and therefore the requirement should be eliminated.

3. Exhaust emission standards should apply only to engines which receive their initial type certificates after the effective date of such standards.

4. The emission standards proposed for 1976 cannot be achieved in engines certified prior to 1976, unless the standards are modified or postponed.

5. The small engine (Class T1) category must be subdivided to realistically represent the emission characteristics of these engines.

6. The definition of specific emission standards for 1979 should be deferred until needed research and development of new combustor concepts can be completed.

7. Programs must be conducted to establish realistic tolerance bands for any proposed standards.

8. It is mandatory that any proposed exhaust emission standard for aircraft gas turbine engines be referenced to standard atmospheric conditions and further, that methods be provided for relating the measured emission levels to these standard atmospheric conditions.

9. It is recommended that engine compliance with exhaust emission standards be determined on the uniform basis of zero power extraction and zero service air bleed, and that all tests be conducted on engine static test stands at ground ambient conditions.

'THE WORLD'S OXYGEN SUPPLY IS SECURE'

Speaking to an international conference on environment in Mexico in January 1972 Research Scientist Dr. A. L. Jones of the Standard Oil Company of Ohio made a number of significant comments about ecology and man's impact on his environment. Some excerpts follow:

"For several years I have been deeply concerned about reports of the destruction of our environment as a result of technological recklessness, overpopulation and a religious and philosophical outlook that gives little consideration to the preservaton of nature.

"Three years ago I started to evaluate the premises upon which some of our major environmental concerns are based. The evidence that I have been able to find has proved to be quite encouraging to me.

"I wish to make it quite clear that I am speaking to you as a scientist and not as an emotional supporter of any particular 'side' of ecology. . . . As scientists we must work in terms of what we know rather than what we do not know. Unless the pronouncements we make are verifiable by others, they are worthless.

"Some of the facts I present today may surprise many of you. I can assure you my conclusions are supported by evidence that is difficult to interpret in any other way. They can be verified by anyone who wishes to do so.

"My first surprise concerns the air we breathe. Throughout my formal education I have been taught that the oxygen in our atmosphere is supplied by green plants using the process of photosynthesis. It is known that plants take in carbon dioxide and, through activation by sunlight, combine it with water to make starches and cellulose and give off oxygen. In this way the whole chain of plant and animal life is sustained by energy from the sun. When the vegetable or animal materials thus produced are eaten, burned, or allowed to decay they combine with oxygen and return to the carbon dioxide and water from which they came.

"The surprise is that most of the oxygen in the atmosphere doesn't come from photosynthesis. The evidence is now overwhelming that photosynthesis is quite inadequate to have produced the amount of oxygen that is present in our atmosphere. The reason is that the amount of oxygen produced by photosynthesis is just exactly enough to convert the plant tissue back to the carbon dioxide and water from which it came. In other words, the net gain in oxygen due to photosynthesis is extremely small. The oxygen of the atmosphere had to come from another source. A most likely possibility involves the photodissociation of water vapor in the upper atmosphere by high energy rays from the sun and by cosmic rays. This process alone could have produced, over the history of the earth, about seven times the present mass of oxygen in the atmosphere.

". . . the supply of oxygen in the atmosphere is virtually unlimited. It is not threatened by man's activities in any significant way. If all of the organic material on earth were oxidized it would reduce the atmospheric concentration of oxygen by less than 1 percent.

"I believe, as Thomas Jefferson did, that if the public is properly informed, the people will make wise decisions. I know that the public has not been getting all of the scientific facts on many matters relating to ecology.

"Let us not cry wolf until we are reasonably certain that we have done enough homework to know what a wolf looks like. Otherwise we may undermine our credibility and not be believed by the people when we warn them of the real wolves that do exist.

". . . we are not on the brink of disaster. The world's oxygen supply is secure. There will be no build-up of poisonous carbon monoxide. Our waters can be made pure again by adequate treatment plants. The disappearance of species is natural. We cannot solve our recognized problems unless we attack them on the basis of what we know rather than what we don't know. We must use our knowledge and not our fears to solve the real problems of our environment. Our future can be better than most of our past if we choose it so."


MAN IN

SPACE: A Look Forward

By FLOYD E. SMITH

President,
International Association of Machinists
and Aerospace Workers

Floyd Emery Smith, a one-time machinist's helper, is International President of the IAM, a trade union of nearly one million members. Among other positions, Mr. Smith is also Co-Chairman, Machinists Non-Partisan Political League; Vice President of the AFL-CIO and Member, President's Commission on International Trade and Investment Policy.

THE Apollo 17 command module splashed down in the Pacific Ocean on December 19, 1972.

This marked not the end of manned space efforts, but the beginning of a new era of space exploration by man that will see a reaping of incalculable benefits through Skylab, the joint U.S.-U.S.S.R. Apollo-Soyuz Test Project (orbital rendezvous and docking) and the Space Shuttle, the key program for the 1980s. All are based on the foundation created by the Apollo program of the 1960s and early 1970s.

Dr. James C. Fletcher, Administrator of the National Aeronautics and Space Administration, in a thoughtful assessment of the meaning of the Apollo program, made these important points:

- Apollo re-asserted U.S. technological leadership long before we reached the Moon. That was an important fact of international life in the Sixties. It still is.
- After Sputnik, but before Apollo, there was a theory that only a controlled economy and a Communist society could succeed with large scientific and technological undertakings such as space exploration. Apollo exploded that theory. Apollo demonstrated that we could respond effectively to a totalitarian challenge without resorting to totalitarian methods. Apollo produced the kind of government-industry-labor cooperation on large scale research and development programs needed to make the American system work, and keep it competitive with any other systems in the world.
- On the way to the Moon, we discovered planet Earth. This may be the most important return from the Apollo program for decades to come. The startling new perspective of a lonely, lovely, fragile Earth as seen from the Moon gave great strength and impetus to the environmental movement worldwide, and it helped establish the fact that space technology was something new that could contribute greatly to the quality of life on Earth. It made us realize that although our Earth is just a place in space, it is the only home we have.

Building upon Apollo, our next venture in manned space will be Skylab. This project, ready to be launched soon, has not received much public attention. However, it will provide dramatic evidence of the great advances made in the development of capabilities for scientific and practical work in manned spacecraft in Earth orbit. Skylab will have the same living and working room as a three-bedroom house for its three-man crews. The first Skylab will have a mission duration of 28 days and the second and third units will have missions of 56 days.

Its objectives are:

- *Advancement of the Sciences*—To increase knowledge of medicine, astronomy, weather and physics. A prime goal is to collect previously unobtainable information on the Sun-Earth relationship and its effects on our environment here on Earth.
- *Practical Applications*—To perfect Earth-looking camera and sensor systems, and their related data sys-

tems, to benefit mankind's agriculture, forestry, oceanography, geography, geology, water and land management, communications, and ecology and pollution control. Skylab also will open up a dramatic new field—the development of manufacturing techniques in gravity-free conditions, a field that has the potential for yielding such products as higher quality vaccines and machined parts, such as ball bearings, with a degree of near perfection that cannot be achieved on Earth where gravity is a factor.

■ *Human and Materiel Endurance*—To determine the ability of both human beings and Earth materials and systems to maintain their qualities and capabilities during long absence from gravity.

The Apollo-Soyuz Test Project, planned for 1975, is the result of an agreement between President Nixon and Chairman Kosygin of the U.S.S.R., made last May, for the rendezvous and docking of a U.S. spacecraft with a Russian spacecraft. An Apollo spacecraft will link up with a Soviet Soyuz spacecraft and while docked together astronauts and cosmonauts will visit both spacecraft and perform a number of scientific experiments.

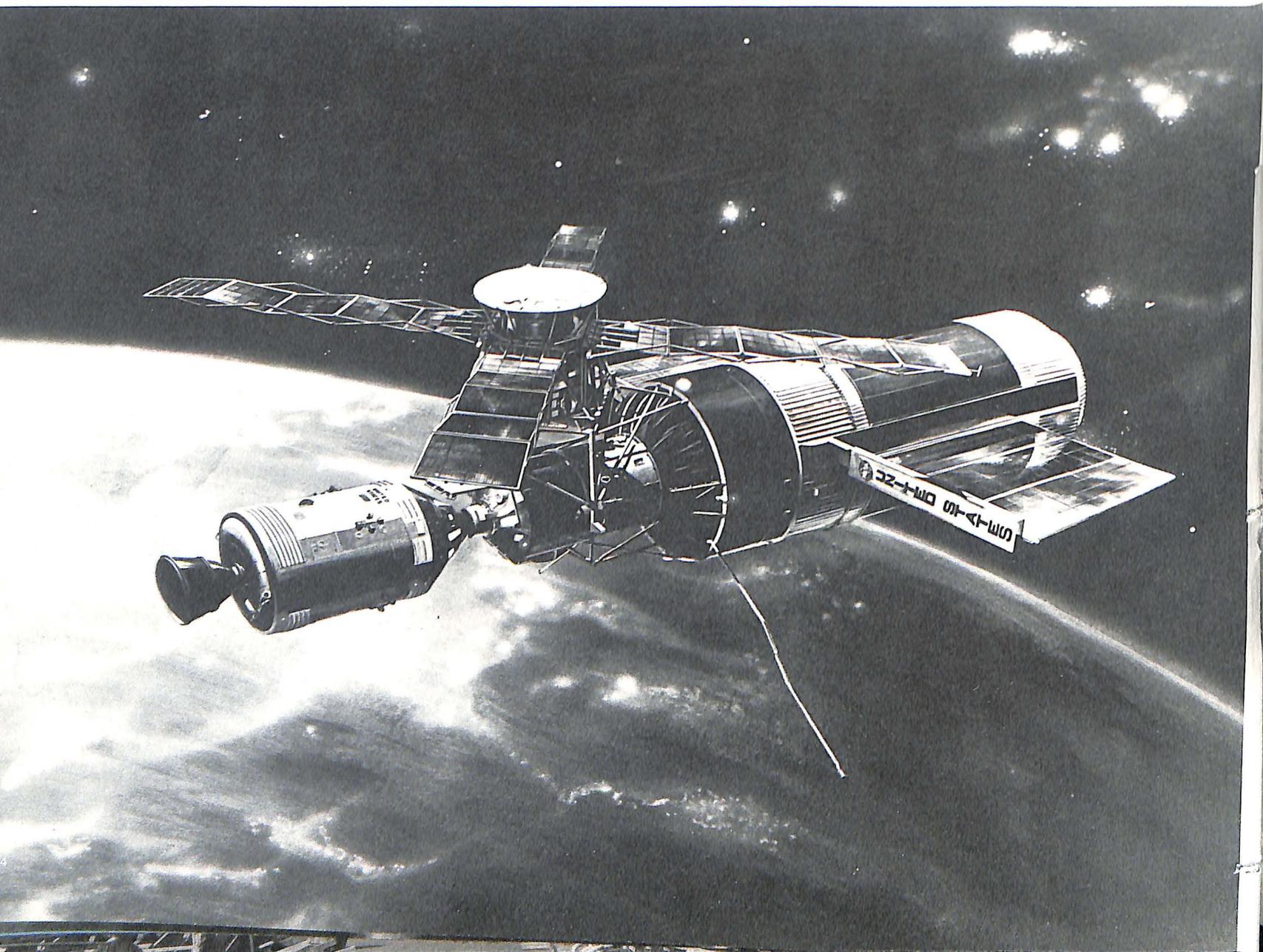
A major purpose of the Apollo-Soyuz project is to develop a rescue capability by demonstrating systems that will permit the docking in orbit of any future manned spacecraft of either nation.

But perhaps the greatest benefit from this project is not definable in visible progress: The Apollo-Soyuz project could form the viable basis for our nations to work together at an engineering level in a program that could well spread to other areas of technical cooperation.

The main thrust of our manned space program for the future is the Space Shuttle. An analysis of what the U.S. has done in space would show that we have devoted most of our space effort in the Sixties to overcoming gravity on the way to the Moon and back. In the Seventies NASA aims to overcome the high costs of operating effectively in earth orbit.

The cost of the Space Shuttle is estimated at $5.15 billion compared with the $25 billion price tag on Apollo. This, however, should not be an index of the importance of the Shuttle. The Shuttle calls for much greater technological advances and adds more to our capabilities in space than the general public realizes.

Skylab, an extension of the manned Apollo program, is designed to expand man's knowledge of manned Earth orbital operations and to accomplish carefully selected scientific, technological and medical investigations.



NASA Administrator Fletcher puts it this way:

"Suppose we were back in 1961, and President Kennedy instead of choosing the lunar landing goal, had said: 'Build a Space Shuttle before this decade is out.' Believe me, without the technological progress we have since made in Apollo, building the Space Shuttle in the Sixties would have been an almost impossible assignment. And the cost would have approached that of Apollo. As it is, the cost is much less, but the Shuttle remains a challenging assignment for NASA and the skilled hands and minds of the aerospace industry. Comparing the usefulness of Apollo and the Space Shuttle in Earth orbit would be like comparing Lindbergh's New York to Paris plane of 1927 with an intercontinental airliner of today."

The Space Shuttle appropriation for Fiscal Year 1973 was overwhelmingly passed by the Congress last year. *The Machinist*, our union weekly, noted in a front-page article in a May 1972 issue: "More than 50,000 aerospace workers will be employed on the program between now and its first mission."

Now that figure means a lot to every aerospace worker. It underscores a point I have made many times: The U.S. did not spend one thin dime on the Moon; the entire $25 billion was spent right here on Earth.

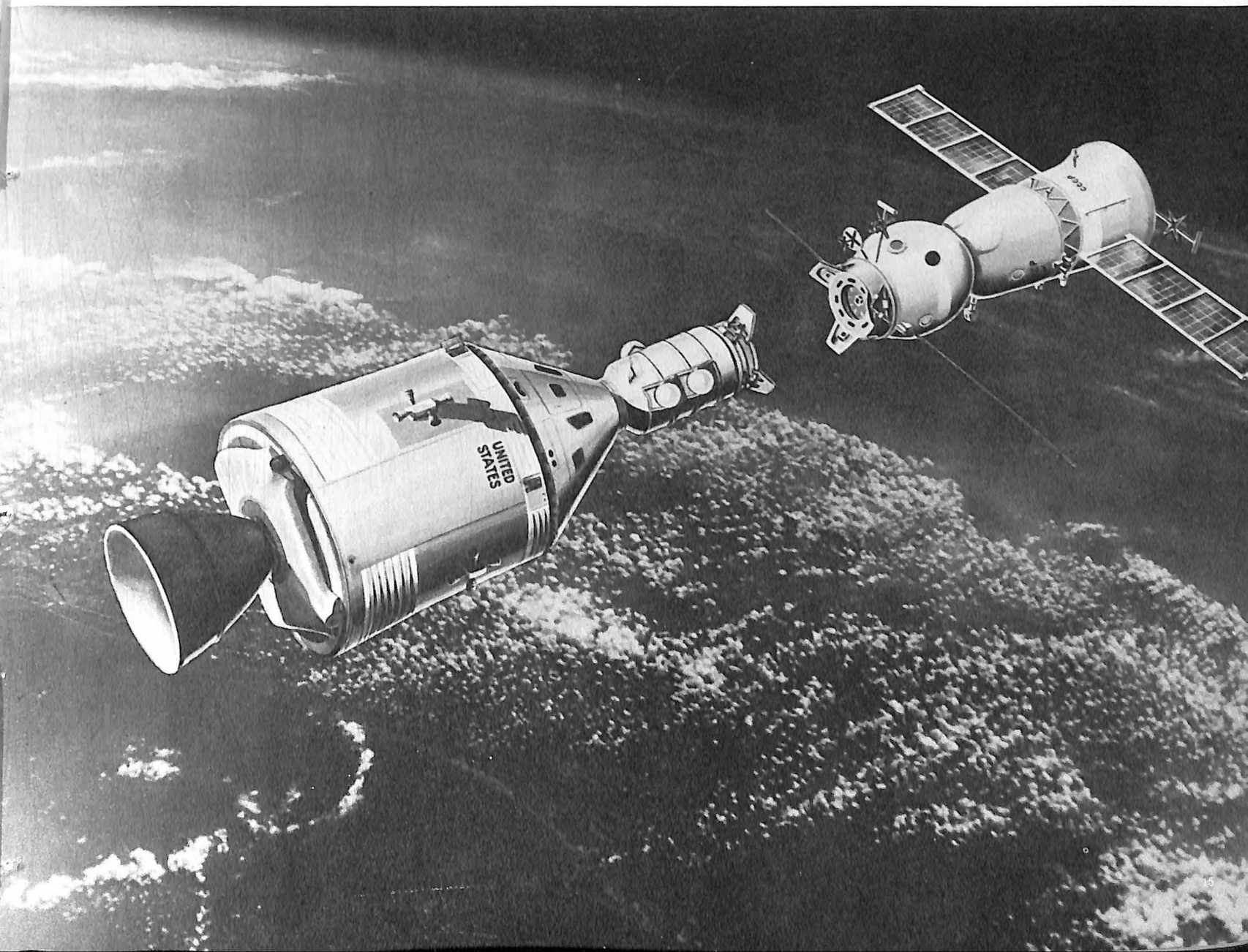
Representative Don Fuqua, of Florida, chairman of the Manned Space Flight Subcommittee of the House Committee on Science and Astronautics, in a speech on the floor of the House, made these cogent points:

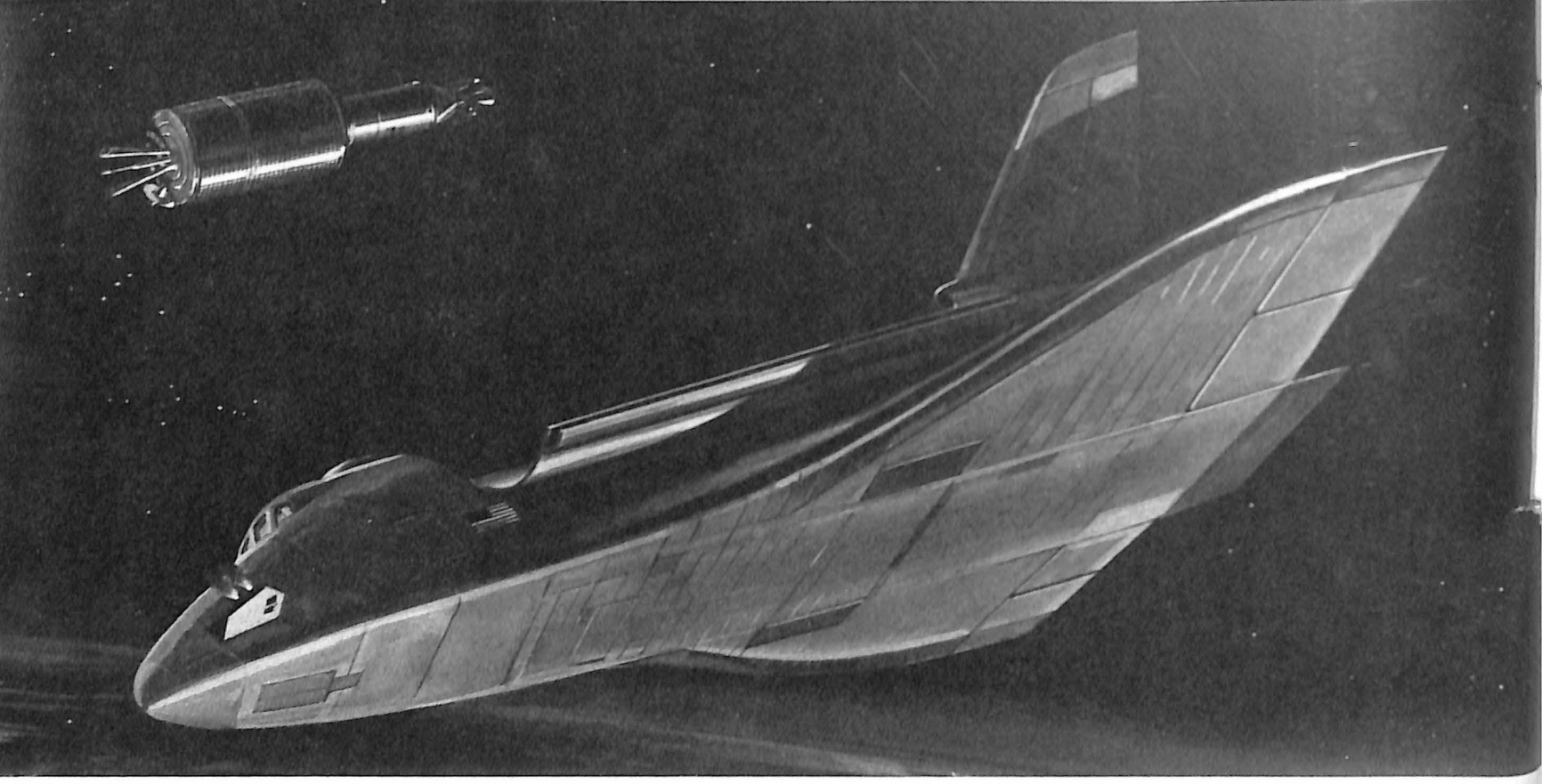
- One dollar spent on the space effort generates $2.50 in Gross National Product (GNP), $2.00 in personal income and $1.50 in consumer outlays.
- A conservative evaluation of a $5.15 billion, six-year shuttle program, applying the multiplier effect, indicates a $12.9 billion addition to our GNP. Personal income contribution would be $10.9 billion with consumer outlays of $7.9 billion.
- The net federal tax return from this activity would be on the order of $2.6 billion, returning half of the original investment.

Congressman Fuqua concluded: "Not all federal activity is or can be such an outstanding contributor to our economy."

These are the direct, identifiable economic benefits

A model of the U. S. S. R.'s Soyuz (upper right) and the U. S. Apollo spacecraft are shown in simulated rendezvous and docking in Earth orbit. The mission, planned in 1975, will involve a joint flight by three U. S. astronauts and three Soviet cosmonauts.





The Space Shuttle releases a satellite into Earth orbit in this artist's conception. The Shuttle will carry up to 65,000 pounds of payload.

What is this program all about in terms of indirect benefits such as cutting the costs of our manned and unmanned space projects?

Courtland Perkins, Dean of Engineering, Princeton University, emphatically states that we must, as a nation, continue our remarkable activities in space exploration.

However, he adds: "At the heart of all this is the potential expansion of these activities through the reduction of the cost of the space operation. Today we are impeded across the full spectrum of activities due to the extremely high launch costs and the cost of space payloads. The National Aeronautics and Space Administration must consider this to be their number one objective in fulfilling their mission of advancing space technology."

Dean Perkins mentions these possibilities for reducing costs: Antigravity; a propulsion breakthrough; recovery and re-use of launch systems *and* payloads.

Today the only one offering a payoff is the recovery and re-use approach—the Space Shuttle. He lists these other major justifications for the Shuttle:

- Takes full advantage of the NASA capabilities developed through their manned space program.
- Reduces our complicated stable of rocket lunchers required for a wide variety of missions.
- Lowers the cost and increases the flexibility of space operations.
- Signals our young people that we are not about to throw away our carefully developed technical capability.
- Can provide the focus for many new technical advances during the next decade.

"We are orienting our national space program along new lines and developing new motivations," Dean Perkins says. "There is a solid base for our national space program which can be expanded further in many practical ways if we can reduce the cost. The shuttle program can do this . . ."

Physically, the Shuttle will consist of a manned reusable orbiter craft, mounted piggy-back at launch on a large, expendable liquid propellant booster and two recoverable and re-usable solid propellant rocket boosters. The orbiter will look like a delta-winged airplane, about the size of a McDonnell Douglas DC-9. In fact, after it completes an Earth orbit mission, the orbiter returns to Earth and lands in the same fashion as a jetliner.

NASA has made studies of Space Shuttle missions over the next 18 years that indicate approximately 26 per cent are likely to be manned or man-tended, including the manned sortie missions.

Man-tended payloads are concentrated in physics, astronomy and processing in space because such missions involve either complicated laboratory equipment and human judgment or selective observations, in the case of astronomy.

The remaining 74 per cent, involving delivery of unmanned missions, are expected to be made up as follows:

Applications: Earth resources, communications and navigation ..... 27 per cent

Science: Physics, astronomy and planetary 25 per cent

Department of Defense ..... 22 per cent

In launching unmanned automated payloads the Space Shuttle flight crew will be able to check out the satellite in space, make adjustments, and calibrate instrumentation to ensure successful operation before leaving the satellite unattended.

If necessary, the satellite can be retrieved and returned to Earth for more extensive repair to avoid a complete loss. The Shuttle will also provide a capability to repair in space or to retrieve a malfunctioning satellite from Earth orbit.

In a study of 131 satellite failures which have occurred in the past, 78 were related to launch problems, which could have been avoided with the more reliable shuttle vehicle. Of the remaining 53, the spacecraft were inoperable or erratic and could have been returned to Earth for further work if the Shuttle were available.

An example of the usefulness of the Shuttle is in the Orbiting Astronomical Observatory program (OAO) where millions of dollars could have been saved by using the Shuttle's operational flexibility. A battery charger failure of OAO 1 could have been corrected by returning it to Earth. The shroud jettison problem that prevented OAO 3 from attaining orbit could have been avoided if it had been launched from a Shuttle.

MANNED SPACE FLIGHT BUDGET PLAN
Principal Programs
(In Thousands)

	FY 1972	FY 1973	FY 1974
SPACE SHUTTLE	$100,000	$200,000	$475,000
SKYLAB	538,500	502,000	233,800
APOLLO-SOYUZ TEST PROJECT	6,900	38,500	90,000
APOLLO	601,200	76,700	.....

I am proud that on my motion the AFL-CIO Executive Council last year adopted a statement backing the Space Shuttle.

The Council said: "The benefits of next generation space applications in such fields as the management of natural resources, monitoring of pollution, weather modification and climate control, television distribution, earthquake prediction and public health and safety will not be fully realized unless we can reduce costs and raise efficiency and acquire a flexibility of action not yet possible. That is what the space shuttle is for. Without it, we will lose many valuable programs."

The Council concluded: "We can no more ignore space than we can ignore the oceans or the continents. We would not have the free world without ships, without aircraft or without land mobility. We cannot envision a secure, technologically advanced western world without technologies that allow us the freedom of space as well."

The statement was valid then. It is even more valid today as the Shuttle moves toward operational readiness.

AEROSPACE INDUSTRIES ASSOCIATION
1725 De Sales St., N.W., Washington, D. C. 20036

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Floyd E. Smith, President of the International Association of Machinists and Aerospace Workers, discusses the future of space flight in *Man In Space: A Look Forward.* Page 12.

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OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • JUNE 1973

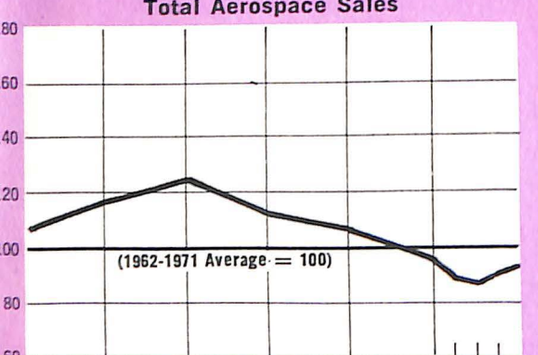
LE FETE AERIENNE

-THE COMPETITIVE CHALLENGE

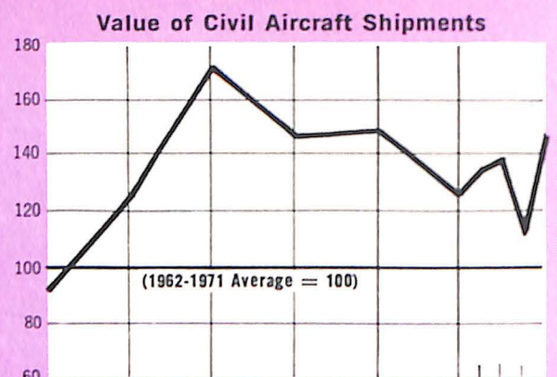
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

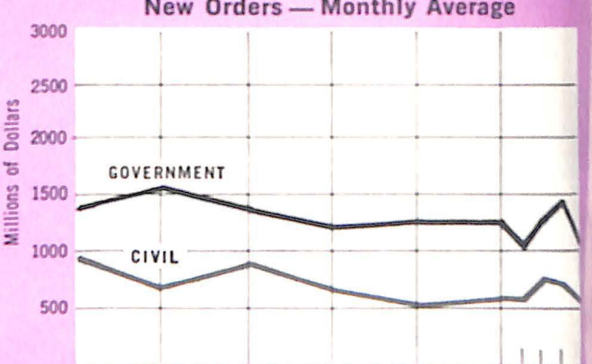


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1962-1971 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	23.5	4th Quarter 1972	21.6	21.0	21.3
	Billion $	Quarterly	5.9		5.2	5.4	5.6
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,240	Dec. 1972	1,565	914	1,045
Aircraft	Million $	Monthly	733	Dec. 1972	900	485	657
Missiles & Space	Million $	Monthly	507	Dec. 1972	665	429	388
Aerospace outlays: Total	Million $	Monthly	1,147	Dec. 1972	1,120	1,094	969
Aircraft	Million $	Monthly	665	Dec. 1972	681	596	531
Missiles & Space	Million $	Monthly	482	Dec. 1972	439	498	438
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,057	Mar. 1973	1,199	625	1,225
Aircraft	Million $	Monthly	631	Mar. 1973	726	328	721
Missiles & Space	Million $	Monthly	426	Mar. 1973	473	297	504
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	270	Mar. 1973	287	227	289
Expenditures	Million $	Monthly	277	Mar. 1973	315	244	302
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	22.7	4th	24.6	26.6	26.9
U.S. Government	Billion $	Quarterly	13.6	Quarter	14.0	15.2	15.2
Nongovernment	Billion $	Quarterly	9.1	1972	10.6	11.4	11.7
EXPORTS							
Total (Including military)	Million $	Monthly	204	Mar. 1973	493	358	569
New Commercial Transports	Million $	Monthly	59	Mar. 1973	252	140	275
PROFITS				4th			
Aerospace — Based on Sales	Percent	Quarterly	2.6	Quarter	1.4	2.3	2.3
All Manufacturing — Based on Sales	Percent	Quarterly	4.9	1972	4.1	4.2	4.4
EMPLOYMENT: Total	Thousands	Monthly	1,286	Feb. 1973	924	944	941
Aircraft	Thousands	Monthly	699	Feb. 1973	508	512	511
Missiles & Space	Thousands	Monthly	144	Feb. 1973	89	94	94
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.48	Feb. 1973	4.54	4.83	4.87

* 1962-1971 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

TOWARD IMPROVING A CRITICAL RELATIONSHIP

By KARL G. HARR, JR.,
President, Aerospace Industries Association

Long before the term "consumerism" became commonplace, the great majority of business managers believed strongly in the doctrine that there is nothing to be gained by "picking on the customer." You just didn't do it.

Last month this association assumed a risk that its release of a report pointing out that government was a "monopsony" could be interpreted as an indiscreet jab at the industry's long-time major customer. To the contrary, the reaction to date indicates general understanding of our purpose in commissioning the study: to make a constructive contribution to a more informed public discussion of the government-industry relationship and to the effort to make that relationship better serve the interests of the nation, the government and the industries concerned.

Readers of *Aerospace* need not seek out a dictionary to learn the meaning of monopsony. Because of the interest generated by our report, "Monopsony—A Fundamental Problem in Government Procurement," we are presenting a summary of its findings and recommendations in this issue.

The aerospace industry has long been concerned that widespread lack of understanding of the nature and complexity of what is termed "the government procurement process" has, on many occasions, led to searches for villains or for simplistic solutions to procurement problems. Essentially, the monopsony study neither "picks on the customer" nor identifies villains, but rather points out how both industry and government have over time become victims of the procurement process itself.

Due to the current interest in the process stemming from an extensive report released earlier this year by the Commission on Government Procurement, hopefully the principles and policies affecting the government-industry relationship can be improved to the nation's benefit.

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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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LE FETE AERIENNE
-THE COMPETITIVE CHALLENGE

By JERRY HANNIFIN
Washington Correspondent, TIME, Inc.

"There is nothing unfriendly in this, but I fail to see how we're going to allow the United States to produce ninety percent of European commercial airplanes . . ."

British Airways Chairman David Nicolson, at the International Aviation Club, Washington, D.C.

The challenge conveyed in Chairman Nicolson's statement reflects the mood of the 30th International Paris Air Show at Le Bourget. At this most significant of all world aerospace shows, it was plain that U.S. preeminence is being challenged by the newly-strong, technologically-competent, and government-backed aerospace industries of Western Europe and also the Soviet Union.

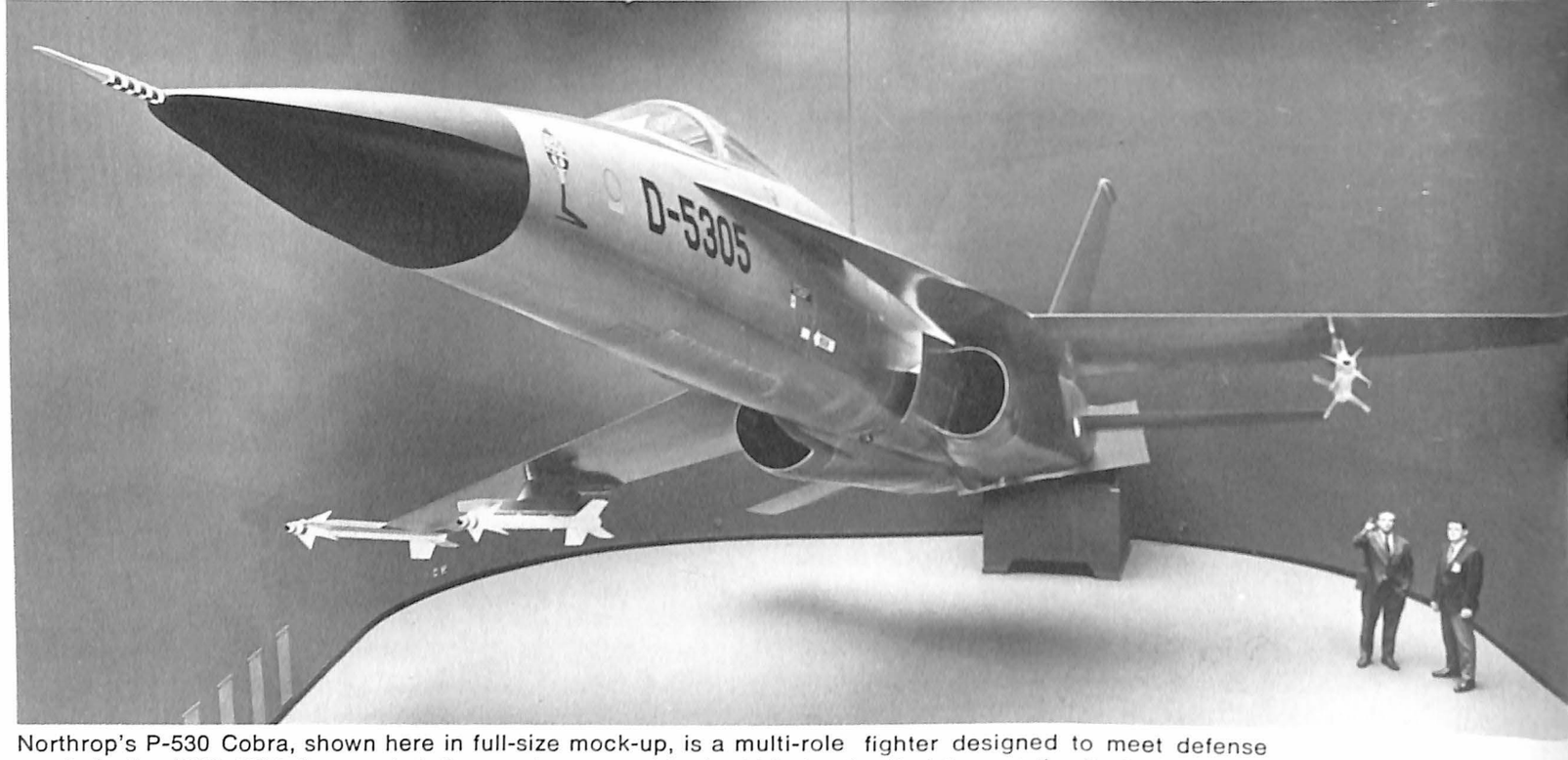
It was the biggest show ever, with more than 700 exhibitors from 19 countries, including Australia, a newcomer at Paris demonstrating a target/reconnaisance drone with RPV (Remotely Piloted Vehicle) potential. Almost one million people, including aerodynamicists, airline presidents and aerospace marketing experts from around the world—also thousands of French family groups, nibbling ice cream cones and standing in line for hours for a brief glimpse inside the Anglo-French Concorde SST—visited the greatest *fete aerienne* of them all.

They also saw a wide variety of new civil aircraft offered by the West Europeans and the Russians, including two supersonic transports, the world's first twin-jet air bus and various military aircraft, and the dazzling new U.S. Grumman F-14, publicly demonstrated for the first time. U.S. Secretary of the Navy John W. Warner remarked after the F-14 zoomed from the runway straight up out of sight: "That, for me, is the greatest event at this show . . ."

But the U.S. plane-makers did not have a single new commercial aircraft design to sell. In fact, the newest major U.S.-made commercial aircraft on display at Le Bourget were the familiar McDonnell Douglas DC-10, and the Lockheed L-1011, both first shown at Paris in 1971. A Boeing 747C in World Airways livery also was on display briefly, and helped to enhance the relatively thin U.S. presence. But unfortunately, the U.S. is neither building nor planning firmly to build the kind of airplanes that the West Europeans and the Soviets already are offering for sale.

What has happened to the U.S. will? Scandinavian Airlines President Knut Hagrup, a Le Bourget visitor, commented: "U.S. commercial jet transports have dominated the world not by accident, but because your aircraft proved worthy in the marketplace. Airlines bought them because they are the best." He should know. SAS has bought $620 million of U.S.-built jets, and that's about three times as much in dollars as SAS has sold the U.S. traveler in services since 1959.

A profound change is shaping in the world market for commercial aircraft, and for aerospace products of



Northrop's P-530 Cobra, shown here in full-size mock-up, is a multi-role fighter designed to meet defense needs in the 1980-2000 time period. It was shown outside the U.S. for the first time at the Paris Air Show.

Senator Barry Goldwater, Personal Representative of the President at the 30th Paris Air Show, stated in his report: ". . . Mr. President, I think we in America have to wake up to the fact that the Europeans intend, not just to catch up, but to replace us as the world leader in aeronautics and everything associated with the field. Our industry must realize that it no longer dominates as it did before the ridiculous decision to stop the SST. I think we must also realize that growth and advancements in the general fields of aeronautics, particularly in the medium of heavier aircraft, will have to be done with an eye on international cooperation and also with the possible, although not needed now, across the board support of the Federal Government in the encouragement of constantly advancing technology."

all sorts. Hot international rivalry is in the works. An aggressive new phase in aerospace marketing is emerging. The 1973 Paris Air Show confirmed a tidal shift in world competition for civil and military equipment.

"Patterns change," said Hagrup. "The competition U.S. plane-makers now face from other plane-makers is complex and intense. In some cases, the competition is now ahead of the U.S. Other nations are *flying* planes for the 1980 markets . . ."

To be sure, there has been a tradition of token competition among the West Europeans in commercial airplane design and manufacture since the end of World War II. The Russians, however, almost universally in the West, simply have been ignored.

Until the advent of the European-designed SST, the Airbus Industries' twin-jet A300B and the new Marcel Dassault short-haul jet Mercure, U.S. plane-makers always have led in introduction of the new product, or they have been able to leap ahead to capture the market with improvements, as Boeing and McDonnell Douglas seized the international jet transport market after the U.K.'s bold but ill-fated venture with Comet I.

"We were first, once, starting with Lindbergh, but we may be running out of steam. We've got nothing new on the drawing boards after the wide-bodied jets," Senator Howard Cannon, Senate Aviation Subcommittee Chairman, commented recently. "Consider that the Anglo-French SST Concorde program well may be a set-back for the U.S. aerospace industry in the long run . . ."

Surely, the members of the British Aircraft Corporation-Aerospatiale consortium, builders of the West's only SST, are to be admired for their courage and achievement with the Concorde, a technologically superb but economically marginal machine. "The Concorde is not a matter of pride with us, please understand," Aerospatiale President Henri Ziegler said at Le Bourget. "Concorde is a matter of business. We have persisted, and we shall persist. That's business . . ."

In business, it may be observed, indifference to marketplace realities is limned with extreme hazard. A hardy corps of senior U.S. aerospace companies alone has borne responsibility for the American presence at the Paris Air Show for more than a decade. At recent shows the U.S. Department of Commerce has lent its support at the still relatively new U.S. Pavilion with enormous success. In fact, Paris Show visitors literally have fought their way into the crowded U.S. Pavilion on public days to see the Lindbergh New York-to-Paris Ryan airplane model, and the U.S. NASA Apollo capsule. This year, the U.S. celebrated 70 years of manned flight in a "Kitty Hawk To Space" exhibit, and the display areas were crowded, as usual, with enthusiastic and curious French children learning about William Boeing, Igor Sikorsky and Glenn Martin—and also buyers from Europe and around the world. U.S. Pavilion officials estimate that upwards of $100 million in prime or secondary orders will result from the 1973 Pavilion displays (up from $56.6 million in 1971), ranging from sales of Aviatech Company's flight simulators for single and light twin engine aircraft, to Boeing's new airport administration subsidiary.

The U.S. display also honored the Brazilian air pio-

United Aircraft's exhibit at the Paris Air Show, along with its turbine engines, featured its rocketry and flight systems.

General Electric CF6-50 engines, rated at 50,000 pounds of thrust, have been shipped for use in the McDonnell Douglas DC-10 Series 30 aircraft, Airbus Industries A300B and the Boeing 747-300.

neer, Santos-Dumont, born in 1873, whose Paris flights in his fragile 14-Bis monoplane made aviation history.

In terms of long-range significance for the U.S. aerospace industry, the 1973 Paris Show may have signaled a moment of historic change, a technological crossroads. Meaningful shifts in international marketing style, and also in conceptual modes of international joint effort clearly were in evidence at Le Bourget. The question which now rises and broods is whether the U.S. aerospace industry will respond to the extraordinary opportunities discernible on the international horizon. Furthermore, U.S. Government attitudes and responses are, at best definition, quite ambiguous in a trade area of national significance. Fortunately, there already are signs that individual U.S. aerospace industry leaders have analyzed positively the new opportunities and are prepared to engage the new international market and production potential so dramatically in evidence at Paris.

Boeing Company Chairman Emeritus William Allen, widely admired for his internationalist views, spoke for a major segment of the U.S. aerospace industry when he urged the elimination of tariff barriers on aerospace goods in international trade, and also recommended a free and open transfer of technology on a "two-way street . . ." In substance, aerospace industry leader Allen was addressing himself to the reality made plain at Le Bourget. The Western Europeans indeed already have benefitted from access to advanced U.S. technology, but the Europeans themselves also have made major contributions which amount to breakthroughs in aerospace technology, including Sir Frank Whittle's revolutionary jet engine itself, as well as the helicopter and the swept wing. Allen's summons to the U.S. aerospace industry is that its horizon will expand only in direct proportion to its willingness to keep future foreign markets open by cooperation, including joint ventures with foreign companies.

Northrop Corporation's President Thomas V. Jones also is in concurrence with Allen's philosophy. At Paris, where Northrop revealed a full-scale mockup of its proposed new P-530 Cobra fighter-interceptor for the European market, Jones said: "We would prefer to make our U.S. technology available to the world, to apply those technologies to the needs and purposes of others—in socio-economic, political and human factors. We are not just U.S. hardware salesmen. It is the U.S. style, as a country, to run an open race. It also has been U.S. policy to help make these nations strong, to assist them in providing for their own defense. It is my belief that the U.S. must emphasize its R&D in advanced technology in order to obtain a continuing flowback in orders from abroad. Meanwhile, we shall remain independent ourselves as the world moves toward independence . . ."

The competitive world mode confirmed in substantial evidence at Le Bourget this year virtually will require U.S. aerospace prime contractors to become international, along the lines of Boeing and Northrop. Northrop has internationalized the Cobra program by developing the aircraft along common requirements and specifications of various nations. The participating countries would then participate in production of the aircraft in proportion to their orders.

The Boeing Company is swiftly diversifying, bridging aerospace to inner-city systems management projects, and agri-business, and also is engaged as shareholder, partner or in licensing joint efforts around the world—in Japan, with the Messerschmitt-Boelkow-Blum group of West Germany, and with Italy's Aeritalia. In Italy, Boeing is engaged in the joint design and construction of a revolutionary "7X7" twin-jet RTOL—a reduced takeoff and landing aircraft, using new engine and air foil lift technology. Later models of the "7X7" would include long-range aircraft, but all of the new series would use a new engine, the European designated "dix tonne," or ten-ton thrust (20,000 pounds) turbofan. Although the proposed engine is still called the "ten tonner," its thrust growth already is projected in the 40,000 pound class.

Significantly at Paris, the Pratt & Whitney Aircraft Division of United Aircraft Corporation announced that a group of international engine makers, including Germany's MTU—Motoren-und Turbinen-Union—and Italy's Fiat-Alfa Romeo group had initiated an agreement to build the JT10D, a 25-30,000 pound thrust class turbofan. The new P&W design would incorporate the latest improvements in engine noise control and exhaust emission technology. The JT10D would be a candidate engine for the new Boeing "7X7" series, as well as other new commercial aircraft in Europe and in the U.S.A.

P&W President Bruce N. Torell commented: "We believe the JT10D agreement to be a significant move toward improving the U.S. international trade posture. The world is being restructured, and out of this will emerge new and different approaches in the social, political and business spheres in terms of international cooperation. The complexion of the international marketplace is changing, and to compete successfully in this new trade world, American companies must form new business alliances . . ."

In the judgment of senior Paris Show observers, the JT10D engine—on display in full scale mock-up—and the Pratt & Whitney Aircraft announcement acknowledging a further move toward internationalization was the most significant U.S.-connected event at the Paris Show. "This new engine will bring added vitality to the Western European aerospace industry," Aerospatiale's Ziegler commented.

The P&W Aircraft announcement also confirms a rising level of effort now underway quietly in Europe's international jet engine market. In essence, the western world, aircraft engine makers have initiated technological exchange at an advanced level, principally under licensing arrangements. P&W already is a partner in SNECMA, the French government-aligned engine maker, and General Electric has been granted permission by the U.S. government to transfer certain company-developed combustion technology of the F101 engine (designed for the U.S. supersonic B-1 bomber being built by Rockwell International) to France's SNECMA.

The U.S. approval of transfer of this advanced technology means that General Electric and French SNECMA will be partners ostensibly in competition for the new turbofan engine in the Boeing-Aeritalia "7X7", among other advanced aircraft designs. Significantly, the U.S. Administration approval was announced at Paris.

Top officers of the U.K.'s Rolls Royce engine company also recently visited GE in the United States to discuss possible licensing and joint parts manufacturing possibilities. The Rolls proposals are now under study at GE.

In summary, a new dimension of international cooperation in commercial jet engine design and production is visible, with the two U.S. giants, GE and Pratt & Whitney, moving toward technological sharing and partnership in fact with the West European majors, Rolls Royce, SNECMA, Germany's MTU, and Italy's emerging Fiat-Alpha Romeo.

Reported *Aviation Week & Space Technology* Editor-in-Chief Robert B. Hotz in an editorial: "The name of the U.S. export game is changing. Customers no longer want just hardware or licenses. In most cases they want advanced technology, technical training of their own nationals and some management expertise . . . The joint ventures of Boeing with Italy and Japan, the Pratt & Whitney Aircraft JT10D consortium proposal and the Northrop Cobra development offer clues as to trends that should prove successful in the new climate . . ."

It is going to be very difficult to sell U.S. military aerospace hardware in Europe in the time ahead—unless U.S. engine and plane-makers are willing to collaborate intensively with the new and still-forming European consortia. A pertinent example, as announced at the Le Bourget Show: Westland Aircraft Ltd. of the U.K., and France's Aerospatiale have formed a jointly owned company called Heli-Industries, Ltd., registered in England, but with headquarters in Paris. A major mission: to promote European rotary winged aircraft throughout the world, increasing the "competitiveness" of the European helicopter industry. Plainly, the Europeans feel very confident indeed that they can and will fill their own requirements, and are now prepared to challenge the U.S. aerospace industry, in copters, or whatever, anywhere in the world.

In addition, Western Europeans are taking a more active role in the U.S. space program. Last year, NASA launched 12 West European space probes, and the West Europeans, in consortium, are expected to build "Spacelab," a large satellite that will be launched in 1979.

At Paris, for the first time, a full-scale mock-up of the U.S.-Soviet Apollo-Soyuz was displayed under a huge, white, geodesic dome, and was one of the "showstoppers," with both U.S. astronauts and Soviet cosmonauts appearing regularly at press conferences and mingling informally with the visitors, answering questions in English, French, Russian, German, Spanish and Italian. Translations of other languages were available upon demand.

The 1973 shows at Le Bourget also was notable for the appearance of a maturing new breed of Soviet technician-businessman-sales expert, marching in echelon with black saddle-leather briefcases stuffed with aircraft data, specs—and open contracts. The "New Russians" at the Le Bourget show also were smiling, friendly and out-going, hospitable in the Soviet chalet (No. 1 on the flightline), and cordial in relations with their neighbors in adjacent chalets—the Boeing Company, and also I.A.I., the Israel Aircraft Industries. In fact a Russian sales team from Aviaexport (the Soviet Government's aerospace sales monopoly) called on the Israeli chalet with bottles of vodka and jars of caviar to the delight and also the bafflement of the Israels. The I.A.I. bartender immediately began mixing the gift vodka in "screwdrivers", using Jaffa orange juice.

The Soviets at Aviaexport have used the Paris show not only to assess and regularly copy certain western technology, but also as a training ground for the Aviaexport sales teams. After eight years since the first Soviet formal appearance at the Paris show (1965), the Soviets obviously feel confident and competent enough to challenge anybody.

The significant new Soviet and European aircraft types at Paris:

• Tupolov Design Bureau's new TU-144, a radically redesigned and stretched production version of the original Russian supersonic transport. The 1973 version of the Soviet SST, in the judgment of qualified Western observers is a "very impressive machine . . ." The TU-144 will be the world's first SST to enter scheduled service, probably at the end of 1974, flying a trans-Siberian route within the Soviet Union.

The Soviets also have redesigned the cabin interior of the new TU-144, eliminating the "tube" effect that some customers don't like about the Concorde. The Soviets have split the long, 140-seat cabin into three sections to break up the "tube," using a gold, red and gray color scheme.

• European Airbus Industries' A300B, the first wide-bodied twin-jet transport designed to operate from shorter runways at urban area airports, using General Electric CF-6 turbofans.

• VFW-Fokker's 614, a West German twin-jet with engines mounted on pods over wing, designed for clean, quiet operation from close-in urban area airports.

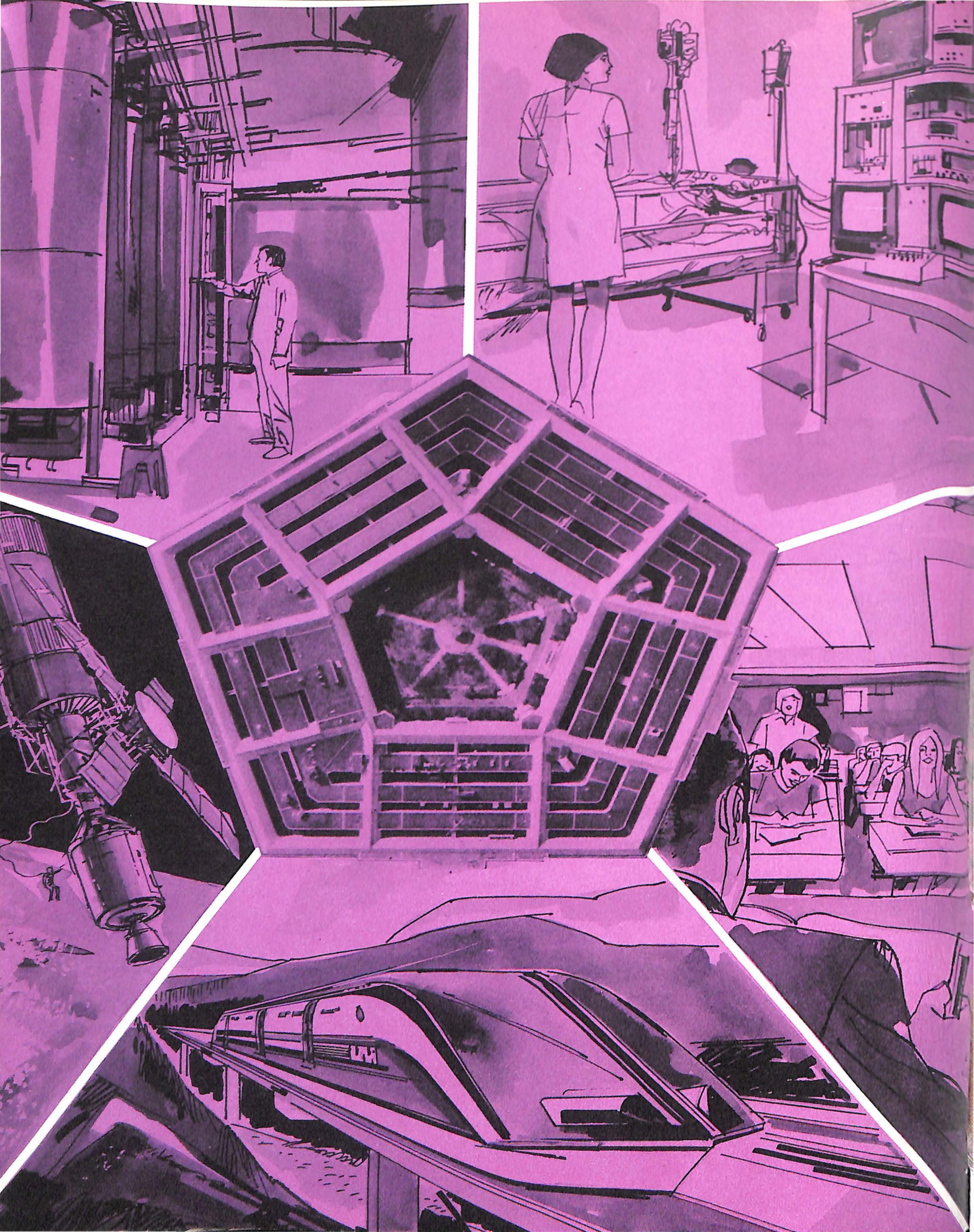
• Concorde, the Anglo-French SST, was shown at Paris in production model, flying a demonstration flight daily from Le Bourget. Henri Ziegler is betting that Western airlines will rush to place orders after the SST Concordes of Air France and British Airways begin to cut the flying time across the Atlantic by half. "Every day that we fly a demonstration group of about 30 persons, we acquire about 30 more enthusiastic advocates for supersonic flight," said Ziegler.

With the appearance at Paris of the new Soviet TU-144, and the production version of the Concorde, various western airline officers who as recently as this spring were immensely skeptical of commercial supersonic flight in the west during the 1970's, now have begun to revise judgment. Perhaps significantly, senior level talks between executives of U.S. Rockwell International, Aerospatiale and the British Aircraft Corporation already are underway concerning possible collaboration in production of an advanced model Concorde SST, a larger, and longer-range version.

The United States has an enormous stake in maintaining its share of the aerospace market, both at home and abroad. Aerospace is still the single largest U.S. manufacturing employer, and during the last eight years, the American industry has sold $136 billion worth of aircraft and engines at home and abroad. During the next ten years, total aircraft purchases in the world are expected to amount to $150 billion. The U.S. can hope that its wide-bodied jets, the Boeing 747, the McDonnell Douglas DC-10 and the Lockheed L-1011 will account for about half that amount. But at the moment there is no U.S. SST on the horizon. Meanwhile, both the U.S. Congress and the U.S. aerospace industry still are suffering intimidation from anti-technologists and environmentalist crusaders.

The U.S., nevertheless, will have to build new airplanes to compete if indeed the U.S. still has the will to compete. A White House analysis warns that U.S. failure to retain its leadership in the aerospace industry could have disastrous effects on the nation's economy. By 1976, the White House report estimates, the U.S. could lose its favorable trade balance in aircraft sales, and by 1985 the deficit could grow to as much as $6 billion annually. By that time, of course, the U.S. would be buying airplanes from Europe and the Soviet Union.

The Boeing 747C, with its nose up for cargo-loading operations, was displayed at the Paris Air Show. Two men can fully load or unload this entire main deck in one hour.



MONOPSONY

A Fundamental Problem in Government Procurement

"Monopsony" may never become a household word, but it is gaining currency in discussions of Government-industry relationships as a result of the latest report released by the Aerospace Research Center of the Aerospace Industries Association.

"Monopsony" is the opposite of monopoly. It is the term economists use to describe the domination of the market by a single buyer.

The new report, "Monopsony—A Fundamental Problem in Government Procurement," zeros in on the lopsided character of the Government-industry relationship as the central flaw in the procurement process, and recommends ways of bringing it into better balance for the benefit of Government, industry and the country.

The report was prepared for the research arm of AIA by The Orkand Corporation, headed by Dr. Donald S. Orkand, well-known economist, specialist in operations research and in the design of planning and management systems.

"The Government can, by virtue of its monopsony power, force industry to accept terms and conditions that differ significantly from those that would result in a free market in which the powers of the buyer and seller were more evenly balanced." That, the report concludes, is the central problem that underlies the various issues and abuses involved in the present procurement process. The remedy recommended by the Research Center is that Congress establish an independent Government Procurement Practices Board charged with the mission of overhauling and overseeing the procurement process on the basis of one overriding criterion: *that the conditions and outcomes of the procurement process should, to the fullest extent feasible, be those that would result in a free market in which the powers of the buyer and seller were more evenly balanced.*

The importance — and the urgency — of reform, the report emphasizes, is underscored by the fact that the government as a buyer of goods and services is moving more and more into the domestic market and beginning to exert its monopsony power in such areas as mass transit, health, education and environmental protection according to the patterns and precedents set in the Defense and Space fields.

The report points out that those patterns and precedents have served nobody well.

There seem to be more and more complaints from experts and non-experts alike in government about schedule slippages, technical failures and cost overruns. These complaints are matched by industry complaints about changing requirements, excessive regulation, inequitable procurement practices and unacceptably low profits. And while government and industry have pointed accusatory fingers at each other, the reaction of a confused and generally unsophisticated public has been a "plague on both their houses," reflecting a suspicion that somehow government officials and private industry are misallocating and mismanaging scarce public resources.

But the problem is that neither party is the villain. Rather, both are, in different ways, victims of the procurement process itself. This process often, and almost inevitably, results in bad bargains for everybody concerned. The process is characterized by:

- A product line determined by the Government customer and subject to severe and sudden shifts in requirements and program levels.
- A product line continually pressing upon the frontiers of technology and thus entailing an unusually high degree of uncertainty and risk.
- Single programs of high funding levels, high unit value items and relatively small production runs.
- Exceptionally long lead-times in bringing products and programs to eventual completion.
- Lack of a commercial market for most of the industry's products.
- A procurement process that has developed in piecemeal fashion without regard to its overall impact.

After briefly describing the theoretical workings of the free market mechanisms under "pure" or "perfect" competitive conditions, and the familiar deviation of monopoly, the report examines in some detail the unfamiliar condition of monopsony and, in particular, the role of the Federal Government as monopsonist. It traces the monopsonistic power of government to three complementary sources:

1. The government's ability to dominate the market through the sheer volume of its purchases and the uniqueness of the products and services it seeks.

2. Its ability to dominate the market through procedural and regulatory powers that the industries involved do not possess.

3. The inability of government-oriented firms to leave the government market for freer and more profitable ones.

Since the start of the Sixties, government purchases in aerospace have ranged from 20 to 30 percent of total national defense and space expenditures and have constituted as much as 92 percent of industry sales in the case of some individual firms. This power that the government exerts in the economy as a whole, and in the defense and space sectors in particular, is reinforced by the vast regulatory and procedural powers that the government exclusively possesses. The Armed Services Procurement Act of 1947 and the Federal Property and Administrative Service Act of 1949 are the two basic statutes that set out, in broad terms, the policies and principles governing federal contracts. These overall policies and principles have, over the years, been implemented and supplemented by an ever-growing col-

lection of regulations and provisions, many of which have the force of law when cited in a contract. Government procurement contracts are literally filled with "boilerplate" — a variety of standard provisions that are required by statute or regulation to be included in public contracts and which impose terms that other parties would be unlikely to accept under more normal market conditions.

The standard "changes" clause that permits the government to order certain unilateral changes within the scope of the contract, and the "termination for convenience" provision that lets the government cancel the contract through no fault of the contractor and thus deny him expected profits, are two examples of government power to unilaterally alter or end a contract, not by virtue of the provisions of basic statutes, but by employing regulations and procedural rules that purport to carry out the purposes and principles expressed in those statutes.

The ultimate monopsonistic advantage that the government exerts upon government-oriented firms is the fact that if these firms cannot love the government market, they cannot freely leave it. In fact, the very characteristics of these firms that constitute strengths in the government marketplace — their extreme specialization of both technical and productive resources, as well as marketing and managerial skills — render it difficult for them to compete in other markets. In the words of the report:

> "Firms cannot . . . leave government markets without dissipating the human and physical resources that will be needed to re-enter the market. Further, it is doubtful that the dissipation of these resources is consistent with long-term national interests. The solution, therefore, must lie in reducing the negative impacts arising from the government exercise of monopsony power."

Industry, as a result, accepts contracts whose terms are almost entirely dictated by the government. Neither industry nor government benefits from this process, whose adverse consequences are extensive and severe.

The procedures, for example, by which the government selects major systems contractors customarily require enormous detail and extensive revisions of proposals at considerable cost in time and money to both government and industry.

Under these conditions, it is no surprise that there should arise such practices as: the *"reverse auction,"* in which the procuring agency conducts successive rounds of negotiations with contractors who are all considered as within competitive range; and *"buying-in,"* in which a firm seeks to secure a contract by knowingly offering a price less than anticipated costs in the expectation of either:

1) increasing a contract price or estimated cost during the period of performance through change orders or other means or,

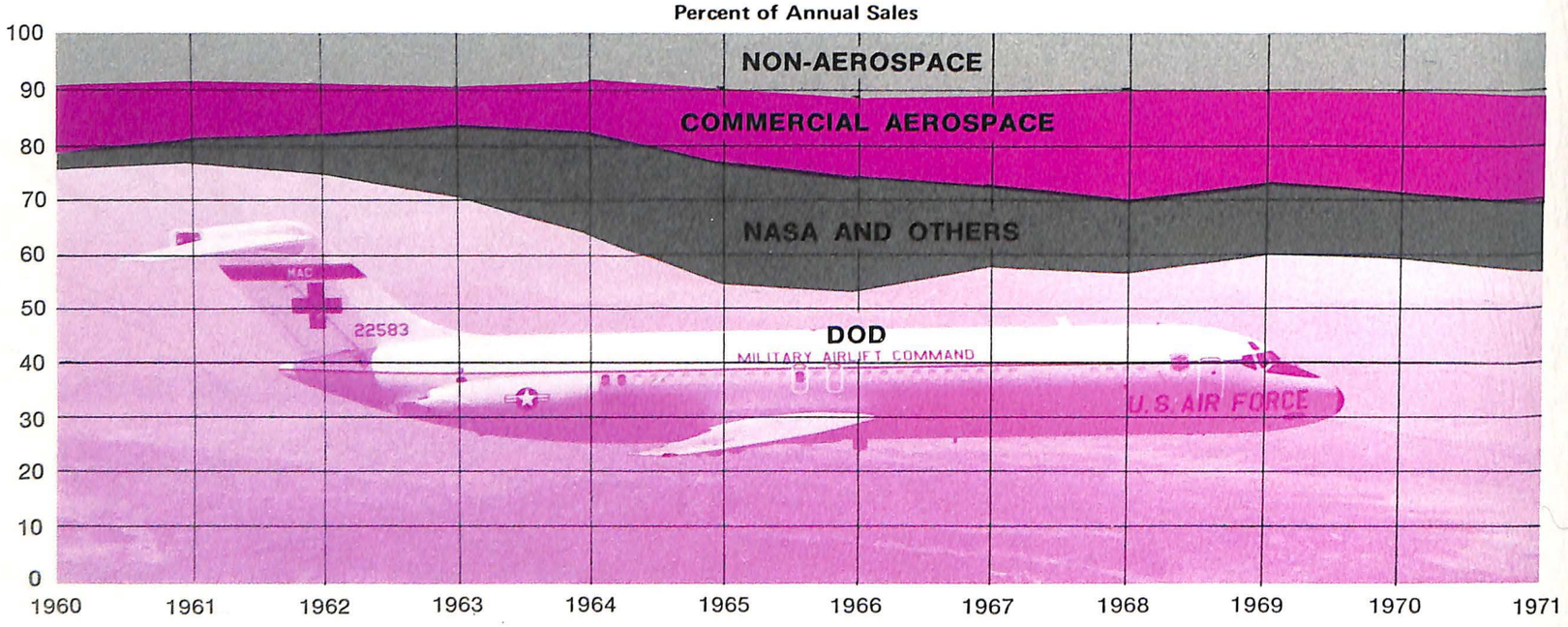
2) receiving future follow-on contracts at prices high enough to recover any losses on the original "buy-in" contract. This latter practice may well be forced upon a firm if it cannot expect to maintain its work force and survive over the short term unless it receives the particular contract.

Through such practices as forced cost sharing, cost disallowance and renegotiation the government cuts prices and profits and inhibits industry's ability fully and effectively to employ its innovative and technological resources on behalf of government programs. Current government statutes, practices and regulations arbitrarily designate certain necessary costs of doing business as unallowable or non-recoverable in government contracts — including such normal business expenses as interest, charitable contributions and most types of advertising.

The renegotiation principles now in effect originated early in World War II as a move to prevent profiteers from taking advantage of the national emergency to make excessive profits on government contracts. In the years since, significant changes have occurred in procurement policies — including the statutory requirements imposed by the "Truth in Negotiations" Act (PL 87-653) — that in large measure preclude the possibility of unwarranted or excessive profits. Yet the Renegotiation Board continues to require the return of

PERCENTAGE DISTRIBUTION OF AEROSPACE INDUSTRY SALES

Percent of Annual Sales



profits it deems "unreasonable" on grounds contractors often regard as vague, subjective and inconsistent. It may even recapture profits earned on fixed price and incentive contracts despite the fact that these contracts are expressly designed to reward superior performance.

Finally, government contracts entail such excessive reporting requirements and restrictions on management decision-making that management finds itself without the freedom and flexibility it must have to allocate and employ its resources most effectively and efficiently.

These are simply some of the restrictions and requirements regularly included in government contracts. These provisions have no counterpart in the private sector, and no contractor would agree to them were government contracts negotiated under normal market conditions.

These practices have, inevitably, affected the health of the aerospace industry, whose level of profits in the government market consistently is considerably lower than in the commercial market. A GAO study of the profits of 74 large DOD contractors during the 1966-69 period showed that, as a percent of sales after taxes, their average profits for DOD work were *less than half* the average profits for comparable commercial work — and that, as a percent of total capital investment, their average DOD profits were almost 3 percent less than their average commercial gains. These low-profit levels are reflected in the significantly greater difficulties experienced by the aerospace industry, as compared to other manufacturing industries, in attracting equity capital investments.

In less obvious, but equally serious ways, the government also suffers under the present procurement process.

In both the long and the short run, its costs are increased and the effectiveness of its program is impaired by excessive proposal requirements, unnecessary management systems, restrictions on management flexibility, and by the prevalence of low profit rates in government markets that — while they may appear to produce short-term savings — have the effect, over time, of dissipating the technical managerial capability required to help meet increasingly complex and critical national needs.

In short, government, through the abuse of its monopsony power:

- *Denies management the flexibility it needs to use its technical resources effectively,*
- *Fails to provide the profit levels required to support a strong technological capability,*
- *Offers little incentive for the allocation of private technological resources to public sector problems.*

The report concludes that only a fundamental reform of current policies and practices in government-dominated markets can assure that public problems and needs will continue to call forth from the private sector the essential managerial, technical and productive resources. It offers a five-point program for such reform:

1. Congress should act to establish a Government Procurement Practices Board (GPPB) charged with the responsibility for limiting the use of governmental power through the implementation of the functions and principles defined in this program.

2. The GPPB should conduct a continuing review of current and proposed procurement policies, regulations and practices on its own initiative and on appeal from industry.

3. The basic criterion that should govern the procurement process, and the actions and approvals of the GPPB should be the conditions and outcomes that would result under balanced free market conditions.

4. Exceptions to the "free market test" criterion should be minimal and should require extraordinary justification.

5. The GPPB should formulate a set of procurement principles, in support of the above concepts, that can be submitted to Congress and enacted into law.

The program recommended by this report is deliberately broad in scope.

The particular mechanism it recommends is not nearly as important as are the essential basic principles — principles that *must* underlie any effective reform of a procurement process that now does not serve Government, or industry or the country well.

FEDERAL OUTLAYS FOR SELECTED FUNCTIONS AND FOR AEROSPACE PRODUCTS AND SERVICES

Fiscal Years, 1948 to Date
($ Millions)

Year Ending June 30	Total National Defense	Total NASA	Federal Outlays for Aerospace Products and Services	Aerospace as Percent of Total National Defense and NASA
1948	$11,983	N.A.	$ 891	7.4%
1949	13,988	N.A.	1,474	10.5
1950	13,009	N.A.	2,130	16.4
1951	22,444	N.A.	2,878	12.8
1952	45,963	N.A.	6,075	13.2
1953	50,442	$ 79	9,204	18.2
1954	46,986	90	11,194	23.8
1955	40,695	74	10,470	25.7
1956	40,723	71	10,544	25.8
1957	43,368	76	12,506	28.8
1958	44,234	89	13,160	29.7
1959	46,483	145	13,330	28.6
1960	45,691	401	13,269	28.8
1961	47,494	744	13,866	28.7
1962	51,103	1,257	15,295	29.2
1963	52,755	2,552	16,214	29.3
1964	54,181	4,171	17,940	30.7
1965	50,163	5,093	15,697	28.4
1966	57,718	5,933	17,771	27.9
1967	70,095	5,426	20,193	26.7
1968	80,516	4,724	21,353	25.1
1969	81,240	4,251	20,472	23.9
1970	80,295	3,753	18,747	22.3
1971	77,661	3,382	17,335	21.4
1972	78,336	3,421	17,061	20.9
1973[E]	76,435	3,061	16,156	20.3
1974[E]	81,074	3,135	16,410	19.5

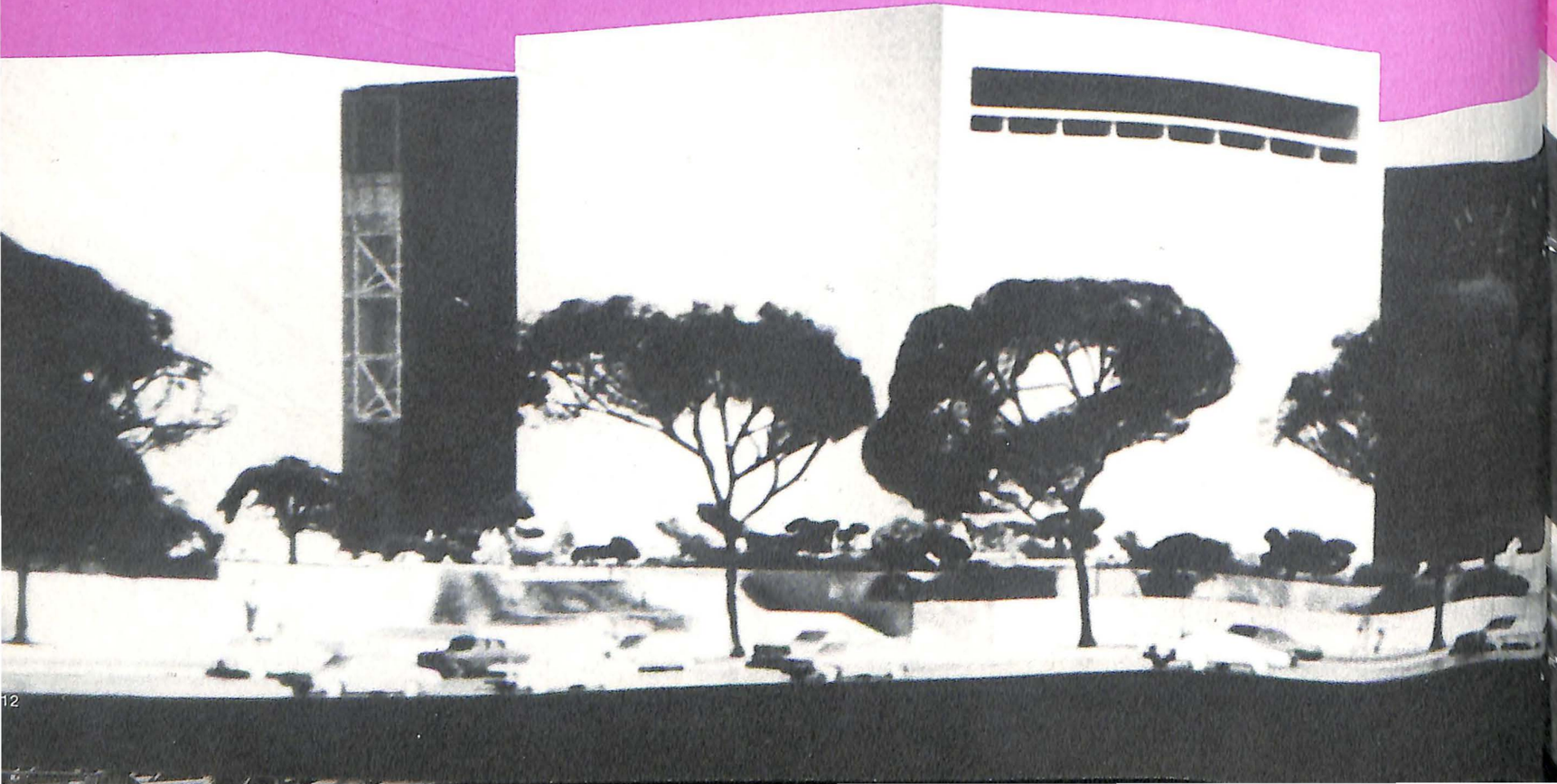
To most Americans, the Smithsonian Institution means the old red, castle-like buildings on the South side of the Mall in Washington — the nation's attic, where one might find the Hope Diamond or Lindbergh's "Spirit of St. Louis." Today, however, the Smithsonian is a growing complex of museums and research facilities spread literally around the world.

On the Mall itself, the changing character of the Institution is nowhere more evident than between 4th and 7th St., S.W., directly across the street from the headquarters of the National Aeronautics and Space Administration, where the new National Air and Space Museum is rapidly rising out of a three-block-long hole in the ground.

A modern building with modern ideas, this new National Air and Space Museum is not as young as one might imagine. In fact, its charter dates back to 1946, when the late General H. H. Arnold, Army Air Corps, convinced Senator (then Congressman) Jennings Randolph, of West Virginia, that a systematic approach should be taken to preserving and displaying historic airplanes. The result was Public Law 722 of August 12, 1946, establishing a National Air Museum, whose responsibility it would be to "memorialize the national development of aviation; collect, preserve, and display aeronautical equipment of historic interest and significance; serve as a repository for scientific equipment and data pertaining to the development of aviation; and provide educational material for the historical study of aviation."

The Congress included provisions for selecting a site for a National Air Museum building to be located in the nation's capital, but it was not until 1958 that the present site was chosen and reserved for this purpose.

AEROSPACE ON



Senator Clinton Anderson, of New Mexico; Leonard Carmichael, then Secretary of the Smithsonian; and aviation pioneer Grover Leoning, the famous aeronautical engineer, pilot, and amphibian designer, were instrumental in this process.

On July 19, 1966, Public Law 89-509 was passed, amending the name to be given this fledgling: it was now to be the National Air *and Space* Museum. [I was unaware of this legislation at the time, having spent the 19th circling the earth 16 times aboard Gemini X.] This same Act authorized and directed the Regents of the Smithsonian Institution to prepare plans and construct a suitable building for the National Air and Space Museum.

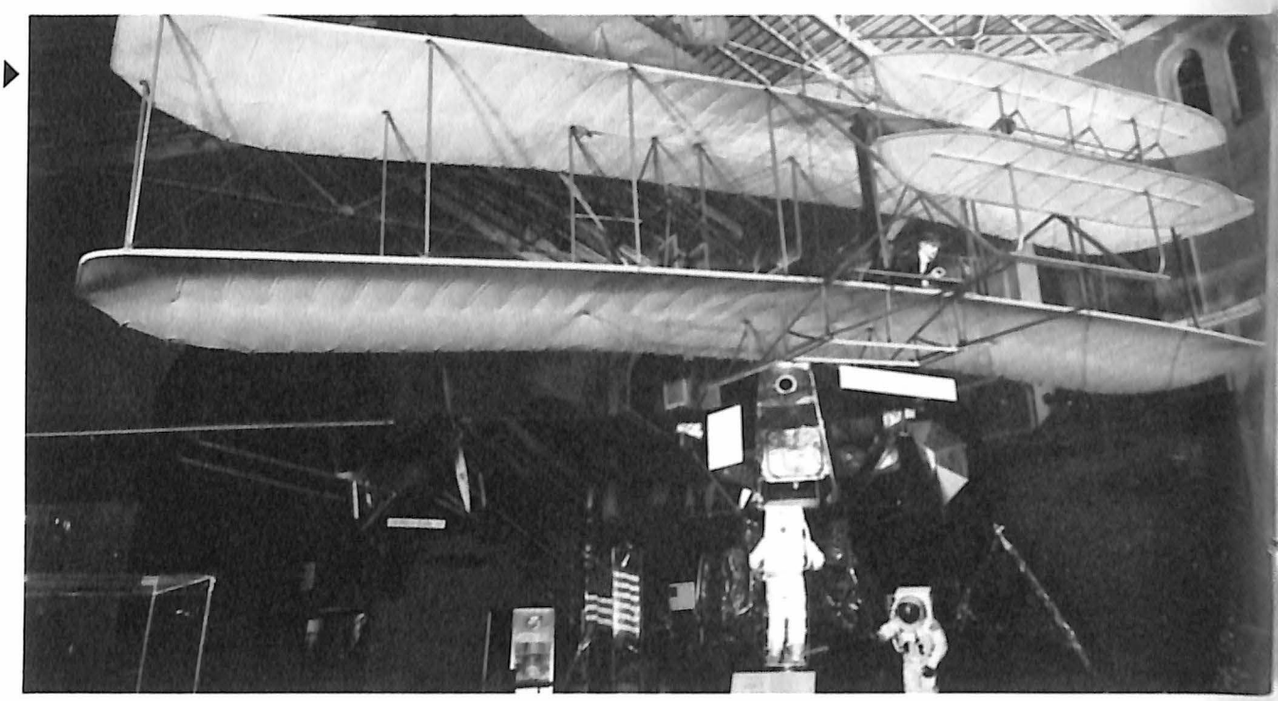
Appropriations for construction were subsequently deferred by the Congress until expenditures for the Vietnam conflict had shown a substantial reduction. In 1971, with the help of Sen. Barry Goldwater, of Arizona, and James Webb, former NASA Administrator, among many others, $1.9 million was appropriated to redesign the building, to make it smaller so that it still could be constructed within the $40 million limit of Congressional authorization. In 1972, $13 million was appropriated and construction began, and mid-1973 finds a steel skeleton which daily assumes more definite form.

When completed, it will have a clean and crisp look which will create a harmonious balance between the sleek aerodynamic shapes within it and the classical elegance of its neighbor, the National Gallery of Art. The genius behind the design is Gyo Obata, of the St. Louis firm of Hellmuth, Obata and Kassabaum. Mr. Obata developed this concept after several years of study, and his award winning design has the approval of

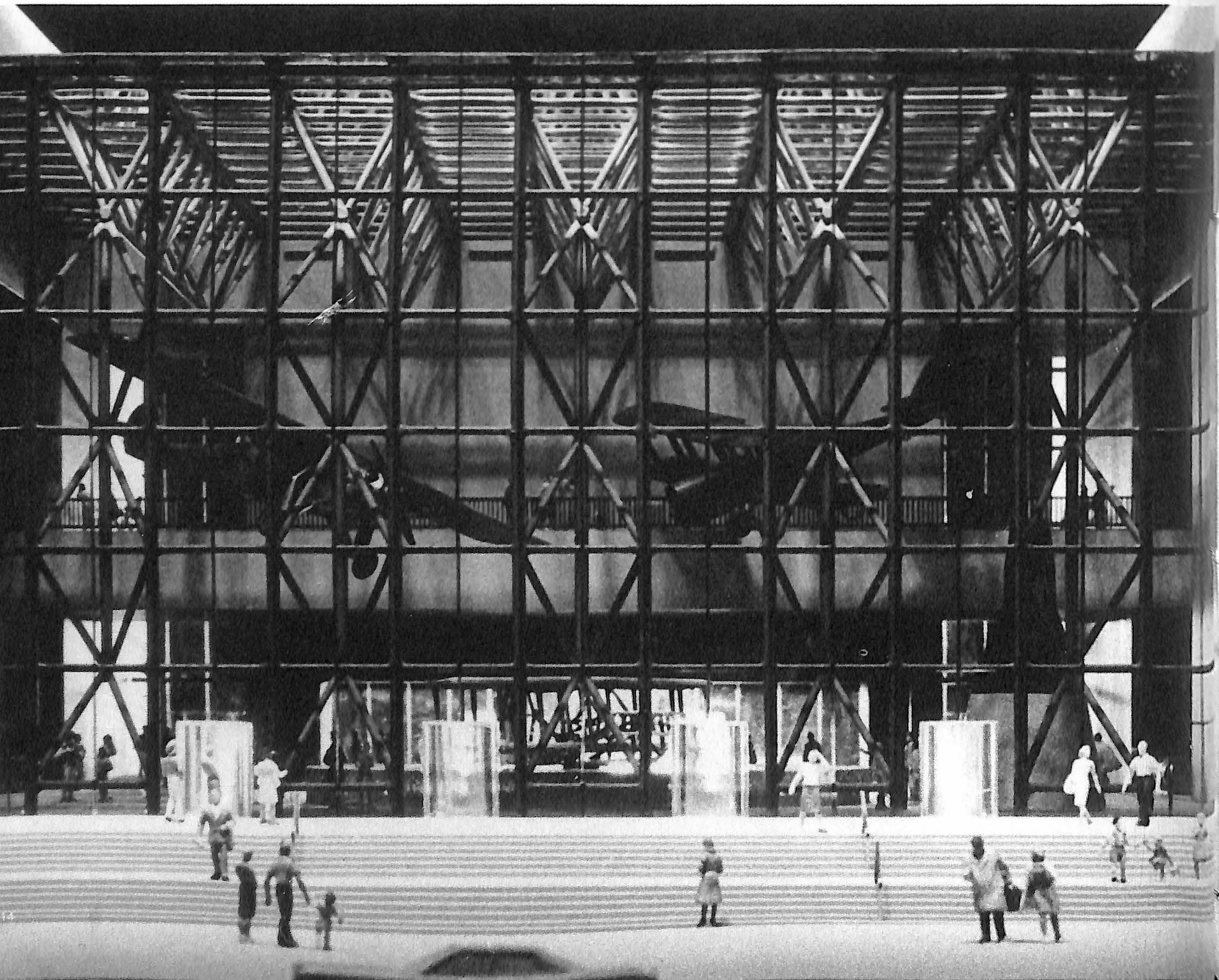
THE MALL

By MICHAEL COLLINS
Director, National Air and Space Museum

The Wright Kitty Hawk Flyer will be one of the few aircraft permanently displayed at the National Air and Space Museum.



Architect's model shows the unusual tubing used to support the glass-enclosed exhibit areas between major sections of the new building.



the Regents of the Smithsonian, the National Capital Planning Commission and the Commission of Fine Arts. In the shadow of the Capitol, the building will be worthy of its location, which is the finest available in the city of Washington.

The exterior of the building will be Tennessee marble of a pinkish hue matching that of the National Gallery of Art, and grey glass designed to filter out harmful ultraviolet rays.

However, as interesting as the exterior will be, it's the interior and its contents that keep me and my staff busy — planning, experimenting, refining, changing — looking for the ideal blend of subject matter. Our charter is an extremely broad one, beginning with man's first aspirations to fly, spanning his first faltering ascents in hydrogen and hot air balloons, and then recording the surge of powered flight which followed the fateful day in 1903 at Kitty Hawk.

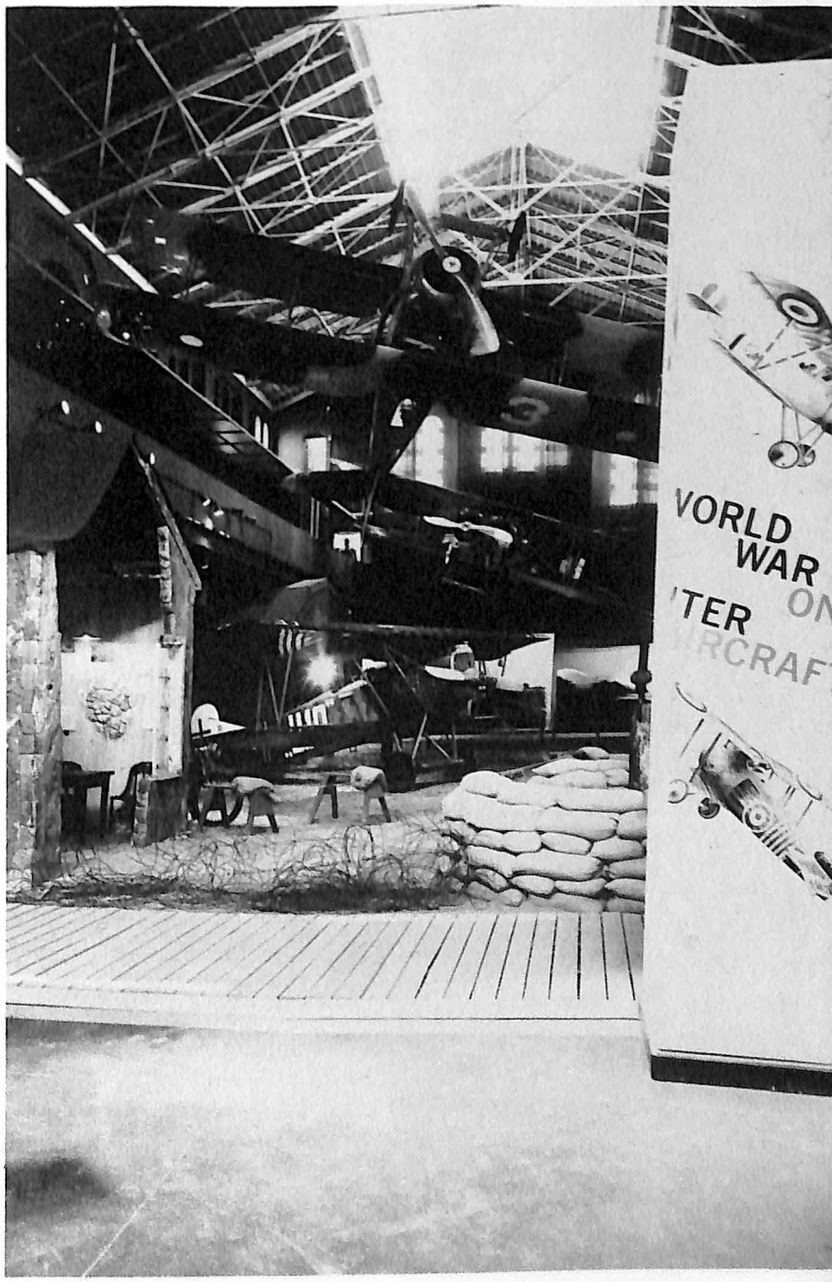
From Kitty Hawk to the moon, the pace has been increasingly swift, the technology more and more sophisticated, the story ever more complex. No important segment of it can be slighted, not the contributions of a Goddard or a Lindbergh, nor the story of the aerospace industries and what they contribute to the quality of our lives.

In addition, I believe that a museum of this type should not only examine the past but explore future possibilities. I believe that it should not only display artifacts, but act as a catalyst in exchanging information, and to grow into a true national center for aerospace historical research.

Opposing these grandiose concepts are the realities of space and budget. The fuselage of a Boeing 747 is longer than our building is wide; a Saturn V, if parked along side it, would loom four times as high. Clearly, we must find an alternative to simply parking machines and putting velvet ropes around them. We must make the best possible use of the technology we represent in creative communications. We must communicate in a wide variety of ways: by showing objects, by labels, by sound, by film, by electromechanical and audio-visual devices of the highest fidelity and reliability. We must shift gears often, for a technique well suited for one subject may be completely inappropriate for another. For example, our hall on Ballooning may include a light, even frivolous treatment of some byproducts of the crazy era of ballooning, featuring balloon music, art, furniture — even a puppet show. On the other hand, the hall devoted to the Earthbound Benefits of Flight will be a thoughtful, carefully researched, highly documented treatment of the spinoffs resulting from air and space technology. In some areas, such as Early Rocketry, our collection may be far from complete, and substitutes for actual artifacts will be found. In other cases, however, we have more machines than floor space for their display, and the process of winnowing and selecting will be accomplished with an eye toward displaying only those machines of the greatest historic significance.

I think that our airplane collection is the best in the world. It includes the original Wright Kitty Hawk Flyer, Lindbergh's Spirit of St. Louis, Amelia Earhart's Lockheed Vega, the first supersonic airplane, the Bell X-1, Billy Mitchell's Spad, a Messerschmitt ME-262 jet fighter, a Mitsubishi Zero, the North American X-15

A Spad does a victory roll over the realistic exhibit of an Allied World War I airdrome. Showing historic aircraft in operational backgrounds is a major goal of the museum.



Hall of Ballooning will include such features as balloons actually ascending and descending, and a puppet show.

the Douglas World Cruiser, the Langley Aerodrome, precision pilot Bevo Howard's Buecker Jungmeister, the first Boeing 707, and on it goes. In all we have two hundred and fifty airplanes, and of course not all of them will fit into the new building at once. For this reason, we will rotate exhibits as funds allow, and only a very few of the very finest (such as the Wright Flyer) will be on permanent display.

In regard to our space program, the Smithsonian has an agreement with NASA which allows us to acquire any object we wish, once NASA's technical requirement for it has terminated. From Alan Shepard's Mercury to the Apollo Eleven Command Module, we have acquired a representative sampling of spacecraft, supporting hardware, documentation, and photographs.

We have started an art collection, small at present, but one which we hope will grow, for frequently the artist's eye has captured the flavor of an important event with incomparable power and precision. Also, from a practical standpoint, color photographs may fade after fifty years, but oils are good for five hundred at least. In the new building, one hall will be devoted to air and space art, but in addition we will add paintings and three dimensional art objects wherever they enhance other exhibits.

In addition to the twenty-six exhibit halls, our new home will have two special purpose chambers for education and entertainment. One will be an auditorium with a fairly steep slanted floor, seating four hundred. The front of this room will accommodate a curved 55′ x 75′ screen, while the projection booth will be capable of handling the finest 70 mm projection equipment. With this potential for large scale visual presentations of the highest possible fidelity, we will be able to offer a dramatic substitute for viewing three dimensional objects. The auditorium will, of course, also be available for more conventional purposes, such as various lecture series which we present now and will continue to present in the future. For example, last autumn the National Air and Space Museum, in conjunction with the Smithsonian Astrophysical Observatory, hosted a nine-lecture series entitled "Man and Cosmos." During this series, some of the finest astronomers in the country provided (to standing room only crowds in a borrowed auditorium) a comprehensive and current survey of man's past and present concepts of the solar system, with particular emphasis on the results of space science research during the past decade. The auditorium in our new museum will be invaluable in allowing us to expand this type of activity.

The second special purpose chamber will be called the Spacearium, and it will most closely resemble a planetarium. The audience of three hundred will be seated in a circle under a pierced aluminum dome 70 feet in diameter. Upon this dome, from the center of the room, can be projected the night sky, including very accurate simulations of any part of the celestial sphere. In addition, special effects projectors will be used, both inside and outside the dome, to assist in creating the illusion that the visitor has left the surface of the planet and has traveled out into space. In keeping with the Smithsonian's reputation for research and accuracy, every attempt will be made to explain recent discoveries in the fields of astronomy and astrophysics, such as pulsars, quasars, and black holes. On a more frivolous, but entertaining level, the Spacearium can be used as a backdrop for a variety of non-scientific productions. It will also be a powerful teaching tool, and will be available to the District of Columbia and neighboring school systems as special school presentations are developed.

Another extremely valuable component of the new National Air and Space Museum will be the research library and information center. Unlike most other libraries, which have aerospace material diffused throughout their collections, our visitors will find concentrated in one spot a wealth of material relating to the history of flight. With more than 20,000 bound volumes and 200 periodicals, the library is today the broadest and most accessible source for scholarly research in a variety of aerospace fields, and the new building will give us room to grow. The Sherman Fairchild collection, for example, offers encyclopedic coverage of the pioneering early days, while at the other end of the spectrum we have one of the most complete

collections of some 30,000 lunar photographs taken by Ranger, Surveyor, Lunar Orbiter, and the Apollo Lunar Missions. In general, our library is probably strongest in its photographic coverage, but it does not neglect other areas, and contains books going back to the 17th Century, as well as the most recent issues.

In some areas, the museum staff includes top experts, such as lunar geologist Dr. Farouk El-Baz, who is a renowned authority on lunar topography and morphology, and who is responsible for the lunar photo collection. While our library in its temporary quarters (the Arts and Industries Building on the Mall in Washington) is quite busy, we are eagerly looking forward to the day when we can expand far beyond our present activity level of 60 visitors, and 600 letters, per month.

In order to meet our deadline of opening to the public on July 4, 1976, it is necessary for us to get a head start in designing and constructing the exhibits to fill the 200,000 square feet of available space. We are using our temporary quarters in the Arts and Industries Building on the Mall in this effort. While not exactly modern, dating back to 1879, the Arts and Industries Building does contain four large exhibit halls whose dimensions are faily close to those of a typical hall in our new building. In three of these four halls, we are fabricating modular exhibits as fast as our resources will allow, exhibits which can be dismantled and stored when we have a replacement for them, so that hopefully by 1976 we will have a storehouse full of exhibits which have been tested and critiqued by the public, and which can then be installed in the new building. So far we have produced a hall on Ballooning and on World War I Aviation, and we will next follow these with exhibits on Air Traffic Control, Life in the Universe, Exhibition Flying, and Flight to the Moon.

Unfortunately, modern exhibits techniques, leaning heavily on sophisticated audio-visual and electromechanical devices, can be extremely expensive — in some cases running over $60 a square foot of exhibition area. If we multiply this number by our 200,000 square foot total, the result is an alarming $12,000,000. The Congress has told us to build a $40,000,000 building, but certainly has made no commitment to finance an additional 30 percent to complete our exhibits program. Clearly help will be needed in this area, and I hope a large share of it will come from our friends in the aerospace industry. With an estimated six to seven million visitors in its first year of operation, our new building will offer an unparalleled opportunity to communicate with the American public, as well as our many foreign visitors. Our country has always been in the forefront of aerospace progress, and has benefited from it in countless ways. That message should be accurately developed in our exhibits, which have the potential of serving as an effective catalyst in the information transfer process.

But talk is easy, words are cheap. The new National Air and Space Museum will happen. The building will be completed in time for the Bicentennial. What kind of building it will be inside, what mood it will create, what message it will convey, all remain to be seen. Time and money are short; exhibits must be produced *now*, if 1976 is to see the opening of the most exciting museum in the world, which I have every reason to expect the new National Air and Space Museum to be.

AIA

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Amphenol SAMS Division
  The Bunker-Ramo Corp.
Avco Corporation
The Bendix Corporation
The Boeing Company
CCI Corporation
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Martin Marietta's exhibit at the Paris Air Show featured its Multiple Docking Adapter which is used to link Skylab with the Apollo Command Module. The MDA is also a major experiment control center for Skylab. (See Le Fete Arienne—The Competitive Challenge, Page 2)

aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • SEPTEMBER 1973

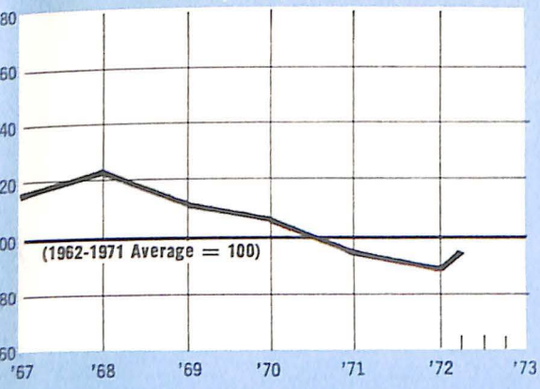
TRANSPORTATION IN THE 1980s

By CLAUDE S. BRINEGAR
Secretary of Transportation

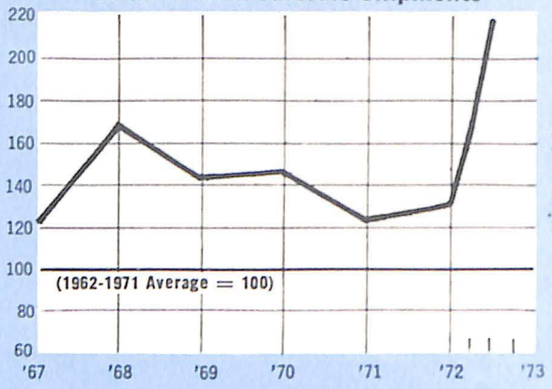
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

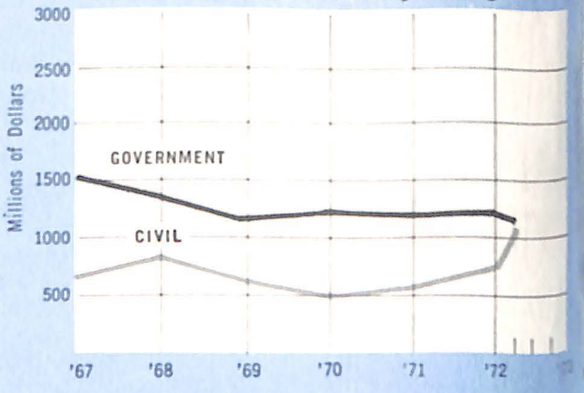


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1962-1971 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	23.5	1st Quarter 1973	21.2	21.4	22.1
	Billion $	Quarterly	5.9		4.9	5.7	5.6
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,240	Mar. 1973	1,249	1,153	1,098
Aircraft	Million $	Monthly	733	Mar. 1973	814	777	526
Missiles & Space	Million $	Monthly	507	Mar. 1973	435	376	572
Aerospace outlays: Total	Million $	Monthly	1,147	Mar. 1973	1,300	960	1,195
Aircraft	Million $	Monthly	665	Mar. 1973	825	569	610
Missiles & Space	Million $	Monthly	482	Mar. 1973	475	391	585
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,057	June 1973	2,067	995	1,592
Aircraft	Million $	Monthly	631	June 1973	1,586	866	1,243
Missiles & Space	Million $	Monthly	426	June 1973	481	129	349
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	270	May 1973	225	281	206
Expenditures	Million $	Monthly	277	May 1973	271	265	256
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	22.7	1st Quarter 1973	24.3	26.9	28.3
U.S. Government	Billion $	Quarterly	13.6		14.0	15.3	15.5
Nongovernment	Billion $	Quarterly	9.1		10.3	11.6	12.8
EXPORTS							
Total (Including military)	Million $	Monthly	204	June 1973	290	553	383
New Commercial Transports	Million $	Monthly	59	June 1973	78	244	96
PROFITS				1st Quarter 1973			
Aerospace — Based on Sales	Percent	Quarterly	2.6		2.3	2.2	2.9
All Manufacturing — Based on Sales	Percent	Quarterly	4.9		4.0	4.4	4.5
EMPLOYMENT: Total	Thousands	Monthly	1,286	May 1973	924	942	941
Aircraft	Thousands	Monthly	699	May 1973	505	512	511
Missiles & Space	Thousands	Monthly	144	May 1973	91	93	94
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.48	May 1973	4.61	4.87	4.89

* 1962-1971 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

AEROSPACE AND TRANSPORTATION

By KARL G. HARR, JR.,
President, Aerospace Industries Association

Much of this issue of *Aerospace* is devoted to transportation, a subject of increasing national and international interest as populations grow in numbers and in the need for mobility.

The aerospace industry is committed to the belief that a fully and carefully integrated transportation system, using sea, land and air modes to the most productive extent of their capabilities, whether it be for the urban, suburban or long-haul movement of people and things, is essential.

We therefore consider it opportune to present the views of The Honorable Claude S. Brinegar, Secretary of Transportation, in which he outlines the thrust of work being done today to solve the problems of transportation in the decade of the 1980s.

Quite properly, we believe, the Secretary has assigned first priority to solving the problem of transportation in large urban areas and along heavily populated corridors. These are the areas where congestion has grown to, or very near to, the maximum tolerable limit, and where private and public transportation are being challenged as to their ability to serve the people efficiently, conveniently and economically. These also are the areas where the concentration of transportation produces emissions that contribute to pollution levels that at times can be harmful to people concentrated therein.

The Secretary makes his priorities clear. Efficient, economical and convenient transportation must come first. Only when we have effective mass transportation can we expect to reduce the masses of transportation vehicles operating in areas that breed congestion.

Aerial transportation, which adds little to the pollution of the atmosphere, can play an increasing role in providing some of this needed transportation, not only between cities but between city centers and outlying airports, utilizing instead of ground space the air space that lies above ground congestion and below the commercial airlanes.

And as for long-haul air transportation, revolutionized by the gas turbine engine, one conservative estimate indicates that the scheduled airline system that flew 38.8 billion revenue passenger miles in 1960 — the equivalent of moving 15.5 million people across the United States — must be ready to provide more than seven times as much (280 billion) revenue passenger miles of transportation in 1980. Revenue ton miles of cargo airlifted will increase even more dramatically — more than 20 times — from 943 million revenue ton miles in 1960 to 20 billion revenue ton miles in 1980.

We will be ready.

Every transportation mode can claim one or more of the advantages of speed, economy, capacity, convenience. An integrated balance of efficient vehicles using the waterways, highways, railways and airways to the best advantage is what is needed — and we believe that the efforts now being made by both Government and industry to achieve such a balanced and effective system will pay off handsomely in the relatively near future.

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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;.

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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TRANSPORTATION

By CLAUDE S. BRINEGAR
Secretary of Transportation

Anyone familiar with scientific and technological advances of the last two decades is going to hesitate to forecast for the next two. After all, it was only two decades ago that a dictionary was defining "spaceship" as "an imaginary aircraft of the future for interplanetary travel outside the earth's atmosphere."

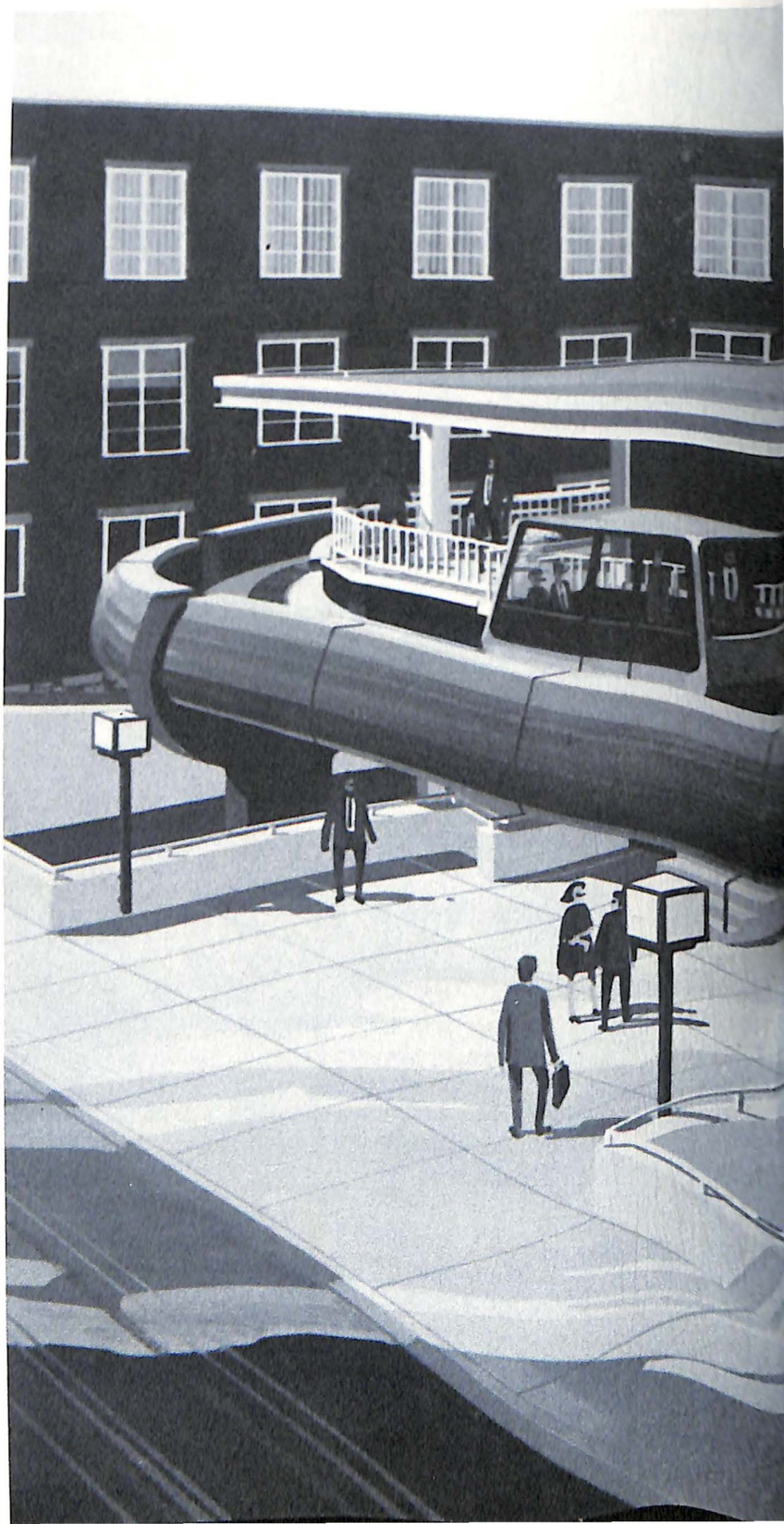
In the interim, imagination has become reality through an historical merging of technology and teamwork. And many people have been asking ever since, "If this country can put a man on the moon, why can't it do something about the transportation mess down here on earth?"

At the Department of Transportation, we are, in fact, doing something about it. But our technical challenge is complicated by non-technical factors. In the past, planners could check available resources against freight and passenger projections and build new equipment or facilities to meet the demand. Now the challenge has been joined by growing constraints to unlimited development. We must balance the social and economic spurs to traffic growth against the need for energy conservation, plus costs in air and water pollution, urban or corridor congestion, traffic casualties, noise, and other "side effects" of progress.

How will we do this in the decades just ahead? It seems likely that we must be prepared to continue the trend of doubling the capacity for carrying people and goods every twenty years or so. Do we manage this herculean task with " more of the same"? Or do we generate new policies and programs to breathe more efficiency into old systems, to expand capacity with minimal consumption of space and resources, and to increase safety and convenience in all modes?

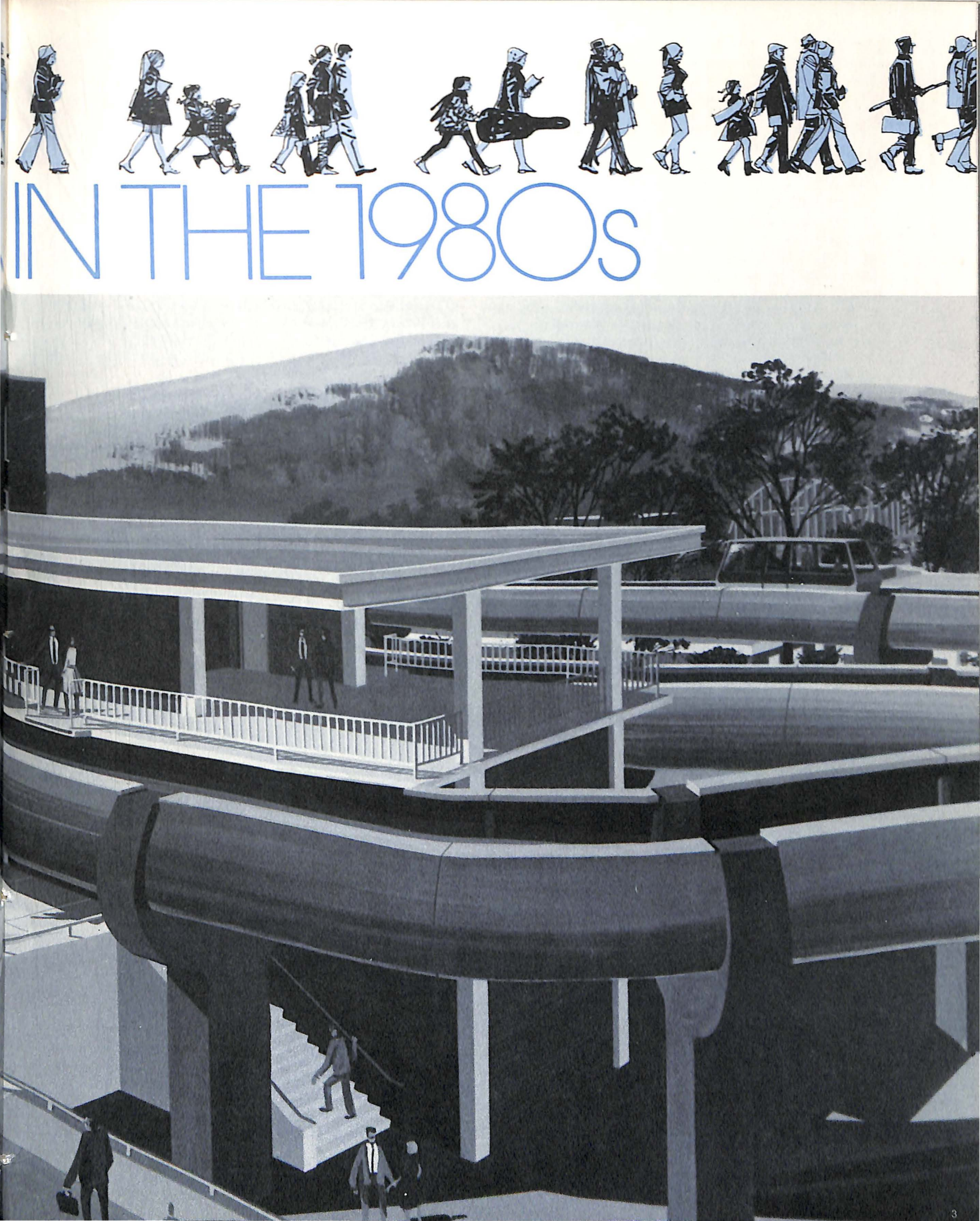
Getting Across Town

In our cities especially, more of the same may not be



Artist's conception shows the Personal Rapid Transit System, sponsored by the Department of Transportation, which is scheduled to go into operation next year at Morgantown, W. Va. The system will connect two separate campuses of the University of West Virginia and the Morgantown business center.

IN THE 1980s



feasible. San Francisco rejected the idea of further expressway construction years ago and many other cities have reached or are nearing the saturation point in street and highway construction.

Fortunately, Congress this year acted to change the long-standing policy of granting funds on a "use-for-highways-or-lose" basis. The landmark Federal-Aid Highway Act of 1973 signed by President Nixon this August allows urban leaders flexibility in expenditure of $2½ billion over the next three years for highways or for such alternatives as buses, exclusive bus lanes, exclusive truck lanes, or urban rail systems. This is in addition to $3 billion in new authority for the Urban Mass Transportation Administration grant program over the same period.

Weaning the American commuter away from his car is going to be a long and probably a painful process. The best antidote to this pain will be public transportation that matches as closely as possible the convenience, comfort, and reliability of his private auto. His suffering may be eased further, at least by comparison with the alternative, if gasoline costs go up and transit fares go down.

One of the most certain changes in the 1980's will be in the complexion of our cities. The direction of change will vary with the individuality that marks each metropolis. In each, though, transportation seems destined to be a catalyst of change.

To be sure changes are for the better, the Department this year developed what we call a "unified work plan," to encourage the several administrative bodies in any metropolitan area to think in terms of the larger issues. Instead of one urban agency deciding to extend a highway, another independently deciding to apply for transit grants, and still another debating where to put a new airport, they'll get together first on such questions as: What is our land use plan? How big do we want this community to be? How many people, how much goods, must we move over our combined transportation system? What improvements will meet our requirements most economically? How will they affect the quality of life? Have we considered all alternatives?

Broadening the scope of those alternatives is one of the objectives of intensive research and development underway by government and industry.

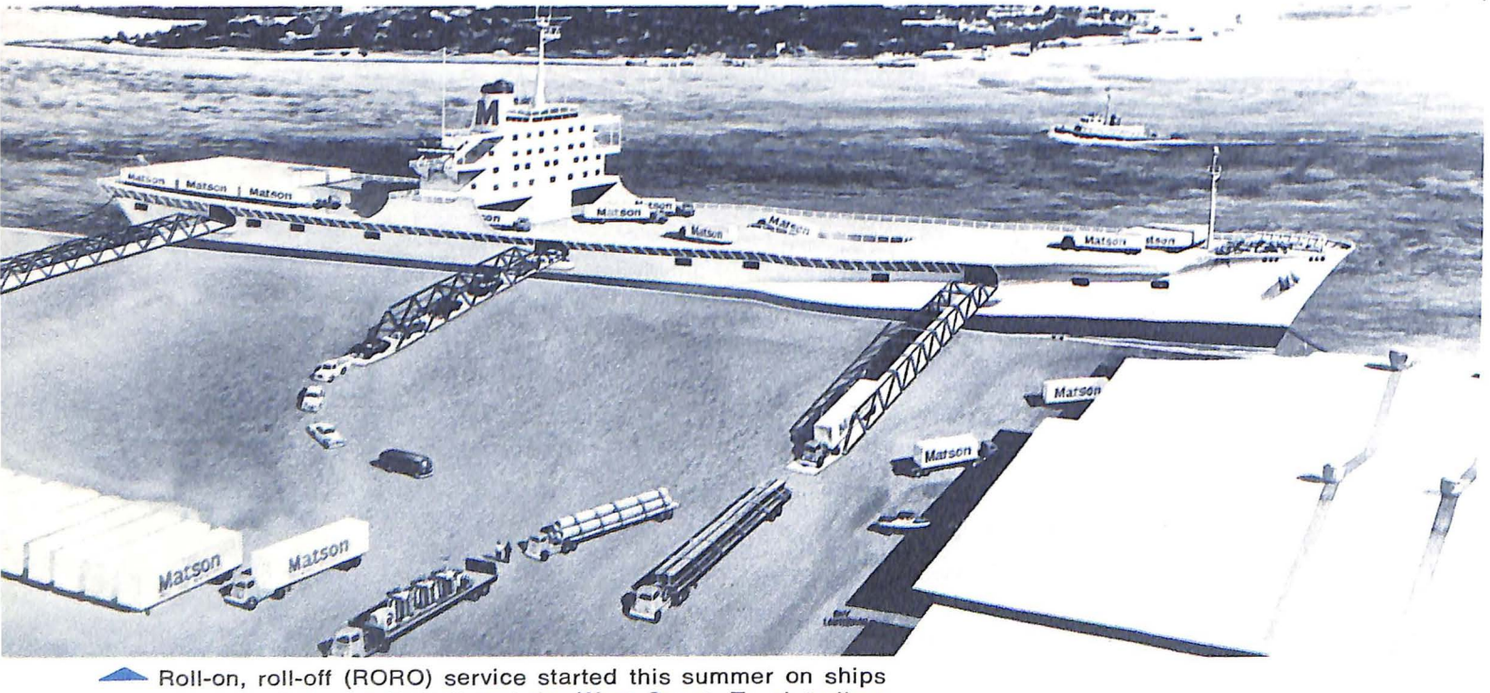
Dial-a-Ride and PRTS

Dial-a-Ride and other demand-responsive systems combine taxi convenience with bus economy. Demonstrations are testing their effectiveness as flexible collector systems connecting to express bus or rapid transit lines. Specially equipped vehicles in some of these systems also afford a much needed service to the elderly and the handicapped for neighborhood trips to shopping centers, clinics, recreation centers.

We'll soon have opportunity to observe two automated, small vehicle systems in service in an urban setting. A Department-sponsored Personal Rapid Transit System in Morgantown, West Virginia, is scheduled for service in 1974. It will connect two separate campuses of the University of West Virginia and the Morgantown business district. At the new Dallas/Fort Worth Regional Airport, an Airtrans system will provide similar service between four terminals, two remote parking areas, mail facilities and a maintenance area. System capacities eventually will be 9,000 passengers, 6,000 bags and 70,000 pounds of mail per hour.

Many cities are now looking for automated, quiet, non-polluting circulation and distribution systems to relieve street congestion in their hub areas. With financing more assured, I think we can count on American inventive genius and industry to come up with a wide range of interesting answers.

The newest thing in ground transportation since the



Roll-on, roll-off (RORO) service started this summer on ships operating between Hawaii and the West Coast. Truck-trailers are driven aboard a RORO ship and then driven off at their destination. Turn-around time is reduced from 48-50 hours to 12 hours.

Large 22-inch bright displays provide air traffic controllers at the Los Angeles Center with identity and three dimensional position information of aircraft flying in an area. The Federal Aviation Administration is studying air traffic control concepts extending into the 1990's.

wheel is tracked levitated vehicles—vehicles lifted away from the friction of contact with rails or other guides and thus able to move rapidly, efficiently and more quietly. Dr. Robert Cannon, who directs our research program, assures me that—whether air-cushion or magnetic—levitated vehicles have a place in our future. We have tracked air cushion vehicles in the development stage and are also experimenting with magnetic levitation.

Meanwhile we'll be learning from Canada's experience with the German TRANSURBAN magnetic-levitation transit system. The Province of Ontario is installing a 15-vehicle, 2.5-mile demonstration system in Toronto as the first phase in development of a new intermediate capacity transit system for the cities of Toronto, Ottawa and Hamilton. With a maximum speed of 50 miles per hour, the system has a designated capacity of up to 20,000 persons per hour in each direction. Completion of the first phase is now scheduled for August 1975.

New hardware understandably excites public interest. But equally effective on the efficiency scale are the low-profile, less-costly improvements: sophisticated command and control systems to smooth and speed traffic flows; express busways with adjoining park-and-ride facilities that attract new riders daily; rearrangement of downtown distribution systems; new marketing and management programs; modernization of terminals, and many others.

Under Department sponsorship, even buses have been given a new look. Three prototypes of TRANSBUS, the bus of the future—safe, convenient, comfortable—will next year be visiting U.S. cities so that planners and prospective riders can make their comments to help guide future production plans.

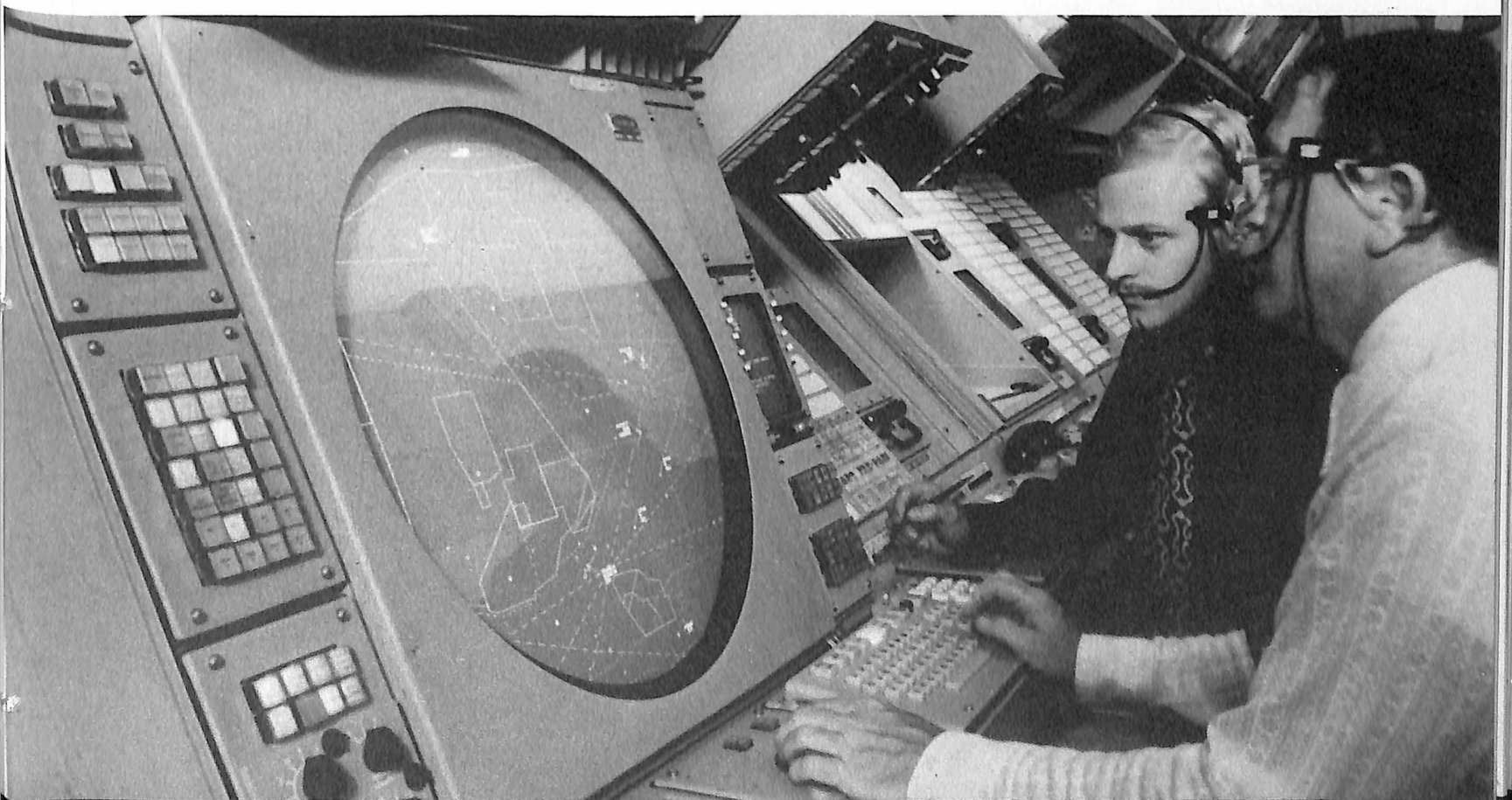
Bikes Have a Place

In re-thinking our approach to personal conveyance, we shouldn't overlook the renaissance of the bike. In 1972 the sale of bicycles surpassed the sale of automobiles, even though car sales also had a record year. The bicycle is kind to the environment, helps the energy problem, requires little parking space, and provides healthful exercise along with transportation. Many cities now recognize it as a viable commuting vehicle, to be properly provided for in comprehensive transportation and land use plans. Drawbacks are its vulnerability in mixed traffic streams, the need of its riders to transfer to other transportation in bad weather, and the problems of securing the parked bike against theft. Led by Oregon, more and more States are now pledging a percentage of their gas tax revenues to resolving these difficulties through construction of bikeways and related facilities. The new Federal Aid Highway Act allows up to $120 million from the Highway Trust Fund to be used for bike lanes and for pedestrian walkways over the next three years.

This does not mean that everyone is to be pedaling to work in the 1980's. But we must build an energy ethic into our approach to the future because the time for energy conservation is clearly upon us.

Last year the United States showed the highest annual increase in use of gasoline in 17 years, consuming a record 106 billion gallons. A chief culprit is the car that gets 8 or so miles to the gallon while moving a single individual through urban traffic. We can and must do better than that.

The world urgently needs improved automotive propulsion systems that operate more efficiently at the low speeds typical of city driving. And a great deal can be done for the integrity of small frames, to give us a safe, economical urban vehicle. Eventually it might be a dual mode vehicle which operates as an automated system part way and is driver-operated the rest of the way. Ideally, these vehicles would be kept in productive serv-



ice throughout the day, freeing for more practical uses the thousands of miles of costly urban real estate now reserved for parking.

Here again, industry and government have been pursuing those objectives through research, both separately and in tandem. Small cars are safer, at least partly because of our international Experimental Safety Vehicle program, and manufacturers have developed prototypes of even smaller vehicles that could be used safely only in a controlled environment.

In another dual mode idea now in the design concept stage, mini-bus type vehicles would be driver operated during the collection and distribution stages, then connected to an automated guideway for the line-haul portion of the trip. In addition to giving more direct home-to-work service, this system reduces labor costs, as the driver would not be needed on the automated section.

By the 1980's we hope to open a new frontier in urban transportation—at our feet. People are only part of the congestion cause. Almost all goods in urban areas moves by truck. If we could move a large part of this distribution system underground it would greatly help the urban congestion problem. A key to progress in this area is reduced tunneling costs. We have several projects underway toward that goal.

How we get across town in the 1980's will depend upon how fast and how well the hundreds of ideas now in the hopper prove out. And upon which ideas work best for any particular city.

Intercity Freight

Movement of the Nation's freight by the various modes—rail, truck, water, pipeline, and air—is of paramount importance to the working of our national economy. Our total intercity freight movement now exceeds two trillion ton-miles per year, and is growing steadily. Rail still carries the biggest share, with about 35% of the total, water is second at 28%, pipelines are third with 20%, and trucks are fourth with some 16%. Air is less than 1% in volume but of course high in value.

For the last 25 years rail's share has been slipping—it was over 50% in 1950—and the share held by pipelines and trucks has been rising. It may not be just a coincidence that 100% of the rail and air ton-miles are regulated, while only 40% of trucking, and less than 10% of domestic water carriers come under Federal regulations.

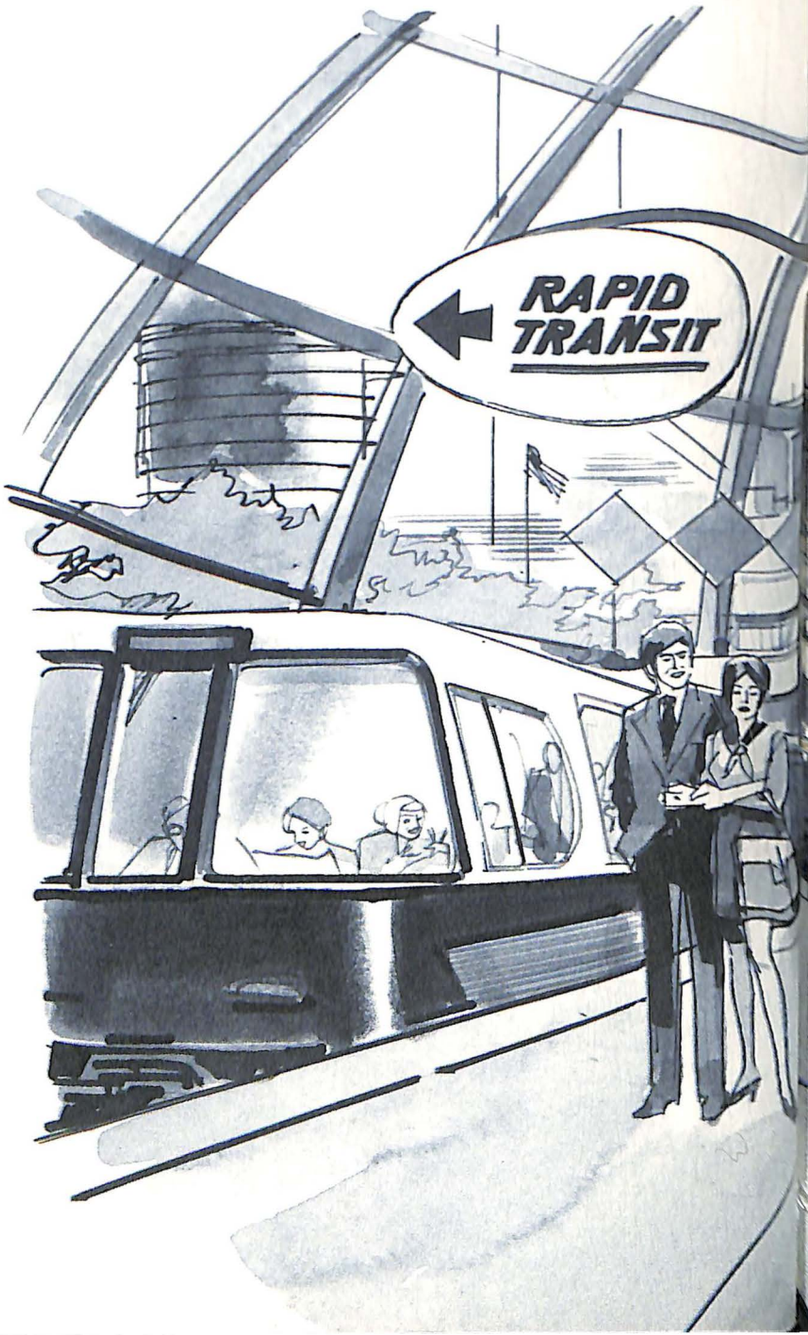
Because of the financial difficulties of a few carriers, many people do not realize that rail remains an extremely efficient carrier of freight, especially over long distances. If we can bring regulatory, taxation, and administrative practices in line with real-world conditions of the late twentieth century, rail may well enjoy a renaissance on a par with its nineteenth century contemporary, the bicycle.

Industry has evidenced its faith in the future of railroading through such investments as Southern Pacific's computerized classification yard at West Colton, California. Completed this summer at a cost of $39 million, this is hailed as "the most technologically advanced rail terminal in the world."

In aviation we will also be relying heavily on technology to help alleviate the acute squeeze between available terminal airspace and the demands of additional aircraft entering the system daily. Even as our Federal Aviation Administration completes installation of the ARTS III (automated radar terminal system) its engineers are proceeding with development of the "upgraded third-generation system." And at our Transportation Systems Center in Cambridge they're in the study phase of development of the advanced air traffic control system concepts extending beyond the 1980's into the 1990's.

Most terminals—not just airports, but ports, loading docks, railroad sidings—offer rich opportunity for improved efficiency. Some delays are caused by paperwork; some by difficulties in intermodal transfer.

The Department has been working closely with industry and with other governments around the world to reduce the paperwork that puts a multi-million-dollar drain on the economy. It is possible that by 1990 shipping data will be transmitted universally by telecommunications, microwave, or satellite, rather than by sheaves of multi-lingual documents.



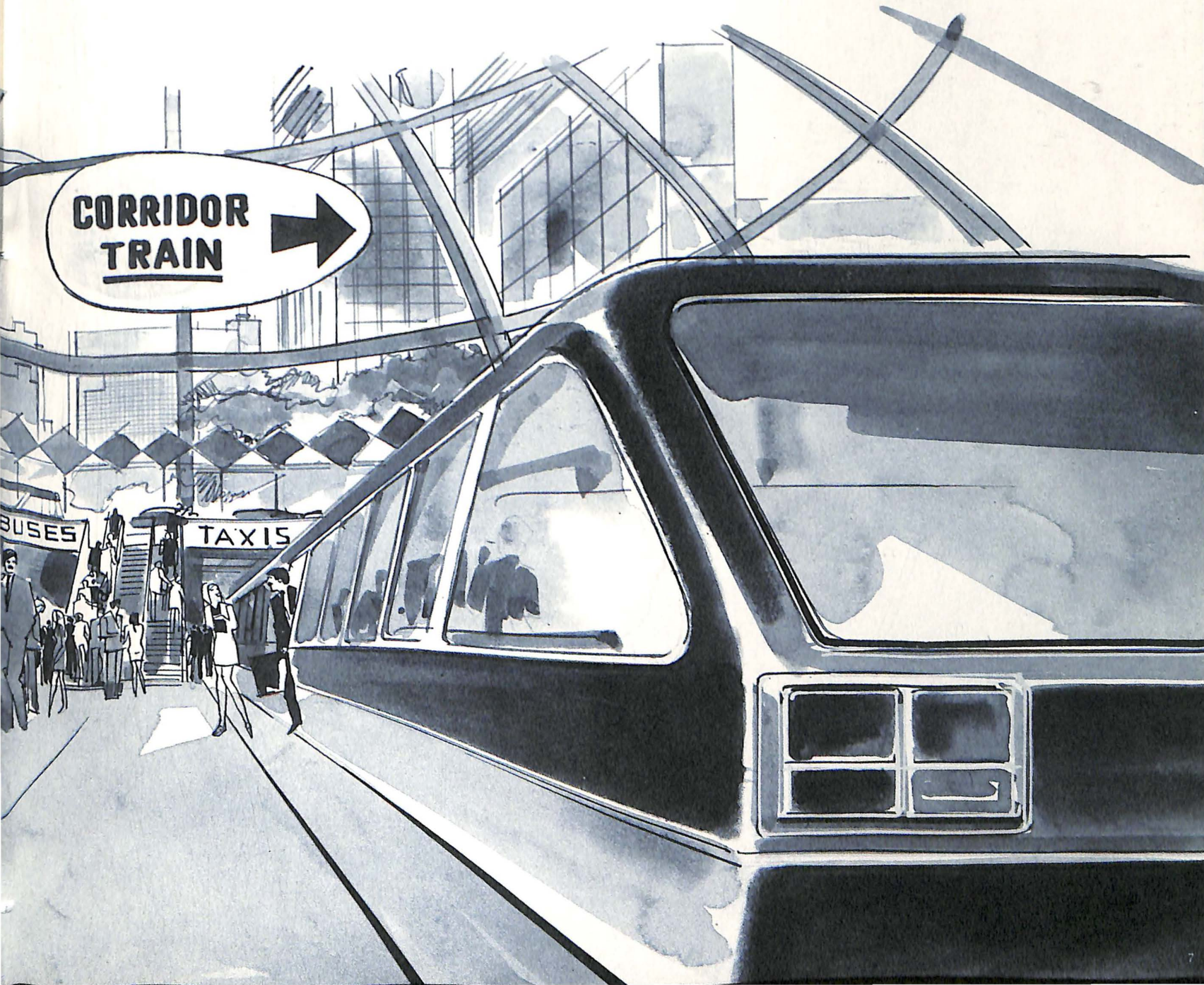
Such new vessel systems as LASH, SEABEE, and the RORO (roll-on, roll-off) service begun between the West Coast and Hawaii this summer are speeding up intermodal transfers at ports. Truck-trailers can be loaded anywhere in the United States, driven to a Pacific Coast port and aboard a RORO ship, then driven off in Hawaii to their destinations. Officials expect to reduce turnaround time from 48-50 hours to 12. Theft and handling losses should also be minimized.

Intercity Passengers

Intercity passenger service poses a somewhat different problem than freight. Here the issue is less one of encouraging competition and low costs than one of options and the sharing of costs. How many passenger options (such as car, bus, train, and air) should there be between cities? Who is to bear the costs of those modes—such as rail passenger or the feeder airlines—that are not economically self-sustaining? How do we measure their usefulness against the cost of subsidies? In the Department of Transportation, we're addressing these questions with the aim of reducing public costs while improving public service.

We are not overlooking the potential of medium-haul short takeoff and landing (STOL) and vertical takeoff and landing (VTOL) air vehicles. These could be particularly convenient for passengers when they can provide environmentally acceptable and economically competitive air transportation above ground traffic congestion (and below commercial airways) to and from airports and between cities.

As with the "spaceship," the speed with which we reach our goals for transportation will depend a great deal upon the teamwork and technology applied by government and industry to meet demands for mobility—with design parameters of energy conservation, noise and pollution reduction, increased safety, and decreased congestion.



NASA AERONAUTICAL R&D- TECHNOLOGY FOR GROWTH

By ROY P. JACKSON

Associate Administrator for Aeronautics and Space Technology
National Aeronautics and Space Administration

Can you imagine more than 1 *million* commercial passengers travelling somewhere in the United States by air *every day* of the year? Can you imagine that being the case in 1985?

Think of the entire year of 1972 when 170 million U.S. domestic air passengers crowded terminals, aircraft and baggage facilities—and when aircraft had to wait in line to take off or wait in holding patterns to land.

The best estimates of experts in the Government and in industry say that the 170 million passengers of 1972 will be at least 185 million in 1973 and will be, conservatively, 427 million in 1985.

That is why the first "A" in National Aeronautics and Space Administration is so important. It stands for "Aeronautics," and NASA, working with the aerospace and airline industries, has been going full speed ahead in this area that sometimes tends to be overshadowed by the NASA "S" that stands for "Space."

Our current aeronautics research and technology program relates to the social acceptability of aircraft, to the economics and efficiency of short-haul systems, to U.S. leadership in long-haul aircraft, military aircraft, and engine systems, to aviation safety, and to general aviation.

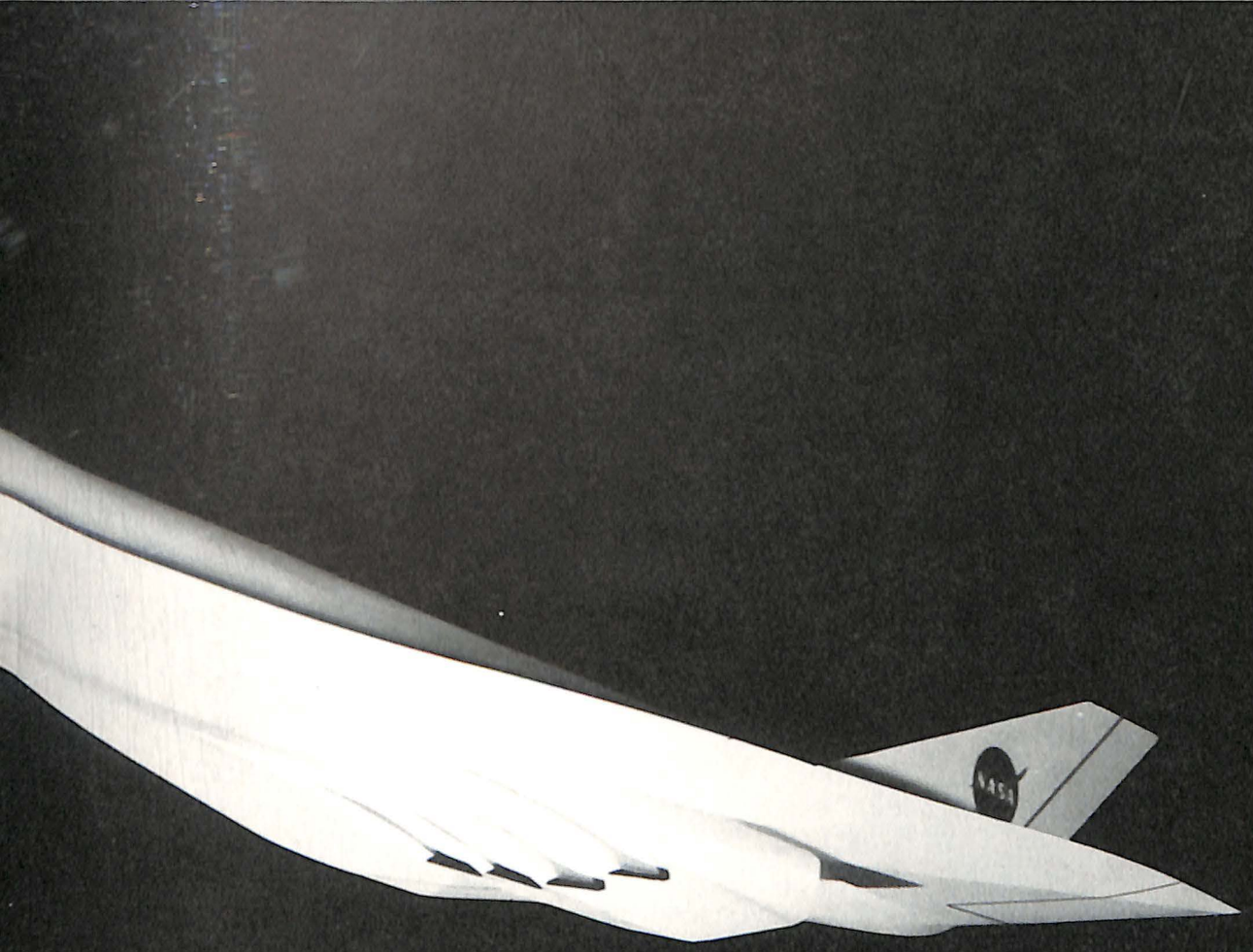
Reduced Aircraft Noise

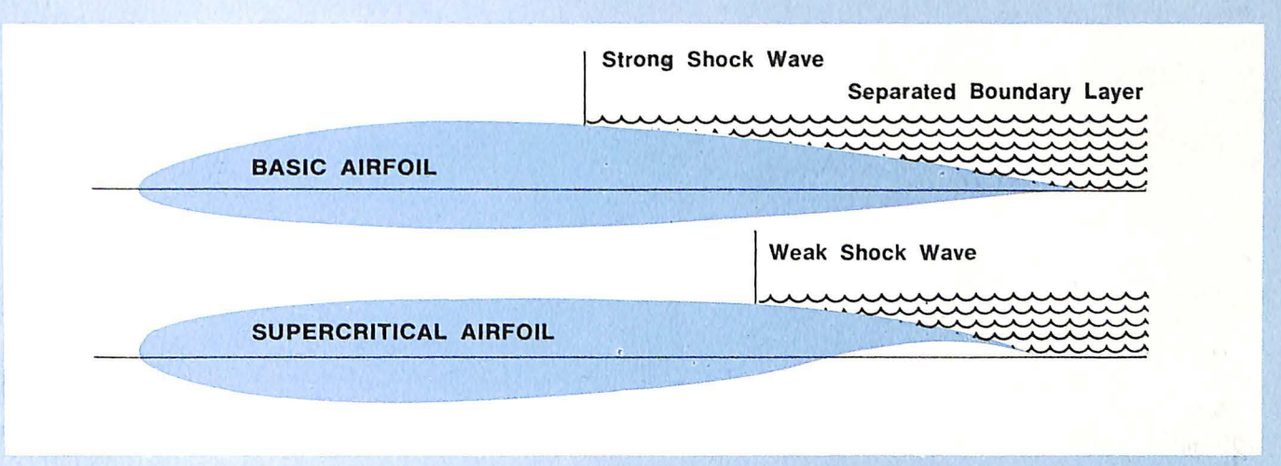
Noise reduction continues to have high priority in our civil aviation research and technology program.

The objective of our engine Refan Program, managed at the Lewis Research Center at Cleveland, Ohio, is to demonstrate the feasibility of significantly reducing the noise of the JT8D engine, which powers the Boeing 727 and 737 and the McDonnell Douglas DC-9. These three aircraft make up the bulk of our domestic fleet. Studies show that it is possible, using existing technology, to quiet these aircraft jet engines without degrading engine or aircraft performance.

The current phase of the Refan Program focuses on developing and testing a modified version of the JT8D jet engine in which the present two-stage fan will be replaced with a larger, single-stage fan. The larger single fan reduces jet exhaust velocity, thereby reducing jet noise an expected 8 to 12 EPNdB (Effective Perceived Noise deciBels). This would reduce the noise-affected areas near airports by 75 per cent or more.

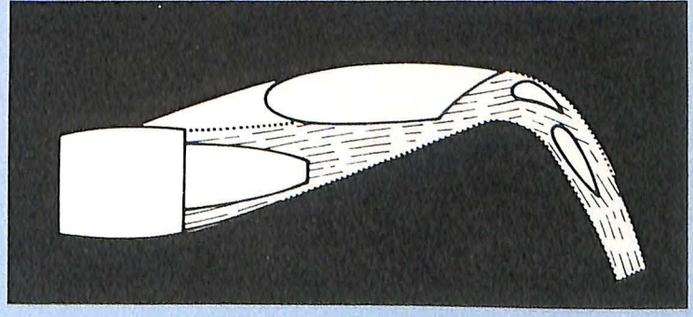
Six engines are being modified by Pratt and Whitney. Boeing will conduct ground tests of a refanned 727 aircraft and carry out design studies of the sound-absorbing nacelle. Douglas Aircraft will conduct flight tests of a refanned DC-9 starting in early 1975.

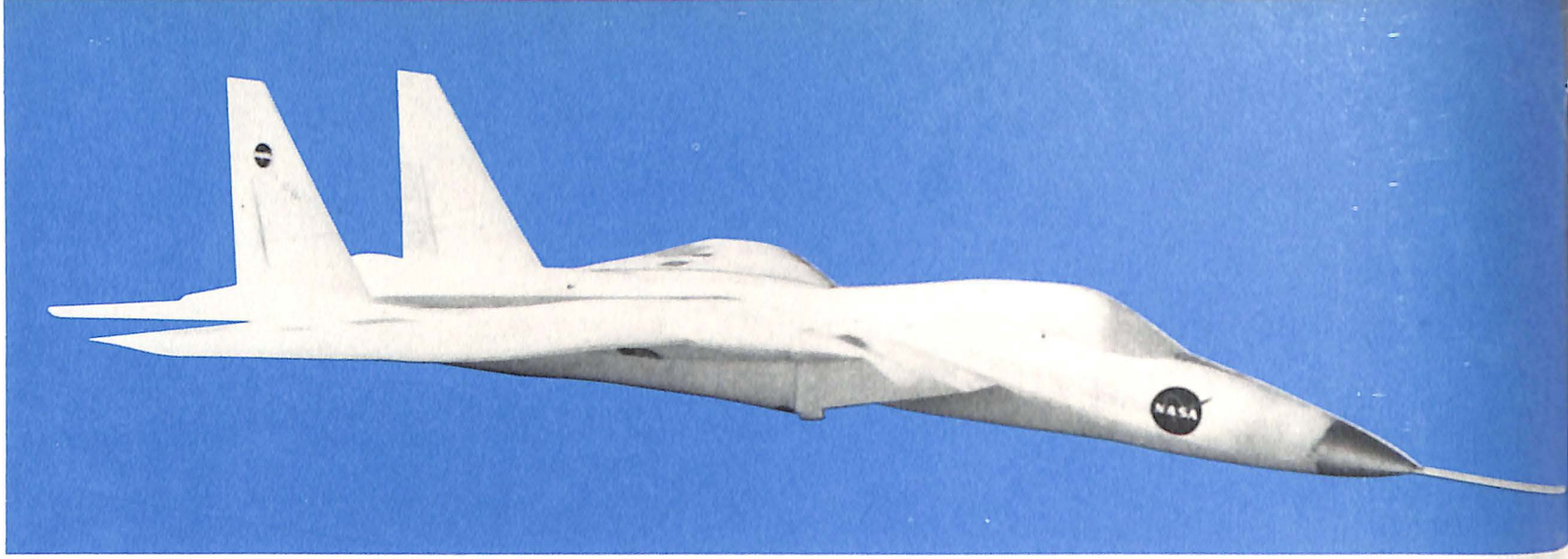




Supercritical wing section is compared with a basic airfoil. The supercritical wing moves the point at which the localized shock wave appears much farther back on the wing. Note reduction of turbulent flow.

A promising approach to increasing propulsive lift is the externally-blown flap. Exhaust from a jet engines can be directed against the flap to augment lifting capability.





The Remotely Piloted Research Vehicle is a new NASA-developed flight test technique. This test model is launched by an aircraft and then flown through desired test maneuvers by a research pilot from a ground cockpit.

NASA's experimental Quiet Engine Program, started in 1969, achieved major program goals during FY 1973 and is continuing in FY 1974. The two ground test engines—one with a low speed fan and one with a high speed fan—demonstrated noise levels significantly below the Federal Aviation Regulation Part 36 requirement. Altitude performance tests are about to start in the first run of the new Lewis Propulsion Laboratory extension. After initial acoustic testing, a sonic inlet (which does not allow forward sound propagation) will be added to the high speed fan engine.

With continuing progress in the reduction of jet engine noise, NASA recently began a program to measure the aerodynamic (non-engine) noise of aircraft in flight by flying with their engines throttled back or turned off. Knowing the various sources of aircraft noise will assist engineers in designing quieter aircraft.

The two-segment landing approach to reduce aircraft noise levels near airports developed by NASA, has progressed to the operational feasibility stage and is being evaluated by a United Airlines jet transport flying in regular airline passenger service. The aircraft descends on a steeper glide path angle during the initial approach and then assumes the normal path for the final approach and landing. It is anticipated that a 67 per cent reduction in the ground area impacted by objectionable noise levels during landing of the 727 aircraft will be achieved by the two-segment approach.

The two-segment approach program at the Ames Research Center, Moffett Field, Calif., is developing procedures and the avionics equipment for this technique. The applicability of the technique for the entire standard-body commercial jet transport fleet will be assessed next year.

Early in 1974, the new Aircraft Noise Reduction Laboratory at the Langley Research Center, Hampton, Va., will open its doors for fundamental research on source noise, its transmission, and its effect on aircraft structure and the surrounding community.

Reduce Aircraft Emissions

The matter of engine emissions as an aircraft growth constraint has led to a major technology effort by NASA. We are conducting programs on emissions from gas turbine engines and their effect on the chemistry and physics of the stratosphere. The Clean Combustor Program, started in FY 1973, is aimed at evolving a practical experimental combustor that can reduce by 75 per cent the present levels of oxides of nitrogen (NOx) with goals for the other pollutants (carbon monoxide, unburned hydrocarbons, and smoke) consistent with potential EPA standards for 1979.

We are heavily involved in support of the Climatic Impact Assessment Program (CIAP) managed by the Department of Transportation, and aimed at an assessment report in 1974. Our stratospheric Jet Wake Experiment is measuring the changes in wake chemistry that take place behind a YF12 aircraft flying supersonically in the stratosphere. NASA also has initiated the Global Atmospheric Sampling Program at the Lewis Research Center to provide monitoring of atmospheric constituents in the troposphere and lower stratosphere. Instrument packages will be installed on 10 to 15 commercial 747 aircraft to provide, for the first time, a substantial, long-time record of changes in the lower stratosphere.

A concept of potential major importance to the reduction of air pollution, while simultaneously conserving our increasingly scarce petroleum reserves, involves the use of hydrogen as a fuel for large aircraft. Hydrogen completely eliminates hydrocarbon pollution and is a more efficient fuel, but the reduction of NO_x may require additional effort. NASA is giving hydrogen serious study as a potential fuel for the more distant future.

Reduce Aircraft Congestion

Airport congestion and delays will continue to grow in the future. New technology must be developed if the air transportation system is to meet the anticipated demand.

Air system congestion particularly affects the shorter distance traveler. To increase airport capacity and make possible the use of small auxiliary runways and airports, thereby reducing congestion, short-haul systems should be capable of tight terminal-area maneuvering and steep, curved approaches, which demand low approach speed capability. To achieve this capability on modern, high performance jet transports, it probably will be necessary to use propulsive energy to augment the lift generated by the relatively small wings.

New Subsonic Flight Technology

NASA propulsive-lift technology for improvement of aircraft low speed flight capability in the terminal area has progressed through years of wind-tunnel investigation and has entered the flight test stage. Initial research with a modified C-8 "Buffalo" airplane is producing valuable flight data on the augmentor wing powered lift concept, where jet engine exhaust is ducted through and out the wings to provide additional lift to the aircraft.

Advanced Medium STOL

For the broader, in-depth flight research required to provide design, operational, and certification criteria, NASA has entered into a cooperative agreement with the U.S. Air Force to participate in the Advanced Medium STOL Transport (AMST) prototype flight testing, and to extend these flights into a NASA technology phase following the military evaluations. The Douglas and Boeing companies are designing and building two AMST prototype aircraft featuring the NASA externally-blown-flap and upper-surface-blowing propulsive lift concepts. Both AMST prototype aircraft use NASA supercritical wing technology as well as the propulsive lift technology. The Ames Research Center manages the NASA participation in this activity, which involves all four NASA research centers. AMST flight research by NASA will be accomplished at the Flight Research Center.

Quiet, Clean Engines

The Quiet, Clean, Short-Haul, Experimental Engine (QCSEE) has been planned for start during Fiscal Year 1974 to demonstrate the performance and low noise technology for very high bypass ratio engines, particularly applicable to quiet, powered-lift, short-haul transport aircraft. The QCSEE technical plan provides for start on fabrication of engine components by June 1974 and delivery of two research engines in 1977 for tests at Lewis. Industrial proposals from GE's Aircraft Engine Group, United Aircraft's Pratt and Whitney Aircraft Division, and GM's Detroit Diesel Allison Division are now being evaluated.

Supercritical Wing

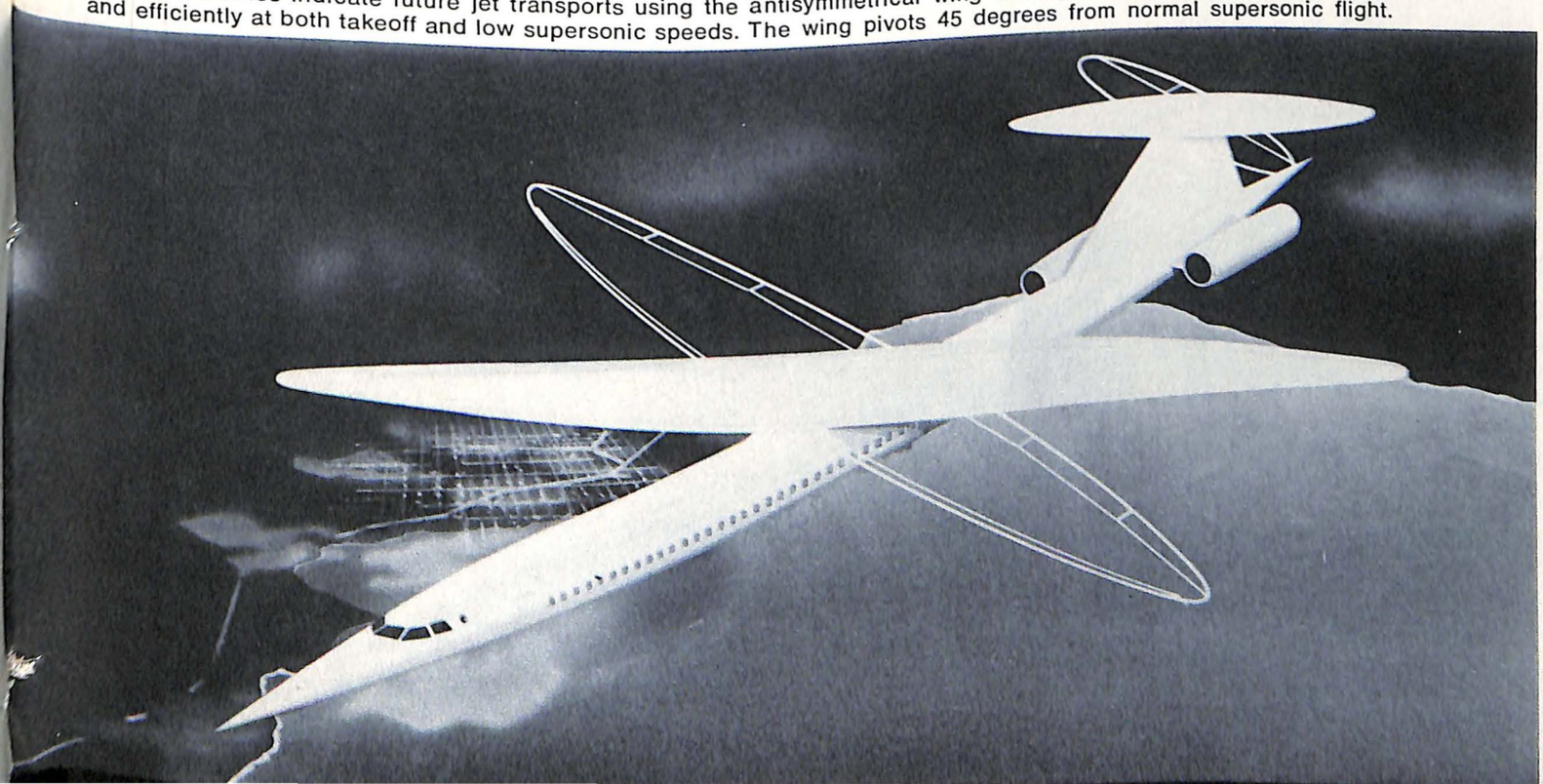
The NASA developed supercritical wing design has completed the first phase of its flight test program, including over 75 flights in a two-year program. The initial flight tests on a Navy F-8 Crusader have successfully demonstrated that the new shaped airfoil does permit an aircraft to operate approximately 15 per cent more efficiently. The supercritical wing shape substantially delays the onset and reduces the intensity of shock waves and air flow separation over the wing as the aircraft approaches the speed of sound. This permits an increase in aircraft flight efficiency.

A supercritical wing is being installed on an Air Force F-111 aircraft for flight tests to begin in late summer. Several U.S. general aviation manufacturers have development efforts underway that will produce a new generation of executive jet aircraft capable of flying farther and faster because of the NASA developed supercritical technology.

According to William P. Lear, developer of the Learjet, the wing will be capable of increasing the cruise speed of the Learjet almost 10 per cent and the range by approximately 20 per cent without any increase in power or gross weight.

Previous studies centered at Langley and aided by Lewis have shown that the application of new technology (supercritical aerodynamics is only one example) can provide a quieter, safer and more economical subsonic transport than current wide-body jet transports. If the latest advances were to be incorporated into a new fleet of three-engine, 195 passenger, 3,000 nautical-mile transports, it could result in almost a 50 per cent increase in return on investment, all other considerations being equal.

Research studies indicate future jet transports using the antisymmetrical wing concept might operate more quietly and efficiently at both takeoff and low supersonic speeds. The wing pivots 45 degrees from normal supersonic flight.



Wind-tunnel testing at both cruise and terminal area flight speeds will continue in FY 1974 on 3- and 4-engine configurations with optimized supercritical aerodynamics, and on a 3-engine configuration at Ames incorporating an antisymmetric wing. Analytical and experimental studies in aerodynamics, propulsion, structures and materials, flight controls and avionics technologies are based on these configuration studies.

Fly-By-Wire

Fly-by-wire is a fast-reacting, computer-controlled electronic system that provides the exact amount of aircraft control response to soften the bumps, sways and lurches of aircraft in turbulent air, resulting in safer, more comfortable passenger travel at high speeds.

Because of its responsiveness, the fly-by-wire control system can be used to reduce directly aircraft loads and structural weight. Additionally, light-weight wires replace the heavy system of metal rods, hinges and hydraulic lines that previously translated the pilot's signals from the aircraft control stick to the control surfaces.

This combined reduction in aircraft weight results in increases in payload potential and in more miles flown per gallon of fuel expended—an economy benefit to the user public.

The use of advanced flight control systems is dependent on the development of the digital fly-by-wire technology. The initial experimental phase at Flight Research Center was a first ever and it established the feasibility of a single-channel digital fly-by-wire system using modified Apollo equipment installed in an F-8C aircraft. Follow-on efforts in FY 1974 will concentrate on the technology of reliable multi-purpose flight computers and on analysis, simulation and laboratory research leading to flight verification by FY 1976.

NASA digital fly-by-wire test pilot Gary Krier recently told the Congress that "by far the best use of the (digital) fly-by-wire technique is to build a control configured vehicle. Such vehicles offer reduced drag and increased lift which means longer range and increased maneuverability, and slower approach and landing speeds, therefore, smaller carrier decks and runway lengths.

"It has been estimated that landing speeds could be cut by 25 per cent and range increased 15 per cent with no sacrifice in mission capability, just by modifying existing aircraft. A much larger improvement in performance could be gained by designing aircraft with fly-by-wire. The digital fly-by-wire/control configured vehicle combination gives us a chance to make a quantum jump in aircraft performance."

Fully Automatic Landing System

A particular thrust of NASA terminal area studies is the technology that would permit the air transportation system to be less weather susceptible and safer by use of fully automatic landing systems. Guidance in terminal area operations will in the future use the microwave landing system now under development by the FAA with assistance from NASA and DOD. We will advance aircraft technology for greater flight path flexi-

STOL aircraft, using propulsive lift concepts like the augmentor wing, could operate from short runways, increase the capacity of existing airports and bring into use smaller community airports to reduce terminal congestion.

bility and control to permit approach path noise reduction and for compatibility with the advanced, congestion-relieving, air traffic control system. Flight research of these systems will be centered at Langley and conducted at the Wallops Island Station. A typical civil transport, a Boeing 737, modified with all-weather systems and advanced powered flight controls, will permit participation of the airlines, airline pilots, airframe and engine manufacturers, and the avionics industry in practical flight evaluation.

Advanced Supersonic Technology

We also requested funds for FY 1974 to support NASA's continuing work in advanced supersonic technology. The objectives of this program are: (1) to provide an expanded technology base for future civil and military supersonic aircraft, (2) to provide the data needed to assess the environmental and economic impacts on the United States of present and especially future foreign supersonic transport aircraft, and (3) to provide a sound technical basis for any future consideration that may be given by the United States to the development of an environmentally acceptable and economically viable commercial supersonic transport. I should emphasize that the NASA request does not include any funds for initiating development of a supersonic transport, or in any way commit the United States to such a development.

These technology studies include a variable-cycle supersonic engine designed for efficiency over the required flight conditions. With the ducts extended in subsonic flight, the engine would perform as a high bypass ratio turbofan configuration with reduced noise levels and low specific fuel consumption. In supersonic flight, with the ducts closed, the configuration becomes an efficient low bypass ratio turbofan engine.

Several elements in the structures and materials program are important to the achievement of reduced structural weight of advanced military and civil supersonic aircraft. The use of titanium and high-temperature composite materials is expected to yield large savings in weight; however, the technology must be advanced beyond the present state-of-the-art.

Technology for Military Aeronautics

Currently, there are 19 major military R&D projects. These studies and programs are being conducted cooperatively between the military services and NASA at our four research centers.

The NASA/Army Rotor Systems Research Aircraft (RSRA) will enable the operation and performance rating of experimental rotor systems under closely controlled flight operating conditions. Pre-design studies were completed in FY 1973. The RSRA will be a winged helicopter incorporating flaps, auxiliary propulsion, a stability augmentation system, and provisions to isolate rotor vibration and measure rotor loads. Detail design and fabrication of the vehicle will be initiated in FY 1974, leading to research flight tests at Langley in FY 1976.

NASA recently selected Bell Helicopter Company to design, fabricate, and test two Tilt Rotor Research Aircraft for use in another joint NASA/U.S. Army "proof of concept" flight research program. The tilt rotor aircraft concept uses large rotors mounted at the aircraft's wing tips for vertical takeoff and landing like a helicopter. Once airborne, the rotors are tilted forward to provide cruise propulsion like that of turboprop airplanes. The combination of longer ranges and higher speeds (potentially in excess of 400 knots) with the utility of the helicopter shows considerable promise for Army air mobility missions as well as for improving short-haul air transportation and reducing airport congestion in civil applications.

The ILLIAC, an ARPA developed super-speed computer with parallel processors, is now on line at Ames where it is being used to develop computational aerodynamic methods. These methods will make it possible to use the computer much the same way we now use the wind tunnel for fundamental aerodynamic investigations to design and evaluate configuration concepts expeditiously.

The Joint USAF/NASA F-111 with a supercritical wing will fly at Flight Research Center in early FY 1974. Remotely piloted 3/8 scale F-15 spin investigation vehicles will be dropped from B-52's starting in early FY 1974. The list is long.

Aviation Safety

NASA's program in aviation safety emphasizes research on the approach and landing flight phase. New technology to avoid accidents will come from many programs including Terminal Configured Vehicle and Avionics, Wake Turbulence Hazard Avoidance, Runway Hazard Avoidance, Cockpit Human Factors, and Meteorological Hazards Research. In addition, NASA research in Fire Retardation, Engine Rotor Burst Protection, and Crashworthiness will provide the technological basis for increasing the survivability of aircraft accidents. Our joint DOD/NASA program on combat aircraft stall/spin resistance technology is ongoing and long term in its objectives.

General Aviation

NASA has established a General Aviation Technology Office to develop the technology base for the design and development of safer, more productive, and superior U.S. general aviation aircraft. It has been projected that some 500 million intercity travelers will be using general aviation aircraft by 1985. The safety program concentrates on approach and landing factors such as improved stall/spin characteristics, and terminal area piloting procedures. Experimental studies, which will bring forth new technology for improved vehicle design, include the development of a series of general aviation airfoils and design techniques for general aviation crashworthy structure.

Laboratory Research Environment

As a nation, we require a superior aeronautical research and technology organization, one that fosters creative work responsive to the goals of the nation. This organization must work in the most advanced facilities and most important of all the researchers and technologists must be outstanding in their fields. We sincerely believe this environment exists in the Aeronautics program at our NASA Centers, Langley Research Center, Lewis Research Center, Ames Research Center, and Flight Research Center.

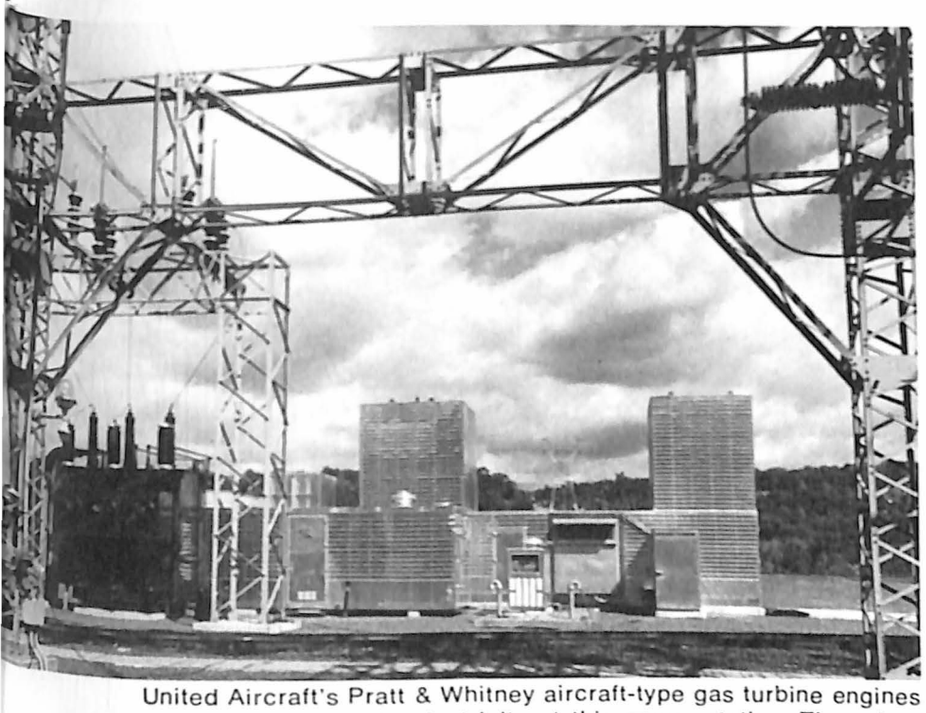
THE GAS TURBINE REVOLUTION

Editor's note: The first gas turbine-powered transport built by a U. S. manufacturer entered commercial service in 1958. That year U. S. scheduled airlines flew 31.5 billion revenue passenger miles and 700 million revenue ton miles of cargo. Last year, less than two decades later, U. S. carriers flew 152.4 billion passenger miles and 5.5 billion ton miles. These astonishing increases (390 percent and 685 percent, respectively) are largely due to the power, efficency and safety of the jet engine, the heart of today's commercal air transportation system.

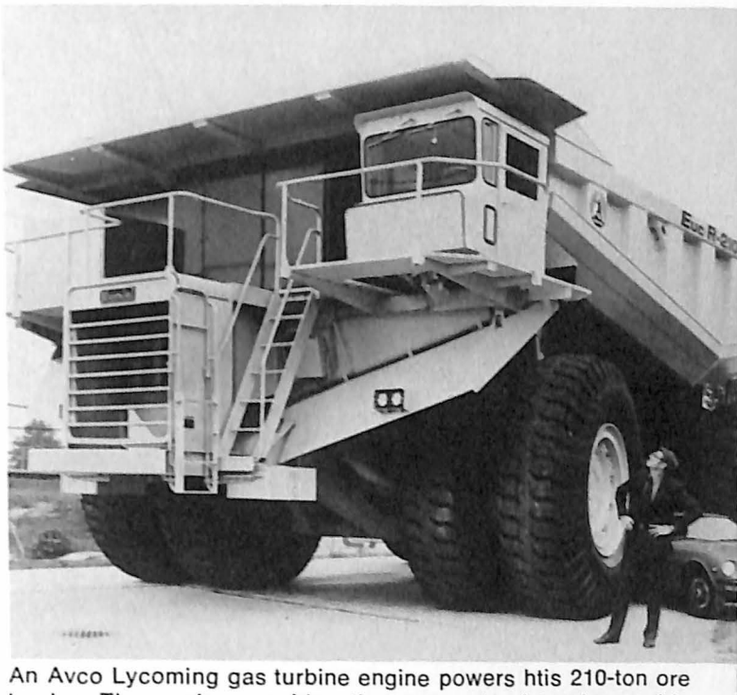
The gas turbine engine is the dominant aircraft powerplant in the world today. Now the powerplant that revolutionized aerial transportation is coming down to earth to serve man as an excellent source of power for a growing variety of tasks.

It can provide power to drive marine vessels, railroad trains, trucks, buses, electricity generating plants, heavy construction equipment and pumps that move pipeline loads. As efficiency continues to increase and noise continues to decrease the gas turbine engine will continue to proliferate, promising a great variety of applications.

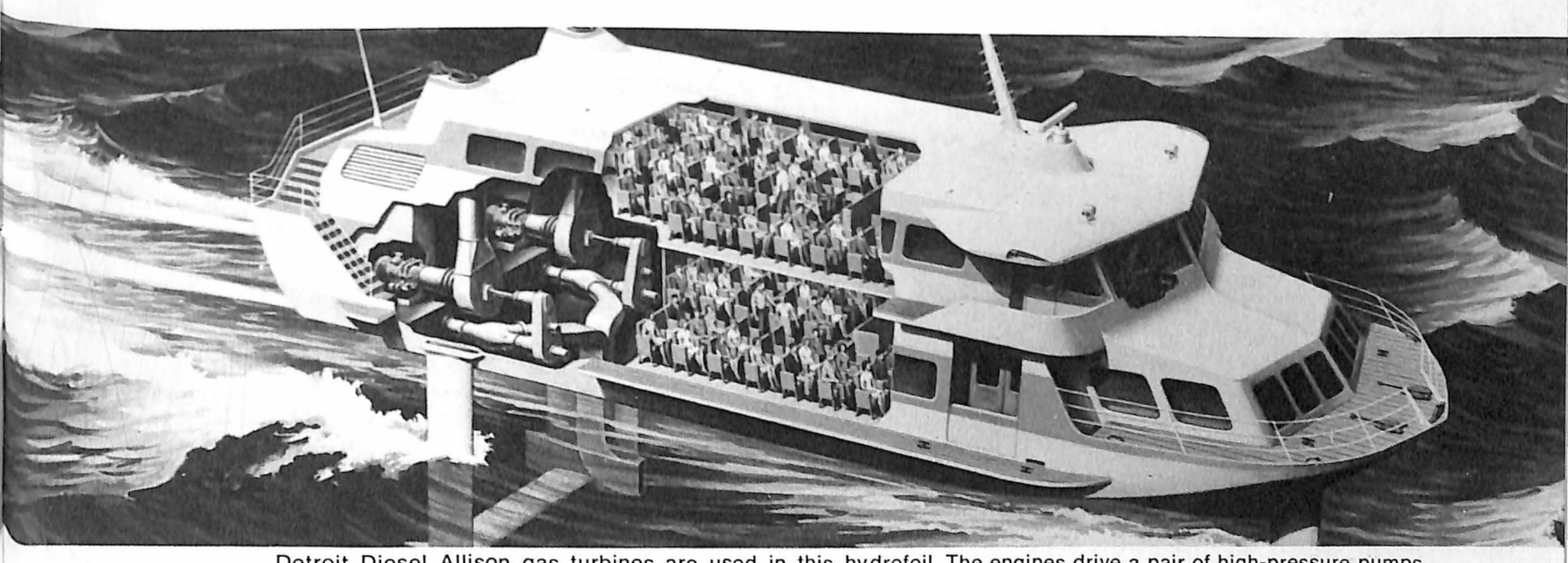
The surprising thing is that it took so long for the jet principle to be applied. A historian for a major



United Aircraft's Pratt & Whitney aircraft-type gas turbine engines are used to generate electricity at this power station. There is a widening acceptance of jet engines as an electrical power source.



An Avco Lycoming gas turbine engine powers htis 210-ton ore hauler. The engine provides the power for interchangeable electric motors at each of the trucks four wheels.



Detroit Diesel Allison gas turbines are used in this hydrofoil. The engines drive a pair of high-pressure pumps which expel water at 45,000 gallons a minute to provide thrust and a cruise speed of 50 miles per hour.

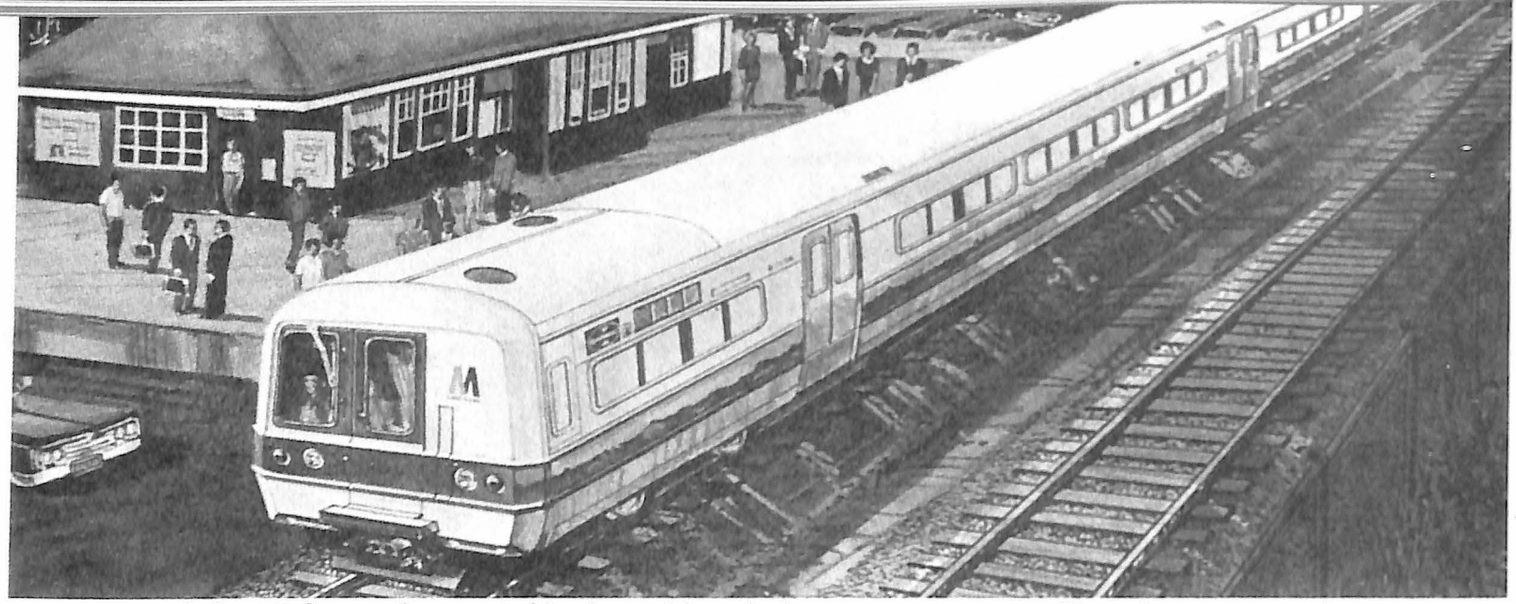
manufacturer of gas turbine jet engines points out that the principle was first put to use more than 2,000 years ago by an inventor with the appealing name of Hero of Alexandria. Hero, it seems, used the jet principle to open the heavy doors of an Egyptian temple. He boiled water in a sphere and permitted the steam to escape through angled nozzles, which caused the sphere to rotate rapidly. This device, with ropes and linkages, pulled open the temple doors.

Hero's invention didn't crop up again until 1,800 years later when an Italian engineer, Giovanni Bianca, in 1629 built a steam-driven turbine device which performed useful work.

Another 162 years passed before the gas turbine, the forerunner of today's aircraft engines, came into being. It was patented in 1791 by John Barber, an Englishman.

However, despite the growing number of inventors seeking to put the gas turbine to work, it wasn't until the late 1920s that a young pilot-engineer in the Royal Air Force—Frank Whittle—came up with the idea that became the first gas turbine propulsion system for an aircraft.

Whittle, who later was knighted for his invention, filed for a patent in January 1930. The idea was far-out for its time because piston engines then were in the 400- to 600-horsepower class, and far from reaching their limits in both horsepower and size.



A Garrett Corporation gas turbine is used in a dual power commuter car. The unique concept of propulsion provides electrical power from existing third rails, as well as being self-powered from the onboard gas turbine. The system automatically switches from one energy source to the other.

Whittle's patents probably influenced the development of gas turbines in pre-World War II Germany. In August 1939 the Germans succeeded in putting into the air the first turbojet-powered aircraft—the Heinkel He 178. However, it was several years before Germany began flying jet aircraft operationally, and they had no material effect on the result of World War II.

Whittle, meanwhile, went through frustrating years of putting his engine design to work. But development moved ahead, and the first Whittle engine flew on May 15, 1941, in the Gloster E 28/29 aircraft. It delivered about 880 pounds of thrust. Whittle's engine plans were furnished secretly to the U.S., but it wasn't until January, 1944, that the two nations jointly announced the jet-propelled aircraft project.

It was difficult then to imagine a propeller-less aircraft. There still is confusion as to how turbine aircraft power plants work. Whittle wrote of this exchange between two RAF officers who had seen the Gloster jet fly:

"How the hell does that thing work?" the first officer asked.

"Oh, it's easy," his friend replied. "It just sucks itself along like a Hoover."

The only similarity between a vacuum cleaner and a jet engine is that both pull in air. It is not the action of the hot gas pushing against the outside air that drives an aircraft. The forward push, or thrust, is the reaction to the high pressure generated by burning fuel in rapidly moving compressed air and allowing the expanded exhaust gases to shoot out the rear of the engine. Essentially, this generation of great thrust follows Sir Isaac Newton's laws of motion that state that every action has an equal and opposite reaction. The flow of a mass of gas or liquid under pressure through an opening or nozzle generates a propelling force in the opposite direction, just as an untended fire hose will whip wildly in reaction to the high pressure stream of water coming out of the nozzle.

The jet engine basically consists of a compressor section composed of sets of blade-tipped wheels that pull in air and compress it, a burner section in which the fuel is burned in the air, and a turbine section through which the very hot, high pressure expanded gas passes out of the engine.

The turboprop engine, which preceded the pure jet in commercial use, differs in that the energy produced within the engine is used to drive a propeller. This is done either by using shafting from the power turbine to turn both the compressor and the propeller or by putting a free turbine that is unconnected to the compressor drive into the stream of hot gas and using the energy from the free turbine to drive the propeller.

Power of the first gas turbines was measured in a few thousand pounds of thrust and they used, for power produced, huge quantities of fuel.

But the military services were delighted with the jet engine. The piston engine was nearing its limits of practical size and power. The jet could deliver sustained speeds that military requirements demanded. But it lacked the economy to earn its keep in airline service.

Constant aerospace industry research and development in the years between the Anglo-American jet-powered aircraft announcement and the installation of such engines on the first U.S. jetliner that entered commercial service in 1958 produced the power and efficiency that made the gas turbine dominant.

This efficiency can be measured by many standards, such as the ratio of weight to thrust generated, and the specific fuel consumption per hours of operation or per revenue-passenger or revenue-ton-miles flown. Perhaps most dramatic and easily grasped, is an example of the record of two commercial gas turbines.

Early in 1969 Pratt & Whitney (United Aircraft) JT3D engines were installed on a Boeing 707 airliner that went to work for TWA. This summer, after more than four years of service, two of the original four engines still on the aircraft were removed for routine scheduled repair.

Each of the two engines had logged 17,261 hours of flying with no more than on-the-wing service. During the same period the aircraft they helped to power logged 8,647,761 miles. This would equal about 18 round trips between Earth and the Moon, or about 346 trips around the world at the equator for the aircraft and those two engines, which were expected to be back on an aircraft and flying again in about 30 days.

Thrust produced by a mass-manufactured jet engine today for commercial use is rated at more than 40,000

pounds. Four of the engines produce more take-off power than the lift-off power of the launch vehicle that put the Tiros weather satellite into orbit.

A major reason for this surge in thrust has been the development of the high bypass ratio or turbofan engine. The turbofan differs from the turbojet in that it has a set or sets of large fans, usually located forward of the compressors. The fans accelerate huge quantities of cool air which bypasses both the burner and turbine sections and goes out of the engine as additional propulsive thrust. Thus, the turbofan delivers more power for a given amount of fuel.

However, in non-aviation fields the gas turbine is demonstrating more and more its versatile and flexible capabilities as a power source. They include:

Auxiliary electrical power. Mobile electric stations, powered by aircraft-type gas turbine engines and capable of generating more than 15,000 kilowatts are in service today.

The turbine can be brought from dead start to full power on the line within three minutes. When used for peak-load periods on a transmission system, the engine will automatically start up, sequence, synchronize with the line and then immediately go to the selected load level. While in operation, the unit can be automatically or manually shifted from one load to another.

When employed as an isolated unit, the turbine may be automatically started from the control trailer.

Hundreds of jet engines are in use today as auxiliary or emergency electrical power sources.

Marine vessels. The marine gas turbine has a power spectrum ranging from 500 to 30,000 shaft horsepower that accommodates most marine power propulsion requirements.

The gas turbine's enormous power is harnessed by replacing the jet exhaust nozzle with an expander, or power turbine, to convert the hot gas energy from thrust to shaft horsepower. The power turbine is spun by exhaust gases. Special materials and protective coatings are used to resist corrosion from salt water. Changes in the combustion system permit the use of diesel fuel.

The use of jet engines permits savings of more than 60 percent in engine room space by replacing the large and complex steam turbine plants or diesel engines used to supply power in conventional vessels.

Ground vehicles. Industrial gas turbines are gaining increased acceptance to drive huge off-highway vehicles such as an ore hauler to transport 200-ton loads over rough mining area terrain. Incidentally, the turbine providing the power to move these ore loads weighs less than 1,100 pounds.

The gas turbine is seeking a major role as a power source in the 500-horsepower class for use in trucks and buses. Four firms, including a U.S. aerospace company, a U.S. truck builder and two foreign firms, have joined in an organization that will develop the powerplant, the truck design and other applications.

The first jet-propelled aircraft was flown only 34 years ago. And today, despite astonishing gains in performance and capabilities, the full potential of the jet turbine engine in a wide spectrum of power applications is far from being fulfilled.

AIA

MANUFACTURING MEMBERS

Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Amphenol SAMS Division
The Bunker-Ramo Corp.
Avco Corporation
The Bendix Corporation
The Boeing Company
CCI Corporation
The Marquardt Company
Chandler Evans, Inc.
Control Systems Division of
Colt Industries
Collins Radio Company
E-Systems, Inc.
The Garrett Corporation
Gates Learjet Corporation
General Dynamics Corporation
General Electric Company
Aerospace Business Group
Aircraft Engine Business Group
General Motors Corporation
Detroit Diesel Allison Division
The B. F. Goodrich Company
Aerospace & Defense Products
Goodyear Aerospace Corporation
Gyrodyne Company of America, Inc.
Heath Tecna Corporation
Hercules Incorporated
Honeywell Inc.
Hughes Aircraft Company
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ITT Avionics Division
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Lockheed Aircraft Corporation
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Sundstrand Corporation
Sundstrand Aviation Division
Teledyne CAE
Teledyne Ryan Aeronautical
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Bell Aerospace Company
Bell Helicopter Company
Dalmo-Victor Company
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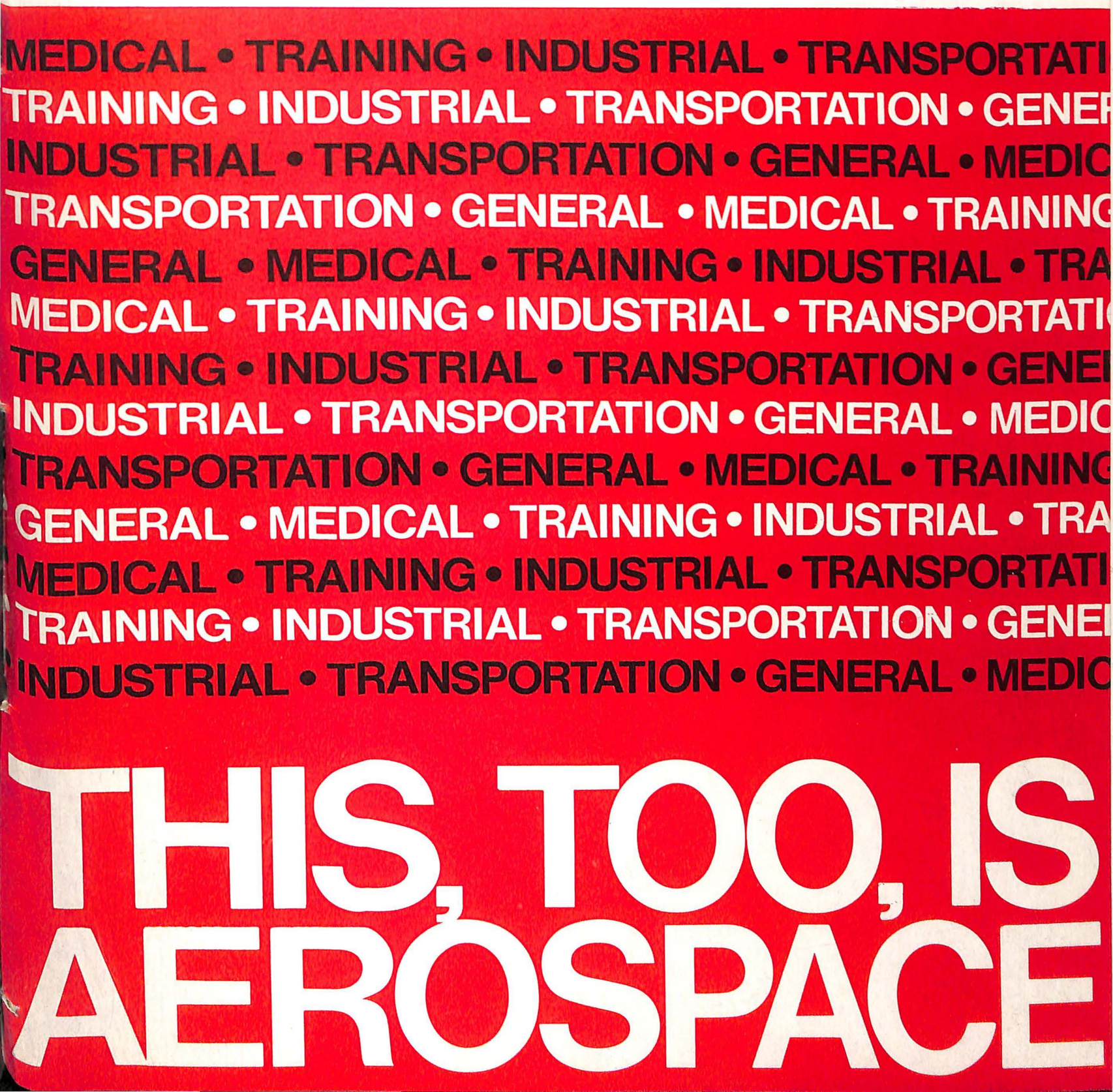
RETURN REQUESTED

The versatile gas turbine engine is utilized as a power source for many purposes, including ships. A General Electric marine propulsion turbine drives the U.S. Navy's new Spruance class destroyers. (See *The Gas Turbine Revolution*, page 14).

aerospace

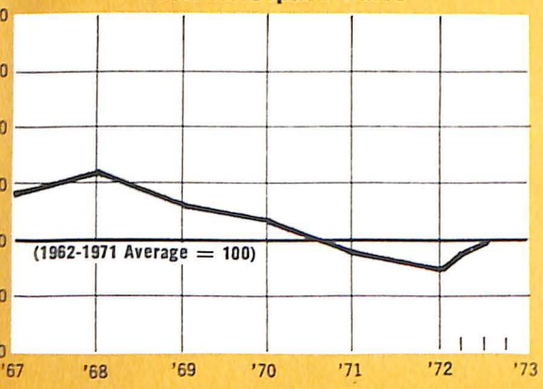
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • DECEMBER 1973



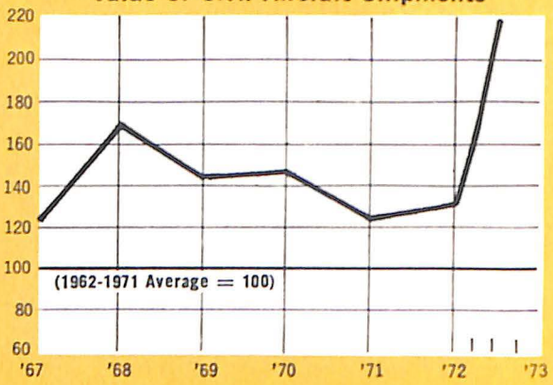
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

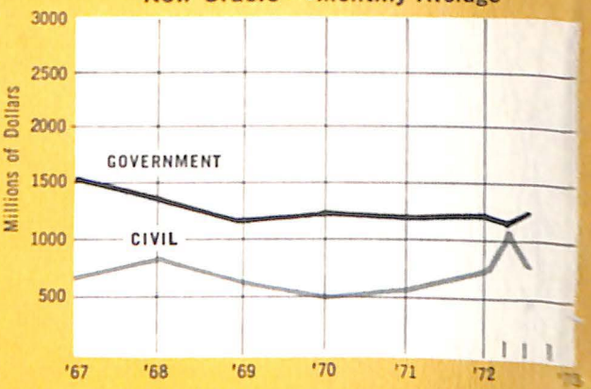


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1962-1971 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	23.5	2nd Quarter 1973	20.4	22.1	23.2
	Billion $	Quarterly	5.9		5.4	5.6	6.5
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,240	June 1973	1,157	894	1,652
Aircraft	Million $	Monthly	733	June 1973	722	720	1,249
Missiles & Space	Million $	Monthly	507	June 1973	435	174	403
Aerospace outlays: Total	Million $	Monthly	1,147	June 1973	1,882	1,230	1,260
Aircraft	Million $	Monthly	665	June 1973	938	680	701
Missiles & Space	Million $	Monthly	482	June 1973	944	550	559
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,057	July 1973	1,636	1,592	603
Aircraft	Million $	Monthly	631	July 1973	955	1,243	396
Missiles & Space	Million $	Monthly	426	July 1973	681	349	207
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	270	Aug. 1973	322	287	293
Expenditures	Million $	Monthly	277	Aug. 1973	289	276	260
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	22.7	2nd Quarter 1973	25.0	28.4	28.0
U.S. Government	Billion $	Quarterly	13.6		14.6	15.5	15.5
Nongovernment	Billion $	Quarterly	9.1		10.4	12.9	12.5
EXPORTS							
Total (Including military)	Million $	Monthly	204	Sept. 1973	248	331	448
New Commercial Transports	Million $	Monthly	59	Sept. 1973	31	70	163
PROFITS							
Aerospace — Based on Sales	Percent	Quarterly	2.6	2nd Quarter 1973	2.9	2.9	3.2
All Manufacturing — Based on Sales	Percent	Quarterly	4.9		4.5	4.5	5.1
EMPLOYMENT: Total	Thousands	Monthly	1,286	Aug. 1973	915	946	946
Aircraft	Thousands	Monthly	699	Aug. 1973	493	512	511
Missiles & Space	Thousands	Monthly	144	Aug. 1973	92	94	95
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.48	Aug. 1973	4.69	4.93	4.98

* 1962-1971 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

By KARL G. HARR, JR.,
President, Aerospace Industries Association

aer-o-space / ˆar′ō-spās′

Just a few weeks ago an investment analyst published a review of the U. S. aerospace industry. In his introduction he quoted the dictionary: "aerospace—the (earth's) atmosphere and the space beyond," and then quickly observed that the aerospace industry could not be contained within such narrow bounds.

What he was saying, as we often have, is that the aerospace industry is also very much down to earth. It is therefore with but limited license that we devote this issue to the theme *"This, Too, Is Aerospace."* We mean, of course, that aerospace is many things. Whether our member companies have the atmosphere and the space above it as their principal endeavor or whether they be widely diversified with a division or two devoted to aerospace—all have a remarkable record of transferring innovative technologies and management techniques to other endeavors.

It's a story we take pride in telling, and space limitations dictate that we can only scratch the surface in these few pages to hint at the host of "non-aerospace" efforts that spring constantly from industrial aerospace experience.

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The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;.

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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THIS, TOO, IS

Understandably, the broad title "aerospace industry" commonly is associated with a new generation of commercial transport or military aircraft, a new missile, or a space mission that puts men on the moon or in an orbiting laboratory.

Nonetheless, for many years there have been some who have suggested, and even insisted, that this high-technology industry transfer more of its recognized talents to a greater variety of products and programs.

Since before recorded history man on Earth has continued to multiply rapidly and has continued to broaden, develop and use his generally limited supply of natural resources, particularly minerals and fossil fuels. In other words, more and more people need more and more food, lodging, energy, medical care, transportation and communications.

Thus it is obvious that as the population grows and natural resources are used we cannot be satisfied with just working hard to stay even. At the same time that we are making the most of what we have, we must work harder than ever if we are to take care of the predictable future.

And that, primarily, is the job of high and ever higher technology.

Given this challenge, aerospace has been responsive. The transfer of technology from aerospace to other fields *has* been going on, and the flow has been far more than a trickle. It has been a flood.

"Spinoffs," "technology transfers" or "diversification" — no matter under what name — have been the natural byproducts of growth in many of our major corporations. This has been especially true among those immersed to one degree or another in aerospace where the name of the game has been pushing forward the frontiers of technology part by part, product by product.

Products, of course, are the more visible accomplishments. More difficult to perceive is the "people" factor of aerospace, involving the transfer of aerospace-trained and oriented scientists, engineers and managers into other sectors of the economy. These men and women carry with them imagination and innovative concepts that can be applied

AEROSPACE

successfully to a wide variety of challenges. As a result, commercial activities that once moved forward in a predictable, evolutionary process now frequently are the subject of revolutionary changes.

Indeed, the interplay between high technology and other sectors of the nation's industry is paying off handsomely.

Recently the Midwest Research Institute carried out a study for the National Aeronautics and Space Administration concerning the effect of research and development programs, largely performed by aerospace firms. The study covered the decade of 1959 - 1969. MRI found that the $25 billion (in 1958 dollars) spent on research and development during that decade had added $52 billion to the Gross National Product, and benefits continue. By 1987 the impact on the GNP (again, in 1958 dollars) will be $181 billion. This is an astonishing return on investment — a return in which no attempt has been made to calculate what other research and development programs have done to provide a better life for mankind.

A word of caution, however,

In our economic system is it important to remember that "a need is not necessarily a market."

With the exception of a few Government agencies, most notably the Department of Defense and NASA, high-technology industry generally lacks customers — single sources that can, to cite just one example, contract with industry to develop solutions to a growing world demand for energy.

So what this industry has done — without an aggregated market — is to tackle single projects here and there, broadening its impact in one locale and another, in one field and then many more. In total, the quantitative and qualitative impact is impressive.

This issue of *Aerospace* magazine, limited in space as it is, is intended to illustrate briefly the fact that there has been considerable diversion of technology by member companies of this association from aerospace into fields where new products and processes are benefitting mankind.

Medical

Clean room techniques for surgery were developed by Martin Marietta Corp. for the National Aeronautics and Space Administration. A surgical team here performs a hip-joint replacement in an atmosphere that lessens danger of infection to the patient.

Portable Kidney Machine

Studies into the use of biowaste purification systems for space applications through the means of chemical sorbents by CCI Corp., in the early 1960's led directly to the development of a portable kidney machine.

About the size of a portable TV set, the dialysis unit operates independently from cumbersome special plumbing and electrical fixtures, does not require a treated water supply and frees the kidney patient from the restrictions of either frequent visits to a hospital or the limits of a permanent home installation.

Such patients now can travel freely with their own units. The unit, called the REDY machine is now in production at a CCI subsidiary, CCI Life Systems, Inc., after an exhaustive development and clinical testing program covering more than five years.

Rapid Data Turnaround

Northrop Corp., through its Berkeley Scientific Laboratories, Inc. (BSL), has a medical data system in operation in clinical laboratories throughout the world. Known as CLINDATA, it provides the physician with a rapid evaluation of laboratory test results for use in patient diagnosis. BSL clinical laboratory systems contribute to improved patient care through dramatically reducing the time that elapses between the moment when a specimen arrives in the laboratory to when the value from the determination is available for reporting to the attending physician.

Also, because the computer system performs calculations formerly done by technologists and eliminates the requirement for transcribing test results, the system actually relieves lab personnel of clerical tasks that have been estimated to consume as much as 30 percent of their time. As a result, highly-skilled medical personnel are free to concentrate on more demanding duties.

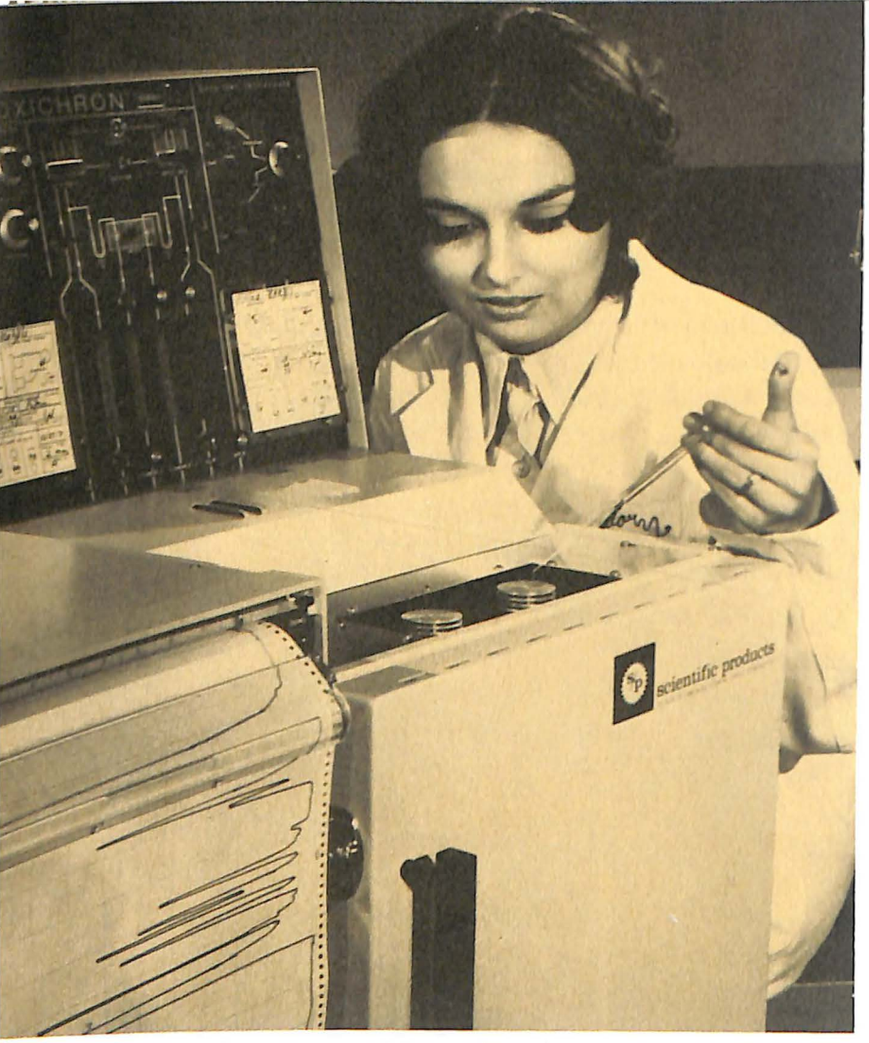
Drug Analyzer

An instrument that dramatically reduces the time required to identify and analyze drugs that do or can harm unconscious or incoherent patients has been developed by Bendix Corp.

Called the Bendix drug analyzer, the instrument is designed to meet the need for accurate emergency analysis of blood and urine obtained from suspected drug overdose victims.

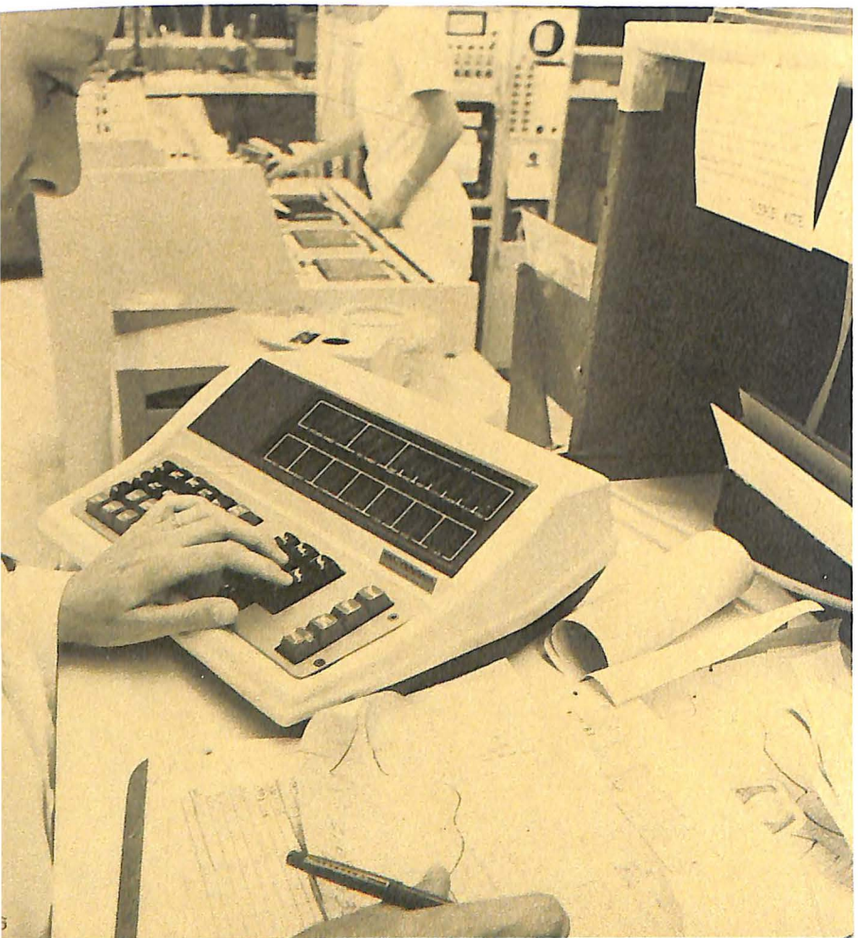
It provides rapid qualitative and quantitative analysis of four drug groups: barbiturates, alcohols, amphetamines and alkaloids, including heroin, cocaine, morphine and quinine.

Until the development of the Bendix instrument,



A technician can rapidly analyze for drug content blood or urine samples taken from unconscious patients with a new system developed by Bendix Corp.

An aerospace-developed remote control data terminal provides laboratory technician with rapid information.



qualitative and quantitative analysis of abuse drugs required the services of extensively trained technicians for periods as long as eight hours.

Medical Equipment Maintenance

A planned engineered approach to maintenance of biomedical electronic equipment, launched three years ago by Bendix, has received wide acceptance among hospital administrations. The program was developed to meet the increasing demands of hospitals for more reliable data and technical assistance in the maintenance and calibration of patient care devices.

The company provides periodic inspection, calibration and safety checks of hospital biomedical electronic equipment, with emergency service guaranteed when required.

More than 60 hosiptals across the U.S. have contracted with Bendix for planned servicing of their electronic equipment.

A unique feature of the program is the information feedback provided by reports to hospital administrations which aids in evaluating both service and the medical equipment. This information system provides failure rates and certifies all work done on each item.

Super Clean Surgery

A germ-control and dust purging technique developed for the production of spacecraft components has evolved into a surgical procedure designed to reduce the risk of infection during operations requiring large incisions remaining open for several hours.

Martin Marietta Corp. designed and furnished the equipment under a NASA contract for use at Denver's St. Luke's Hospital. The technique employs a plexiglass laminar flow clean room deployed inside the conventional surgical theater with operating room personnel wearing clear plastic helmets and clothing impenetrable to bacteria.

The helmet draws air through an opening in the top and carries exhaled breath away through vacuum lines. Headsets provide communications among the members of the surgical team. The result is a highly antiseptic operating environment.

Thermometer In A Pill

A miniaturized transmitter housed in a tiny pill can detect and broadcast very small variations in temperature as it travels through a person's alimentary tracts. Such localized temperature rises often reveal the presence of infections or other disorders and constitute a valuable diagnostic aid.

The pill was designed by scientists at NASA's Ames Research Center to monitor test subjects in

simulated space environments. The pill, no larger than a vitamin capsule, transmits its information during a two-day trip through the human digestive system.

Brain Response to Stimuli

Medical researchers are gaining an understanding of the complex patterns of brain response to various stimuli—which ultimately may lead to improvements in the treatment of epilepsy and various forms of mental instability—through an instrument derived from the electronic development of a film drive system for aerial photography.

Called a multiple microprobe, the device was designed for scientists at the University of Pittsburgh by researchers at Teledyne Ryan under a grant from from the National Science Foundation.

The new device permits the recording of electrical activity in the brain in space and time and within a few seconds. This allows observations of the interrelationships among several cells.

Improved Hearing Aids

An improvement in hearing for those who wear hearing aids has been developed by Bendix. It consists of tiny blocks of microscopic glass tubes which, when added to hearing aids, permit those with impaired hearing to hear only what they want to hear.

The blocks of perfectly parallel tubes, or capillary tube arrays, greatly reduce the volume of all other noises.

The arrays are produced from optical glass fibers which are the basic components of innumerable types of optical and electro-optical devices.

For most applications the fibers are solid, but for the hearing aid requirement they are hollow. The tiny device is cut from a block of solid fibers that have been fused together. The tubes are then made by a special etching process. The capillary arrays also are used as precision filters for biological, chemical and acoustical research work.

The device measures only one-half-inch by one-quarter-inch by one-eighth-inch, yet it contains 300 glass tubes, each having a diameter of less than that of a human hair.

The capillary tube array is installed in a standard hearing aid microphone. All sounds to the rear of the wearer must first pass through the array.

Rear-entering background sounds are slowed down slightly by air friction, but enough to "throw them out of phase" with the sounds which also enter the front along with the sounds the wearer wants to hear. Thus, a significant portion of the extraneous noises cancel themselves out, permitting the useful sound to be heard more clearly.

Systems Analysis and Hospital Design

Architectural design criteria of a proposed hospital in Chicago were developed by Northrop through the application of aerospace management techniques and systems analysis procedures.

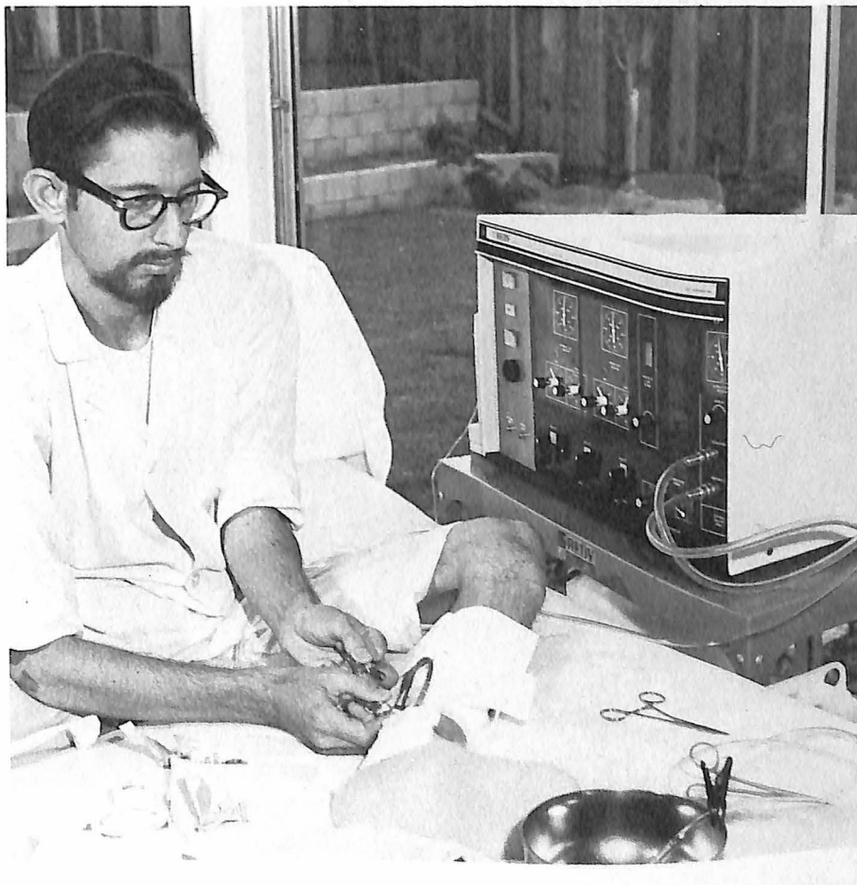
The objective is a completely integrated medical center as a functioning entity rather than "just another pretty building" with all of the medical requirements stuffed in later. The Northrop systems analyses—which followed the same basic process used in the design of a new aircraft—resulted in 16 major design reports which were furnished to the architects for incorporation into the overall design.

Remote Health Care

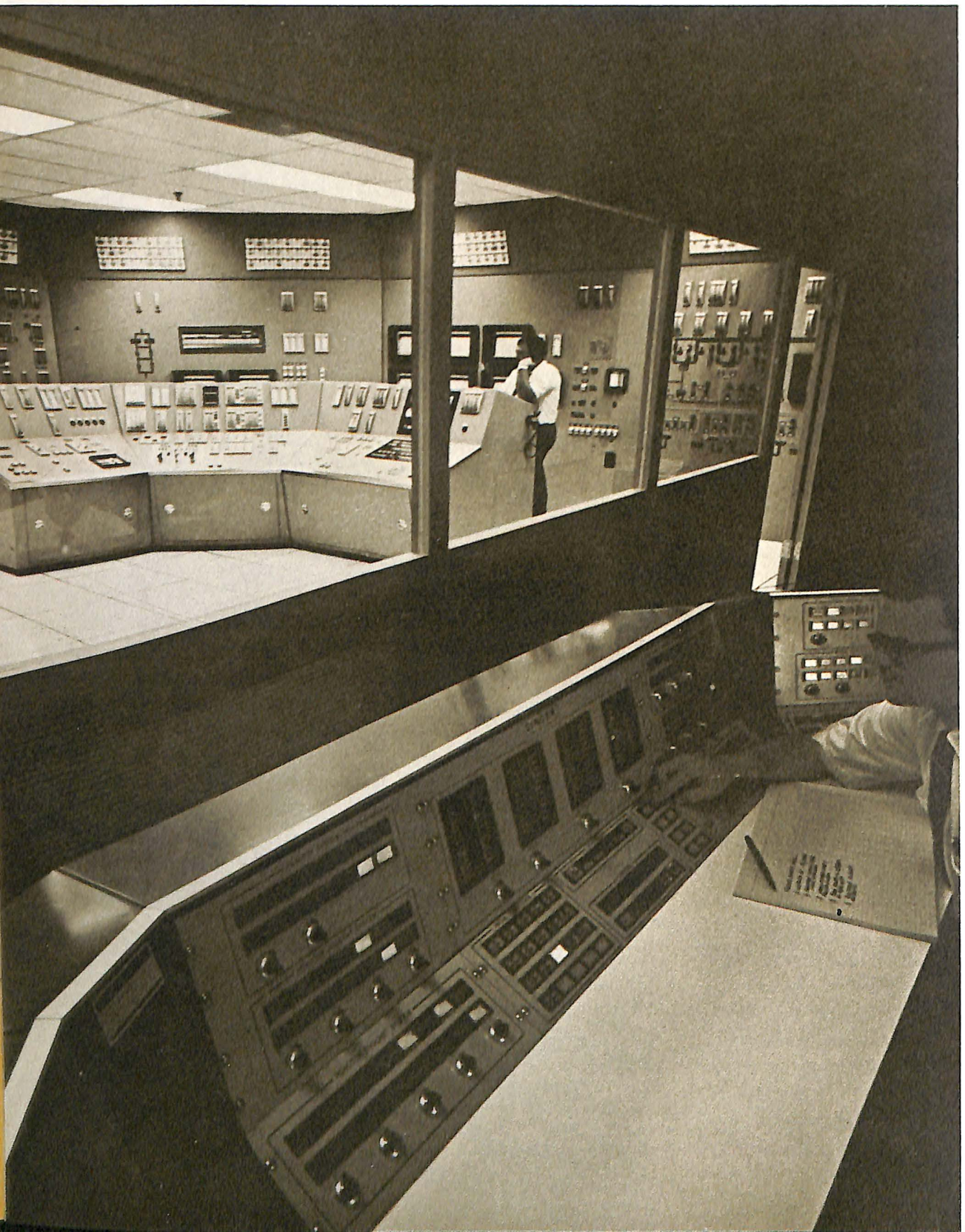
Lockheed is designing and testing a remote health care system which will bring hospital-quality care to a community at a distance from established hospital facilities. This work began in 1973 under a four-year NASA contract.

It combines advanced medical instrumentation with computerized data techniques and voice and picture transmission. With it, specially trained paramedics at remote locations will be able to send X ray photos and other medical data to enable physicians at a central hospital to diagnose illnesses and prescribe possible methods of treatment.

CCI Corp. has developed a portable kidney dialysis machine through its aerospace experience. This machine permits the dialysis patient to travel without recourse to hemodialysis centers.



Training



Singer Company has built the nation's first pressurized water reactor simulator. A mistake in reactor operation is not a disaster, simply a learning experience.

RCA's microelectronic two-way radio incorporates direct application of space technology. One circuit is no larger than a pencil point yet contains the equivalent of 93 separate components.

Tailored Education

LTV Aerospace Corporation's Education Systems, Inc., is training business and vocational students.

Additionally, ESI has moved into several other education-related areas, including training of the disadvantaged and Vietnam veterans under the JOBS 70 (Job Opportunities in the Business Sector) program, education of secondary and elementary students with learning difficulties and the production of books and educational hardware.

ESI began with its college division, which consisted of the long-established skills training group of Vought Aeronautics Company of LTV Aerospace and three business colleges in Texas.

The college division operates under the philosophy that everyone does not want—or need—a four-year college degree, and that today's high school graduates must have the additional education that can best develop their capabilities and enable them to earn a living in an ever-more technical economy. ESI's job as an educator is to offer these students training in the business and vocational skills that are most in demand.

Paging System

Martin Marietta's paging system is a fully digital system that provides reliable paging service for entire metropolitan areas.

By dialing a special number on a standard telephone, a caller is connected to a paging terminal through the telephone system. The number being called is checked by a miniature electronic computer in the terminal that sorts out incoming calls, then sends a call number code to a radio transmitter.

Paging receivers continuously monitor all messages from strategically located city-wide radio transmitters. These receivers, smaller than a pack of cigarettes, and weighing about 4 ounces, recognize, accept and notify subscribers that they are being called by sounding a distinctive "beep" tone. The entire paging procedure is accomplished in a matter of seconds.

A deviation of Martin Marietta's earlier development of an Army digital communication system, the system has been widely accepted by Bell System and independent telephone companies.

Two-Way Radio

RCA has produced a pocket-size two-way radio that incorporates a direct application of space technology to portable commercial communications.

The 18-ounce radio is the first commercial transmitter-receiver to use the same type of small, highly-reliable integrated circuit employed in advanced satellite and missile control systems. It is designed for police departments, industrial firms and other applications requiring high quality, portable communications.

The radio resulted from a major engineering effort which has successfully adapted space technology at a cost suited to the commercial communications market.

Nuclear Powerplant Simulator

The Singer Company has reached into its bag of aerospace training tricks for an answer to the problem of simulation of nuclear power stations.

Using techniques gleaned from years of designing realistic substitutes for spacecraft and airplanes, Singer built a complete replica of a pressurized water reactor control room with fully functional controls and instrumentation.

Nuclear powerplant operator trainees can practice reactor manipulation in the complete confidence that even should they make a mistake during training it merely will be another learning experience.

The 'Reading' Pen

A pen that "reads" price tags, then automatically totals the bill for a department store customer's purchases may make the ubiquitous cash register obsolete.

Instead of ringing up the price of each item being purchased on a cash register, the check-out clerk merely passes the tip of the instrument across a printed code placed on the item.

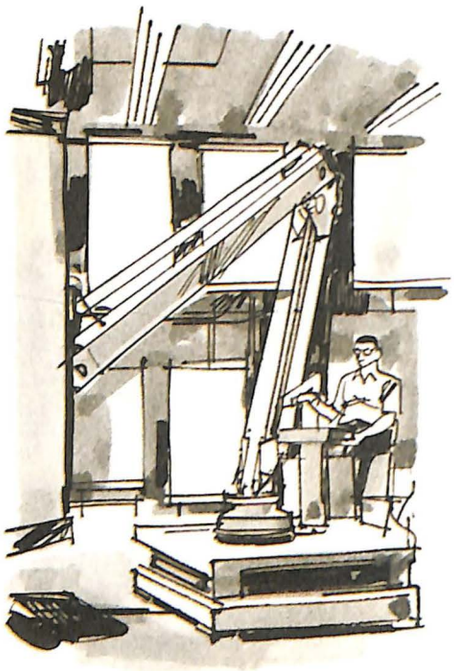
An optical image pickup in the tip "reads" the code which is transmitted to a miniature computer that records the amount, keeps the total of the purchases and updates the store's inventory records.

Developed by Bendix, it is the only device of its type that is completely self-contained—no other electronics are required to provide the necessary computer inputs. The image pickup is surrounded by a miniature light source. The body contains a sensor, which identifies the image and microelectronic circuits which convert the image into computer signals.

The instrument which resembles a ball point pen or pencil, will operate with any type of black and white bar code printed either on a tag attached to the purchased product or on the product itself.

Industrial

A Lockheed engineer demonstrates an experimental self-rescue breathing device designed to provide a one-hour emergency supply of oxygen to miners in the event of an underground disaster.



General Electric has developed an advanced electrochemical machining process, known as Electro-stream, that can produce holes in super-alloy metals as small as 0.005 inches in diameter and with a depth up to 50 times the hole diameter.

Rankine Cycle Mass Transit Engine

About a decade ago the U.S. Air Force let a development contract to build a solar dynamic electric power supply source for space vehicles. Now it is possible to design, build, test and demonstrate the performance and low emission levels of an 88-horsepower bus powerplant. The bus would use liquid propane as a fuel and drastically would reduce pollutant emissions in comparison to existing engines used for urban transportation vehicles.

So today Sunstrand Aviation is demonstrating the feasibility of a closed Rankine cycle system engine with an organic working fluid and turbine expander to provide power to the transmission and driveshaft.

The non-polluting feature of the engine is derived from the fact that the combustion of fuel is more nearly complete in the open air than in an enclosed cylinder.

In the bus engine, a working fluid is circulated through a system consisting of a vaporizer, turbine, regenerator and condenser. The working fluid is completely enclosed and recirculates.

Superalloy Machining

General Electric's Aircraft Engine Group is selling to the metalworking industry patented Electro-stream machining equipment—a proprietary process originally developed for use in manufacturing aircraft engine parts.

The Electro-stream process is an advanced electrochemical machining method that can produce holes in super alloy metals as small as 0.005 inches in diameter and with a depth of up to 50 times the hole diameter. Alloys that have been successfully drilled by this process include cobalt, nickel, titanium, stainless steel, tool steel, and carbon steel.

In addition to offering the Electro-stream equipment for sale, GE will also do contract drilling for metalworking concerns not needing the equipment fulltime.

Potential uses for the equipment include drilling small holes in carburation systems for automobiles, diesel engines, and electrical power generation turbines. Electro stream equipment is safe, efficient, and designed for long life. Drilling is automatic and frees the operator for other duties after startup.

Sophisticated Analysis

A nondestructive method of performing highly detailed quantitative analysis and sophisticated qualita-

tive analysis is embodied in a microprobe analyzer perfected by TRW Systems Group.

The device irradiates a specimen with a high powered beam of electrons and the X-ray result is characteristic of the elements in the test item. Applications range from the determination as to whether a car's headlights were on at the time of an accident, checking the quality of the shaving razor's edge and determining the reasons for the failure of dental alloys in false teeth.

Reaching Out in the Warehouse

Years of developing remote devices for handling and manipulating radioactive and otherwise toxic products have led to a series of devices by General Electric which enormously magnify the strength and reach of the warehouseman.

Called Man-Mate, the machines literally extend the reach and complex operation of the human arm maneuvering bulky and heavy loads. The GE development fits almost precisely into the demands imposed on industry by keeping the man out of the danger zone yet allowing him to reach, sort, inspect, move and otherwise handle an uncountable range of inventoried products. This innovation could revolutionize the storing and accessability of thousands of parts, components and packaged items.

Electrochemical Electricity

An electricity-generating concept which met the needs of the Apollo moon exploration program is being developed as a commercial powerplant to meet the United States' growing demand for more efficient, nonpolluting power production.

The new form of generating electricity is based on the fuel cell, a device that uses an electrochemical reaction to make electricity directly without combustion.

The Apollo fuel cells were developed for NASA by Pratt & Whitney Aircraft, a division of United Aircraft Corporation. Three hydrogen-oxygen-fueled units performed flawlessly on the Apollo missions, providing the electricity the astronauts needed on their roundtrips to the moon. The byproduct water was used for drinking and preparing food.

Today, Pratt & Whitney Aircraft, working in cooperation with 32 gas and combination gas/electric utilities in the U.S., Canada, and Japan, is well along in a nine-year experimental program to demonstrate the practicality and feasibility of on-site generation of electricity using fuel cell powerplants fueled with natural gas supplied through pipes to the site. It is a joint program, launched in 1967, even before the first successful moon mission, supported by the group of utility companies, known as TARGET (Team to Advance Research for Gas Energy Transformation).

Technology Interchange

Rockwell International has a lengthy record of accomplishment in contributing to the commercial utilization of aerospace technology.

For example: Rockwell engineers with microminiaturization expertise developed in a decade of work on missile guidance systems have applied this technology to knitting machines. They developed an electronically controlled knitting machine where a pattern can be changed in a matter of minutes. It used to take hours or even days before this development.

These engineers are also developing a computer-actuated anti-skid braking system for safe stops of large, over-the-highway rigs on wet pavements. The company estimates a potential $100-million market for these systems.

Rockwell, in conjunction with Commonwealth Edison Company of Chicago, is spending $1.6 million on an experiment to prove that the technology used in developing the Saturn rocket engines can be adapted to pollution-free generation of electricity for utilities during peak-demand hours.

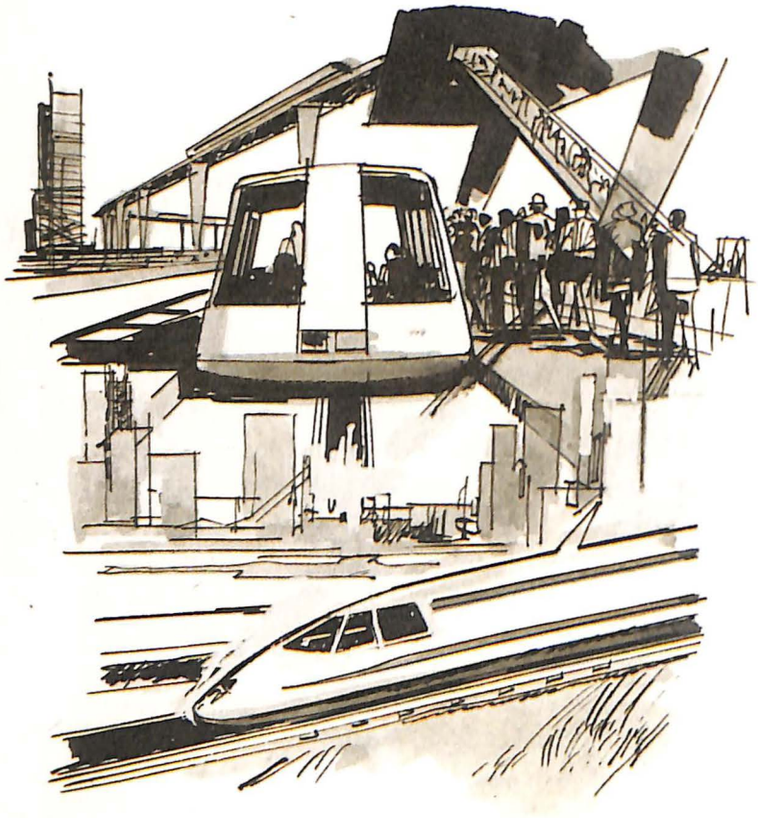
Miner Rescue Device

An experimental rescue breathing device designed to give miners a better chance to reach safety in case of underground fire and explosion, has been built by Lockheed under a research contract from the Interior Department's Bureau of Mines.

It is designed for miners to carry on their equipment belts where they can get it quickly in case of emergency. The rescue breathing unit is designed to supply high-purity oxygen for at least an hour of strenuous physical activity.

The apparatus uses the miner's exhaled breath to release oxygen from a chemical that also absorbs carbon dioxide. Such a device would give miners a better chance of getting out of a mine filled with gas, smoke, and dust than standard "self-rescuers," which screen out carbon monoxide but not other dangerous gases.

Transportation



Cryogenic Transfer

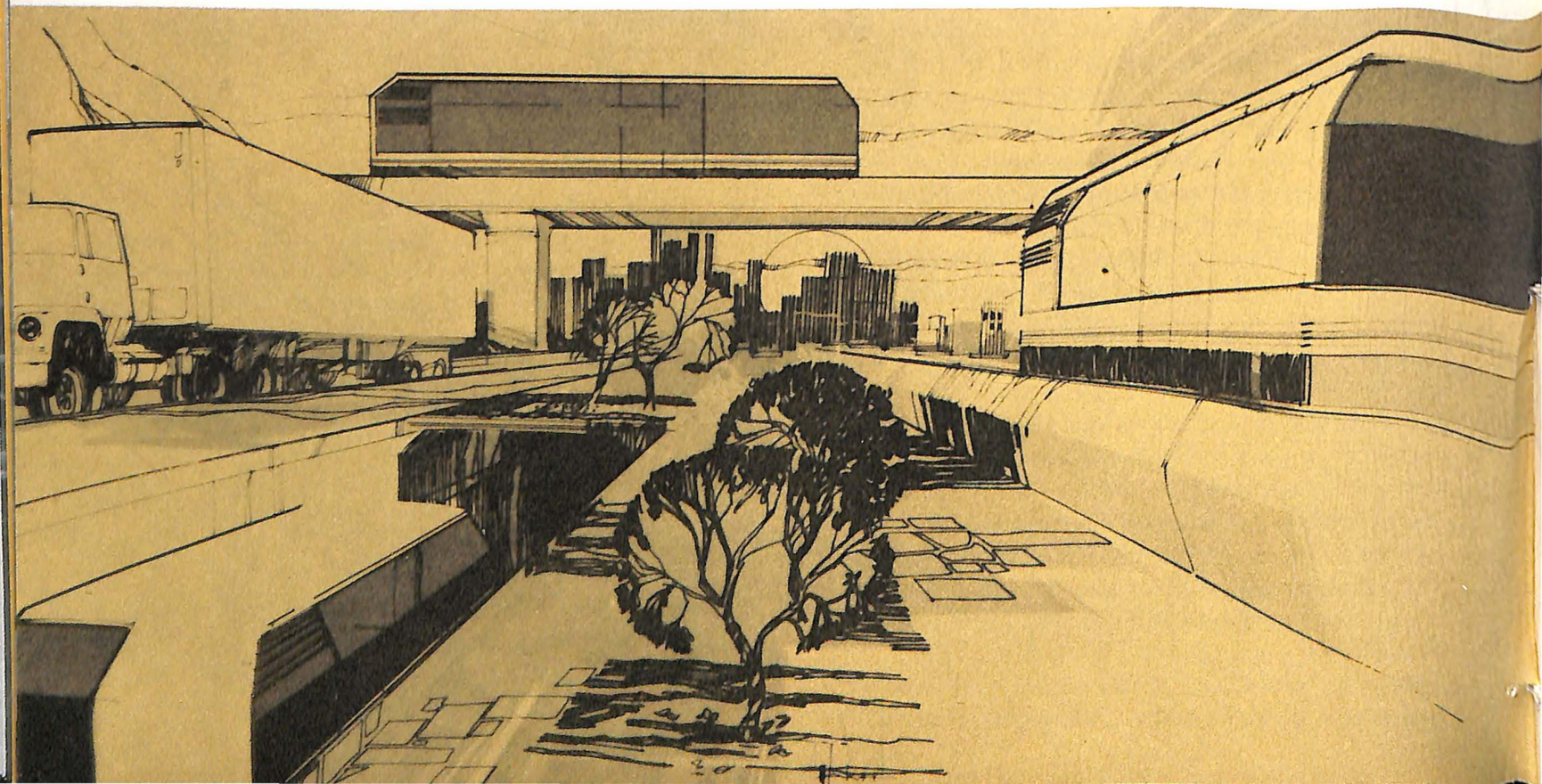
General Dynamics is successfully using aerospace technology to eliminate development risks in building liquefied natural gas cargo systems for LNG tankers.

Key aerospace engineers were transferred from other divisions to the Quincy Shipbuilding Division where seven 125,000 cubic meter LNG tankers are currently under contract for delivery starting in the last quarter of 1975. The engineers brought with them technical expertise acquired through development of aerospace programs.

An example is the transfer of cryogenic (very low temperatures) experience from the Convair Aerospace Division, and the continuing cooperation between the two divisions as needed to economically engineer the cryogenic LNG tanker system. Convair Aerospace Division has in excess of 18 years of cryogenic aerospace technology developed primarily from the very successful Atlas and Centaur Launch Vehicles programs.

Automotive Crash Bags

Thiokol Corp. has successfully applied solid propellant technology to the development of a



collision safety device for passenger vehicles. The resulting propellant produces a non-toxic gas species in the very short time required to protect passengers in a collision. This propellant has been incorporated in a small gas generator design using solid rocket design techniques.

The resulting automotive crash bag inflator weighs under 10 pounds and fits in the steering column of an automobile. In production quantities, it will be available at a low cost and will provide passenger protection within 30 milliseconds after a collision. Test results indicate that thousands of lives will be saved through the application of this aerospace developed technology.

Automatic Transportation

The Ford Motor Company, utilizing a broad spectrum of technologies, has developed an Automatically Controlled Transportation (ACT) system designed to transport people and cargo within congested centers.

This concept in public transportation consists of a fixed aerial guideway with driverless vehicles routed by a computer, resulting in reduced trip times and fewer intermediate stops.

Passengers at stations may select their destinations, and are transported automatically in comfort and safety.

BART System

Rohr Industries has utilized its aerospace engineering capabilities in the design and production of rail transit cars for San Francisco's Bay Area Rapid Transit (BART) system, the first all-new rail transit system to be built in the U. S. in more than half a century.

In every respect, the Rohr-built cars are adapted to the needs of the modern metropolitan transit system. In appearance, safety, comfort and efficiency the BART car was designed and built with passenger appeal as the foremost consideration.

Multi-Purpose Transit

LTV Aerospace Corp.'s Airtrans is a transportation system built for an airport but flexible enough to serve the transit needs of shopping centers, campuses or even central business districts.

Built by LTV Aerospace Corp. for the new Dallas/Fort Worth Airport, it is designed to function well on

LTV Aerospace Corp.'s Airtrans system at the new Dallas/Ft. Worth Airport is more than a people mover. It is a key element in the total ground support system, not only for people but for baggage, mail and supplies.

either end of the transit spectrum: as a slow-moving collection and distribution system or as a higher-speed link between points such as an airport and a downtown area.

Like the small personal rapid transit systems (PRT's) envisioned by many planners for the transport of small groups of persons in congested areas, Airtrans is modern, automatic and quick.

And like buses—the conventional haulers of large groups of people in many areas—Airtrans cars can be linked together to carry many passengers in peak traffic periods.

At the airport, its 68 cars circulate among four passenger terminals, a hotel, a maintenance facility and other stops along a 13-mile route. Passenger versions carry 40 persons, 16 seated and 24 standing.

Hydroaerodynamics

An old idea, new electronics and an up-to-date understanding of airfoils are bringing the smoothness of the commercial jet passenger aircraft to water transportation.

The Boeing Company is deeply involved in a second generation hydrofoil water transport market with its fully submerged systems centered in the jetfoil program—a high speed, 100-ton, passenger-carrying hydrofoil. Boeing designs, both military and commercial, draw on their extensive understanding of aircraft development coupled to the advent of advanced concepts of electronic control systems.

Computers and Congestion

The huge variety of concepts and hardware being applied to urban transit during the past several years is the target of a series of computer-aided analyses developed by Honeywell Inc.

The approach provides urban planners with a basis and methodology allowing intelligent comparisons and the selection of alternatives from a performance standpoint. The application example is the surveillance and control system program operating in the Minneapolis area with Honeywell as systems integrator.

The objective is to minimize peak-hour congestion by metering automobile access and preferential express transit service.

High Speed — On the Track

Garrett Corp. is a major participant in advanced technology for the high speed ground transportation systems field.

Garrett has developed for the Department of Transportation a linear motor research vehicle which is a high-speed steel wheel on steel rail research vehicle. To date, at the DOT High Speed Ground Test Center, Pueblo, Colorado, speeds in excess of 190 mph have been achieved. This vehicle will provide much of the basic technology required for effective high-speed rail systems in this country for operating speeds over 200 mph.

For the near term, Garrett has under construction four gas turbine electric cars for the Long Island Railroad. These cars are geared to 100 mph and are configured to the same exterior and interior arrangements as the current fleet of Long Island cars.

Garrett, together with three other firms, recently completed contract design studies for the ACT I (Advanced Concept Train) under a program sponsored by the Urban Mass Transportation Administration of DOT through its system management contractor, The Boeing Vertol Division. Garrett, in its design, has embodied all of the latest concepts of car body design, interior styling, carpeting, diffused lighting, and air conditioning.

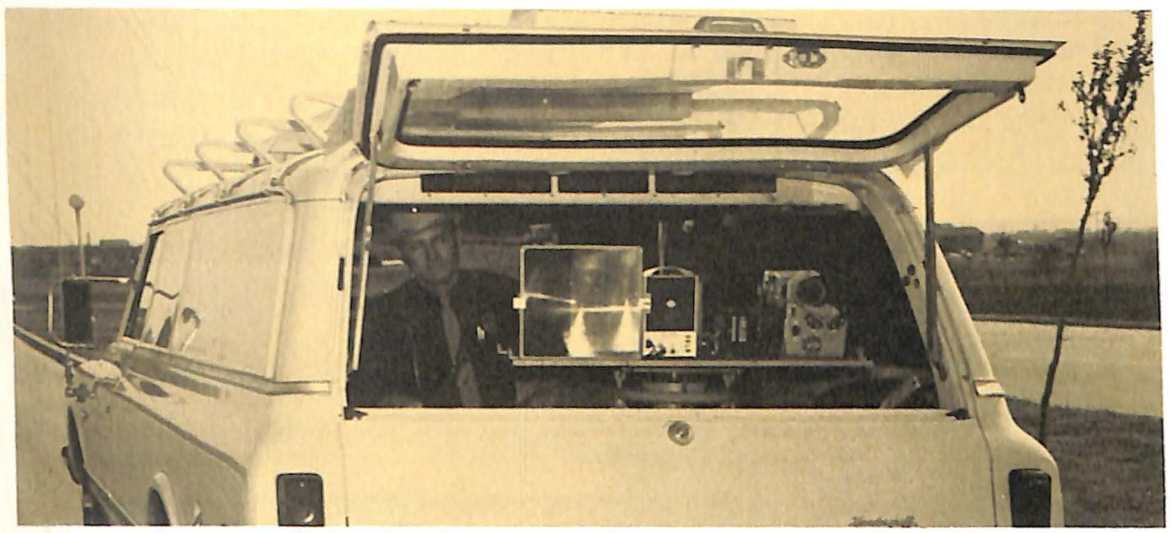
A much more powerful linear induction motor, capable of speeds of 300 mph has been developed by Garrett under another DOT contract for installation in the Grumman Tracked Air Cushion Research Vehicle. Garrett has drawn upon its extensive aerospace technology to achieve the necessary "flight" weight objectives.

Braking the Trucks

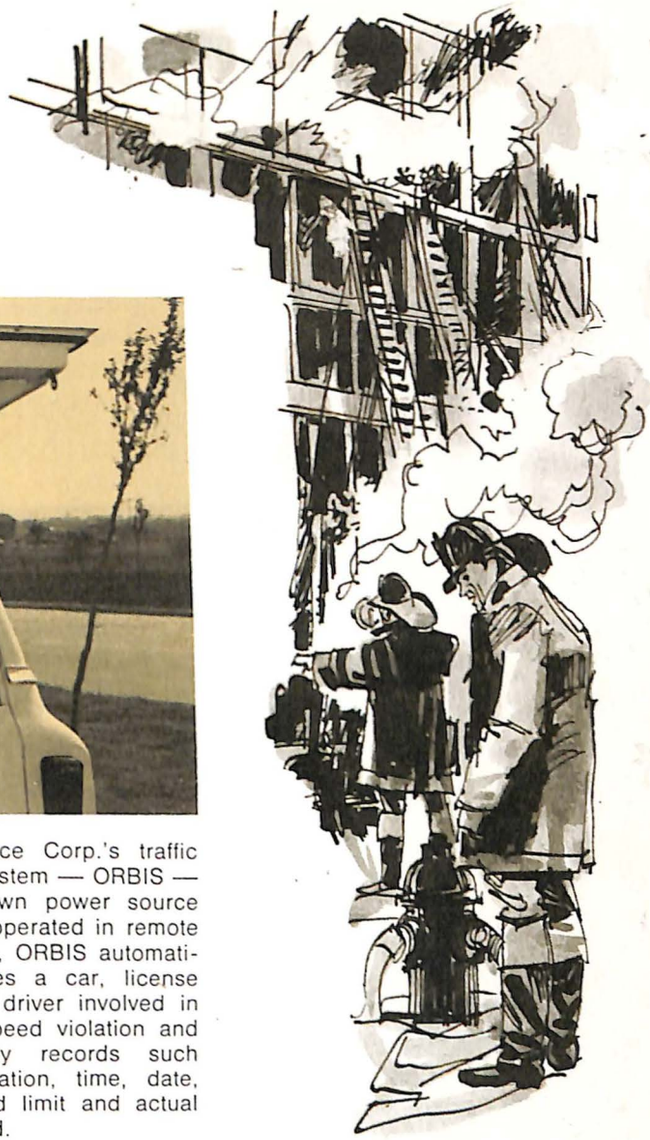
Two developments out of the B. F. Goodrich Aerospace & Defense Division will bring those big rigs running the highways to fast, safe and controlled emergency stops. One is an electronic skid control system born in the need for skid prevention in landing large aircraft and the other is a caliper disc brake with its beginnings going back to the same source. The skid system brings maximum braking force to each wheel just short of the skid situation.

This means that, while the wheels are allowed to continue turning, the braking effect is working at its absolute maximum. The driver maintains complete control and, in effect, brings the big rig to a stop far faster than if the wheels were locked through excessive braking. The caliper disc brake will bring a 10,000 pound rig to a halt from 50 mph in about 174 feet instead of the more than 200 feet normally required. Of simple design and thus requiring less maintenance, the disc brake also is highly resistant to fading because of its inherent heat dissipation ability. The genesis of both products—heading into a growing multi-million dollar market in over-the-road applications—lies in the demands created by high performance military and commercial jet aircraft.

General



LTV Aerospace Corp.'s traffic monitoring system — ORBIS — carries its own power source and can be operated in remote areas. At left, ORBIS automatically identifies a car, license number and driver involved in an unsafe speed violation and simultaneously records such data as location, time, date, posted speed limit and actual vehicle speed.



Multiple Land Use

In the first years of the space age, The Boeing Company leased 100,000 acres of land near the Columbia river from Oregon until the year 2040.

Today that acreage at Boardman, Ore., is the site of a host of multiple use projects, all well conceived under the most stringent environmental restrictions. Uses range from the nuclear generation of power to irrigating dependent crops. These two different uses are tied together because the water supply which cools reactors is the water supply used for irrigation.

A municipal waste recycling project is in being and what once was a barren sage-brush covered desert area devoted to rocket and aircraft engine testing is becoming a huge test bed for multiple land use, providing a constantly replenishing source of knowledge on the intricacies of such involvement with the earth. The 100,000 acres, known as the Boardman Development Project, still is growing, and Boeing continues to conduct tests on the site as required to support its traditional aerospace programs.

The combination of Boeing's imaginativeness and state cooperation, is resulting in land reclamation that grows corn 14-feet high and that ultimately will be the nucleus of a small and prosperous city.

Sliding to Safety

In an emergency, the quickest way off the sixty-story-high deck of an offshore oil platform may be a ride down an inflatable slide of nylon and rubber.

The slide, ranging in lengths up to 95 feet, can evacuate 60 persons a minute if need be and can safely handle the injured and unconscious.

Developed by B. F. Goodrich, Aerospace and De-

fense Products Division, it can be fully deployed, including a detachable life raft to get evacuees out of the danger area, in less than eight seconds after the inflation system is activated.

The slide is an advancement of a similar system Goodrich developed for the Boeing 747 transport.

Several oil companies are considering using escape mechanisms such as this to protect personnel who may number as many as 40 on some of the larger platforms. It is quite possible that more than one slide will be used on a platform so that an alternate escape route is available should one of the slides become inaccessible during a fire or some other emergency.

The system works on a simple gravity principle. When the metal container attached to the edge of the deck is released, simply by undoing two straps, the slide falls out, triggering the nitrogen inflation system. By the time the free end of the slide reaches the water, it is nearly inflated, as is the raft, which has a capacity of 24 persons.

Automatic Traffic Cop

ORBIS III is a unique traffic monitoring system designed by LTV Aerospace Corp. to regulate highway speeds by letting the motorist know it's there and that it can record unsafe speeds—automatically, around-the-clock and in any type of weather.

The device will reduce the death and injury rate on the nation's roadways, and can be used for traffic evaluation and highway planning, marketing and recreational area surveys, border surveillance and for numerous other applications.

Using space age electro-optical and computer techniques, ORBIS III operates unattended and obtains complete evidence of unsafe speeds, including a photograph of the vehicle, the license plate and the driver.

And, like an efficient traffic officer, it instantly records the location, the time and date, the posted speed limit and the speed at which the driver was traveling. This information, combined in a single photograph, then can be used as a basis for issuing a citation.

ORBIS III can record the speed violations—either too fast or too slow—of each vehicle in an area under surveillance without servicing. It completely ignores vehicles traveling within posted legal limits.

Experience with the system indicates that if a motorist knows ORBIS III is installed and that an unsafe speed can mean automatic detection, he will not take the chances he does with today's limited enforcement systems. The device also can point up the need for raising speed limits to more realistic levels in areas where this condition might permit.

Aerial photo shows a section of irrigated land across the Columbia river from The Boeing Co.'s Boardman Development project. The irrigated plots are made possible by using sprinkler systems which take water from a central point and pivot in a large circle around the water tap.

Finding Fires

Northrop Corporation is a participant in the "Four Cities Program" sponsored by NASA and the National Science Foundation to seek means of applying aerospace technology to solving urban problems.

Under the program, leading industrial firms provide an engineer to work with the city manager's office in each of four test cities. The cities are Anaheim, Fresno, San Jose and Pasadena, California. A Northrop project is assisting the fire department in locating fires. When a building is filled with smoke, it is often difficult for firemen to locate the exact source of a blaze. The delay often enables the fire to spread out of control.

The "aerospace solution" was the adaption of a hand-held infra-red detection unit to pinpoint the source of the fire. The device, manufactured as a vision enhancement device, has proved to be extraordinarily effective.

Skyscraper Comfort

A McDonnell Douglas engineer, steeped in the knowledge of the thermal balance system for the Gemini spacecrafts, is using this computer based technique to develop thermal control systems for high rise buildings.

The tiny heat universe of the Gemini living space led him to recognize and apply heat transfer, loss and control to the equally artificial closed human habitat represented by the high rise building.

The knowledge acquired now helps builders pinpoint the correct amount of thermal control needed and minimizes the power, fuel and network of ducts in high structures. And, as with Gemini, outside conditions are kept outside.

Oil Clean Up

A Lockheed-developed and -patented system, known as "Clean Sweep," literally scoops up oil from the surface of ocean and inland waters and deposits it in containers for later removal.

Somewhat resembling the flopping paddle wheel of old-fashioned river boats, Clean Sweep works like this:

A series of metal discs are connected around their outside edge by metal vanes. As the device rotates in a slick, the vanes draw oil and water inside where the oil adheres to the discs.

Stationary wiper blades, mounted vertically between each pair of discs, wipe oil from the discs and direct it into a slotted axle where it is pumped to containers for eventual disposal.

The four-foot-diameter, seven-foot-long device is capable of recovering as much as 200 gallons of oil a minute under ideal conditions. A smaller two-foot-diameter model can recover 44 gallons a minute.

Water Purification

Avco is designing a water purification plant under contracts with the Department of the Interior's Office of Saline Water. The pilot plant will extract fresh water from the sea, and the other contract involves research on a process to extract both dry solids and pure water from inland brackish waters.

The pilot plant contract calls for complete design and specifications for a 75,000 gallon per day plant to desalt sea water, using Avco's unique freeze crystallization process.

Avco's approach to purification involves the freezing of pure water out of salt or impure water in the form of small ice crystals. When frozen, the crystals themselves are pure, while the salt or impurities adhere only to the outside surfaces of the crystals. The impurities are then washed from the ice crystals in a wash column and collected as a concentrated brine solution. The pure water crystals are then melted, resulting in pure drinking water.

Pollution Elimination

Aerojet-General Corp. has designed Japan's largest sulfur dioxide removal system, retrofitting it to the rear of an existing stack of a coal-burning power plant.

After visits to the plant by U.S. Government representatives, they reported: "The reliable performance of this system is of real significance to the United States air pollution control program, since the design ground rules for the Japanese unit are quite similar to many of our power utilities requiring desulfurization systems."

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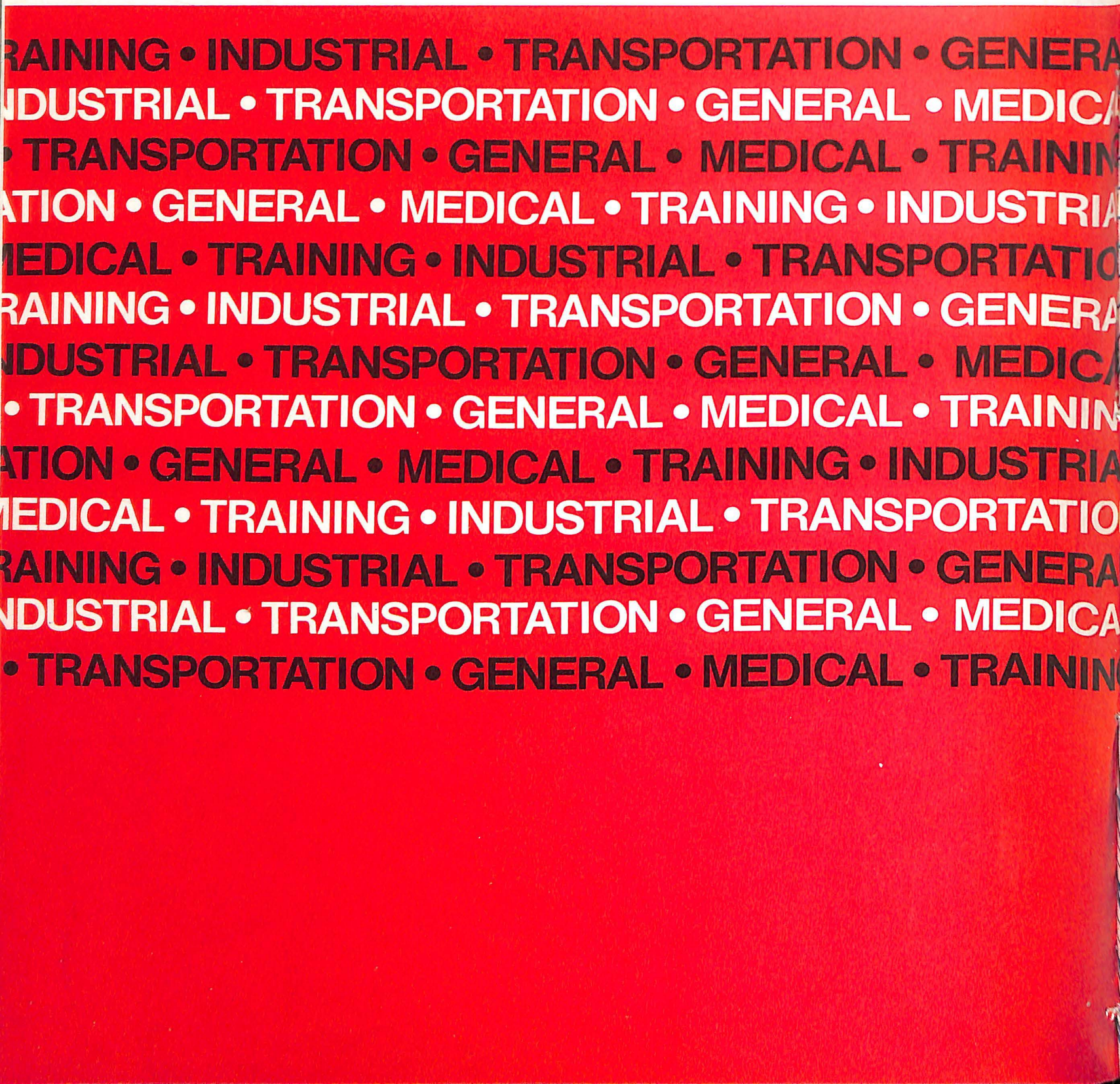

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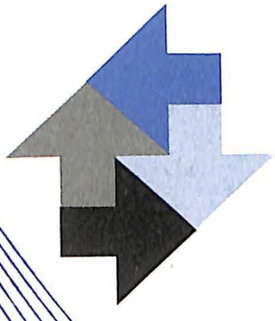
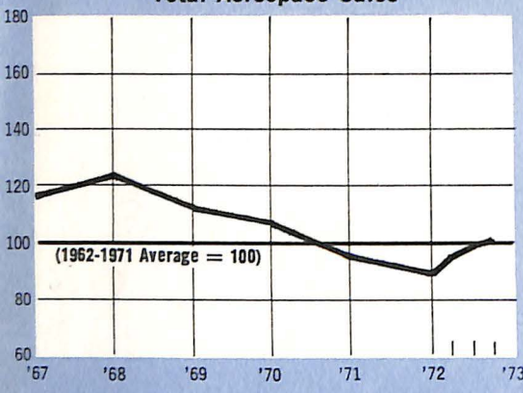
1973 AEROSPACE REVIEW AND FORECAST



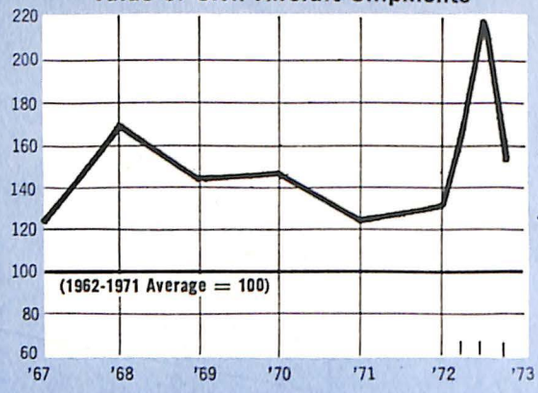
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

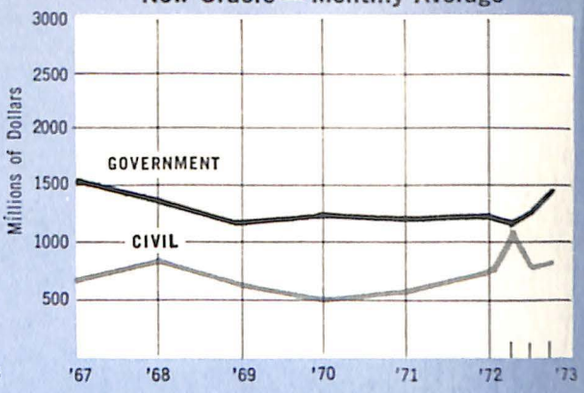


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.

Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1962-1971 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	23.5	3rd Quarter	21.0	23.3	23.5
	Billion $	Quarterly	5.9	1973	5.4	6.5	5.6
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,240	Sept. 1973	1,021	1,363	860
Aircraft	Million $	Monthly	733	Sept. 1973	472	346	506
Missiles & Space	Million $	Monthly	507	Sept. 1973	549	1,017	354
Aerospace outlays: Total	Million $	Monthly	1,147	Sept. 1973	973	1,104	953
Aircraft	Million $	Monthly	665	Sept. 1973	527	626	516
Missiles & Space	Million $	Monthly	482	Sept. 1973	446	478	437
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,057	Aug. 1973	855	603	1,532
Aircraft	Million $	Monthly	631	Aug. 1973	529	396	611
Missiles & Space	Million $	Monthly	426	Aug. 1973	326	207	921
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	270	Oct. 1973	305	161	213
Expenditures	Million $	Monthly	277	Oct. 1973	213	184	193
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	22.7	3nd	26.6	28.0	29.2
U.S. Government	Billion $	Quarterly	13.6	Quarter	15.2	15.5	16.3
Nongovernment	Billion $	Quarterly	9.1	1973	11.4	12.5	12.9
EXPORTS							
Total (Including military)	Million $	Monthly	204	Oct. 1973	299	448	343
New Commercial Transports	Million $	Monthly	59	Oct. 1973	55	163	18
PROFITS (After Taxes)				3rd			
Aerospace — Based on Sales	Percent	Quarterly	2.6	Quarter	2.4	3.2	2.9
All Manufacturing — Based on Sales	Percent	Quarterly	4.9	1973	4.2	5.1	4.6
EMPLOYMENT: Total	Thousands	Monthly	1,286	Sept. 1973	933	947	952
Aircraft	Thousands	Monthly	699	Sept. 1973	503	512	516
Missiles & Space	Thousands	Monthly	144	Sept. 1973	93	95	95
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.48	Sept. 1973	4.34	4.99	5.01

* 1962-1971 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.

† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

THE NAME OF THE GAME STILL IS HIGH TECHNOLOGY

BY KARL G. HARR, JR.
President, Aerospace Industries Association

This first 1974 quarterly issue of *Aerospace* magazine notes that last year saw an upturn in sales and exports of aerospace industry products. However profits still lagged well behind those of U.S. industry as a whole, and unemployment continued on a downward trend, though more slowly.

While it is not too difficult for an industry to note where it has been, it's always a difficult matter when it comes to charting the course ahead.

This is particularly true of 1974 and beyond when no serious discussion can exclude energy — its sources and availability. Mr. Paul R. Ignatius, who as president of the Air Transport Association represents the most effective and integrated transportation system we have today, refers to the airlines' energy problem in an important article in this issue.

Wisely, we think, the government has made it clear that fuel allocation priority must be given to industries of every type — industries that provide the jobs that feed, clothe, house and transport us. Aerospace companies, many of them dependent upon products and services from upwards to 10,000 subcontractors and suppliers, know firsthand that transportation is a rapid, flexible and efficient function without which much of our economic structure cannot operate effectively.

A year ago I noted that the all-important question for the U.S. in 1973 was: "What is the will of this country with respect to technology . . . if we sacrifice technological superiority for the future we must be prepared to pay an unacceptable price in economic progress and national security."

Aside from our current preoccupation with energy, 1973 saw little effort to increase materially the research and development sponsored by the Government, and there has been a continuing lack of understanding, and therefore a lack of encouragement, of contractor-initiated research and development (commonly known as IR&D — "independent research and development,") performed by high-technology industry. In fact, there are perennial attempts to deny any Government sharing of the cost of this type of research and development in the pricing of defense and space contracts.

It is a curious dichotomy that critics of government contractor IR&D have no quarrel with developers and producers of commercial products when they recover their research and development costs in the price of their products, yet such recovey in the puchases by government is viewed with alarm. It would appear shortsighted indeed to discourage the myriad technical efforts initiated by private industry that strengthen the national security, place earth resources satellites in orbit and, through technological transfer, enhance our national problem-solving capacity in many areas.

Employment, tax revenues, a favorable balance of trade, and a place in the forefront of international progress in many fields always will be essential to the well being of this nation — and all such factors depend heavily upon superiority in research and development.

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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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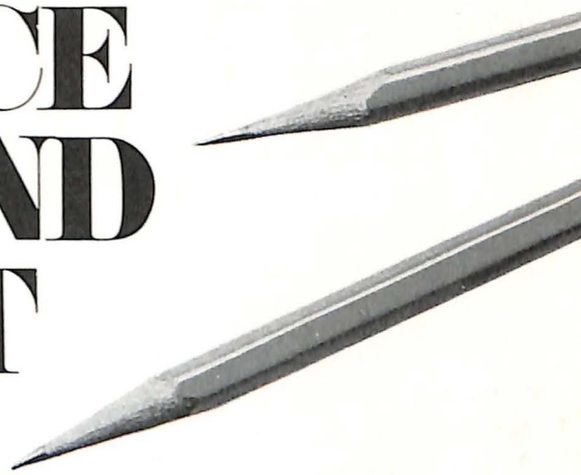
1973 AEROSPACE REVIEW AND FORECAST



Sales by the aerospace industry during 1973 increased to an estimated $24.9 billion, more than 10 percent above 1972, Karl G. Harr, Jr., president of the Aerospace Industries Association, reported in a recent yearend review and forecast.

Much of the gain was due to increased commercial deliveries of wide-bodied transports, helicopters and general aviation aircraft. More than 40 percent of such production was exported.

In forecasting a sales decline to $24.7 billion in 1974, Mr. Harr warned that this estimate might well be optimistic if interrelated energy and economic factors seriously impact traditional buying patterns. He added that "while projections for the short term can be made based on past performance and normal growth patterns, no one today can assess accurately the effects of continued fuel shortfalls on production and sales."

Highlights include:

EXPORTS Due to the favorable effects of two U. S. dollar devaluations as a factor, the export of aerospace products rose a dramatic 27.6 percent to a value of $4.9 billion. This represents a most significant industry contribution to the nation's balance of trade ledger, especially in view of a 1973 increase of 37.5 percent in aerospace imports to a total of $777 million.

NATIONAL SECURITY The Department of Defense remained the biggest single buyer of aerospace products with purchases totalling $13.8 billion in 1973, representing a 3.5 percent growth over the previous year.

COMMERCIAL The most significant growth in sales came from the commercial market sector. A 43.1 percent sales increase in that category during 1973 underscores the current ability of the American aerospace industry to compete in international markets.

PROFITS Consistent with the growth pattern experienced by most U. S. manufacturing industries this year, net profits for the aerospace industry may increase to 2.7 percent of sales after taxes. However, lengthy lead time requirements, increased international competition, and high risks and investment costs associated with advanced technology continue to minimize the aerospace industry's profit ratio. The rate of profit for all manufacturing industries during 1973 is expected to be 4.6 percent.

EMPLOYMENT Personnel statistics fluctuated somewhat during 1973. After increasing to 946,000 in June, the figures began to decline during the second half of the year. Employment at the end of 1973 was about 935,000.

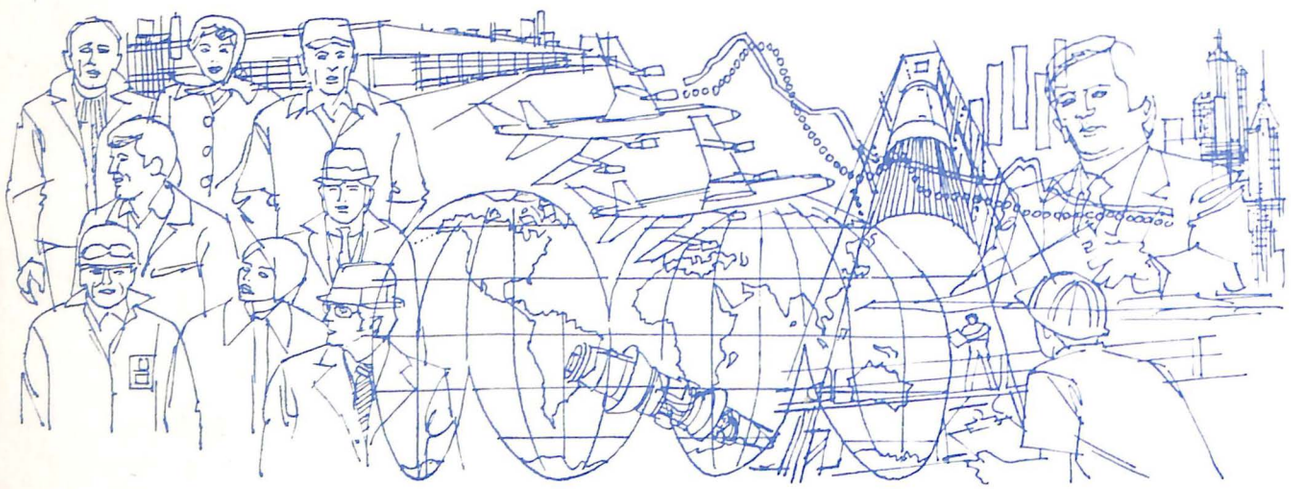
1974 FORECAST

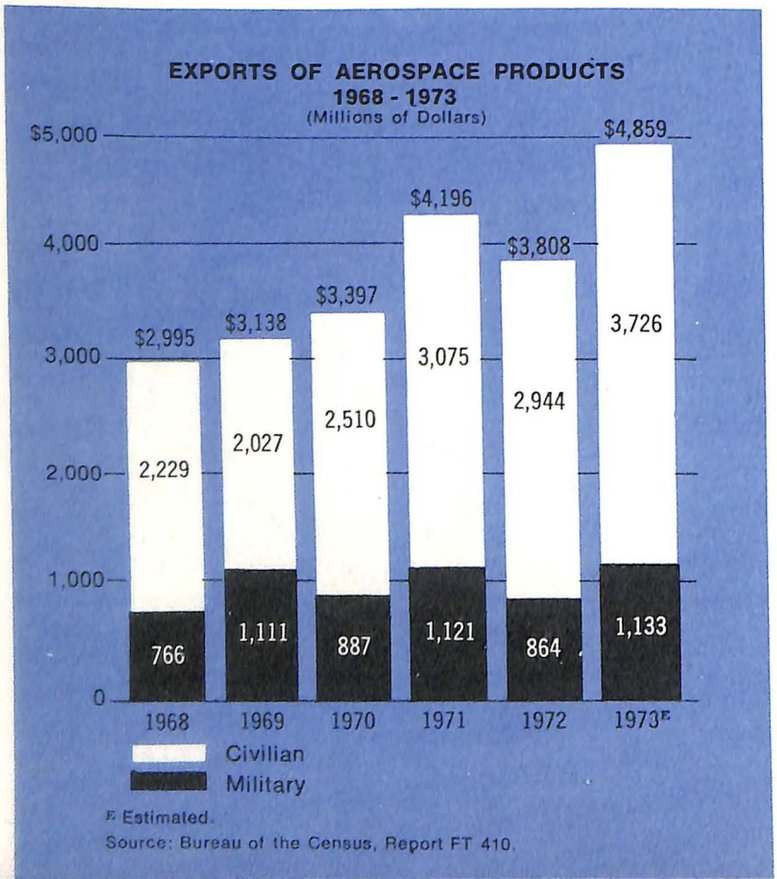
Referring to the 1974 forecast which accompanies the year end review, Mr. Harr stated that "we anticipate a slight decline in total aerospace sales in 1974 with commercial orders being the most affected by the uncertainties of energy supplies. Traditional markets such as Japan and Western Europe are currently reassessing their jet transport and general aviation needs in the wake of the recent fuel shortages. New orders are expected to slacken temporarily as a result," he added.

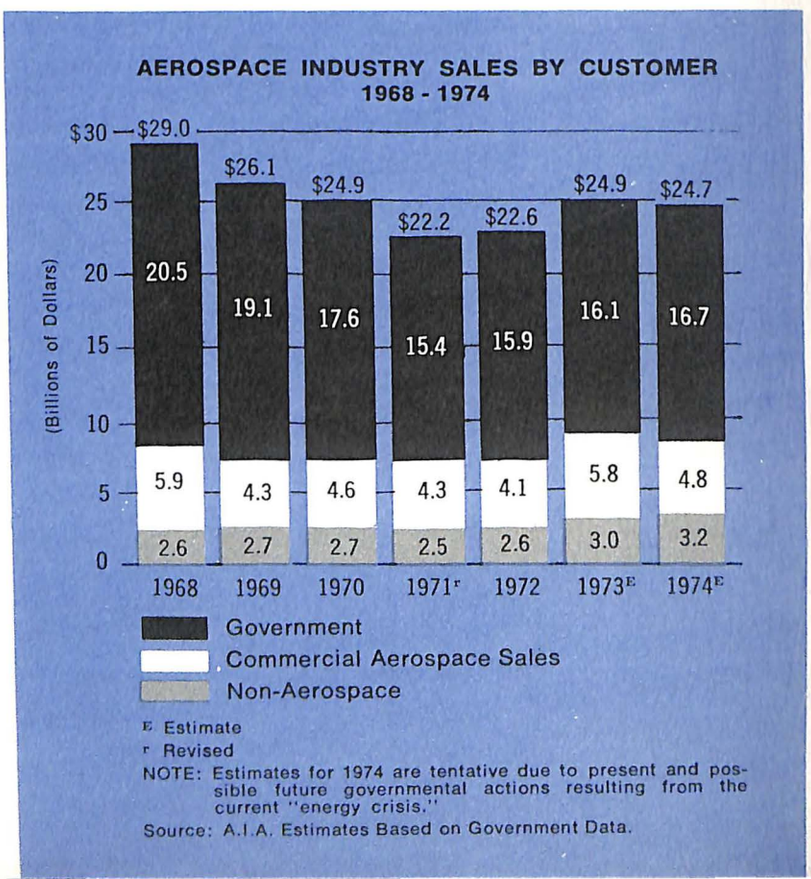
Sales to the Department of Defense in 1974 are expected to show an increase of over one half billion dollars for the year. Purchases by the National Aeronautics and Space Administration (NASA) will show a slight decline. It is expected that aerospace sales to NASA and other non-defense agencies will be down approximately $60 million during 1974.

Consistent with the aerospace industry's efforts to find new applications for its technology, AIA estimates that nonaerospace sales will reach an all time high of $3.2 billion in 1974.

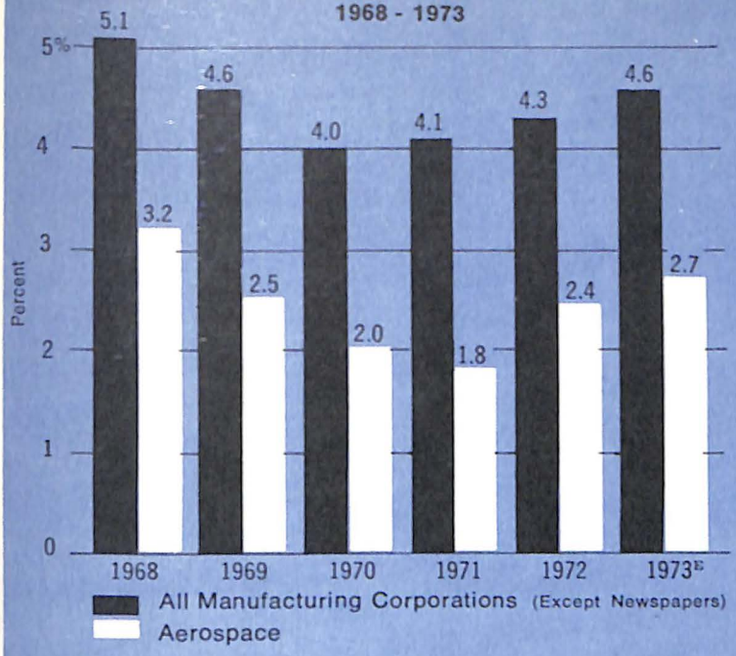
The decline in total aerospace industry sales in 1974 to $24.7 billion will be one of the factors responsible for the further reduction of total employment figures. It is anticipated that employment levels will be reduced to 915,000 during 1974.







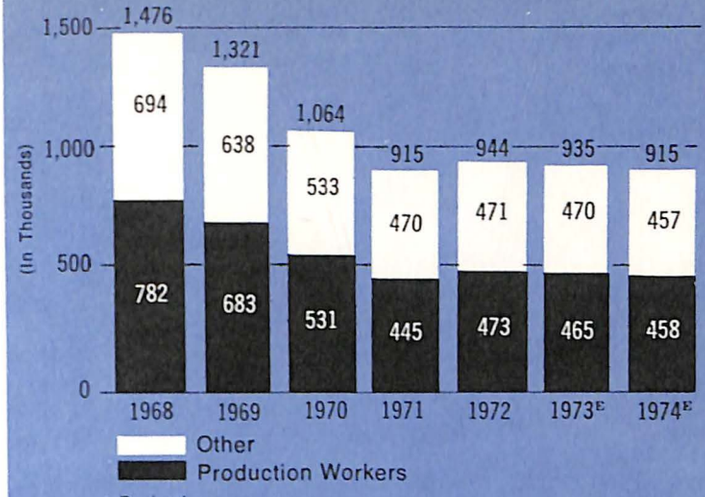
NET PROFIT AFTER TAXES AS A PERCENT OF SALES AEROSPACE AND ALL MANUFACTURING CORPORATIONS 1968 - 1973



E Estimated.

Source: Federal Trade Commission, "Quarterly Financial Report for Manufacturing Corporations."

AEROSPACE EMPLOYMENT AS OF DECEMBER[r] 1968 - 1974



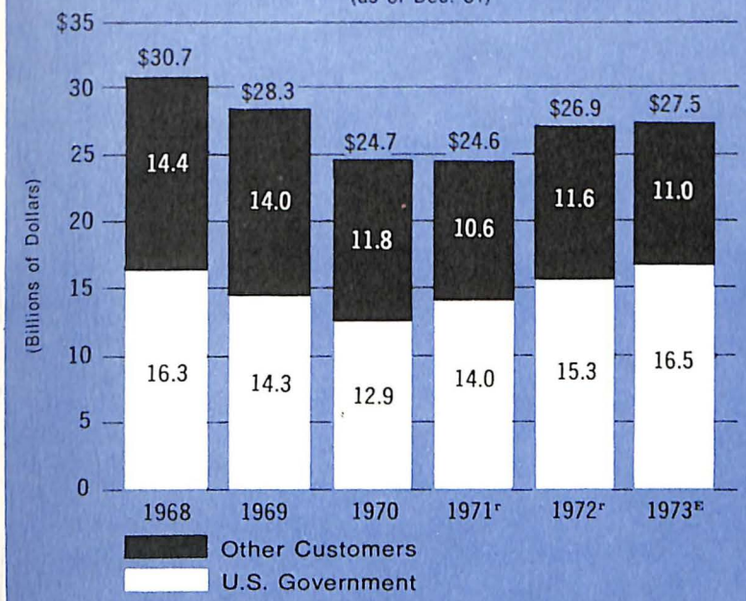
r Revised.

E Estimated.

Source: Aerospace Industries Association, Based on company reports and Bureau of Labor Statistics data.

BACKLOG OF MAJOR AEROSPACE COMPANIES[a] 1968 to 1973

(as of Dec. 31)



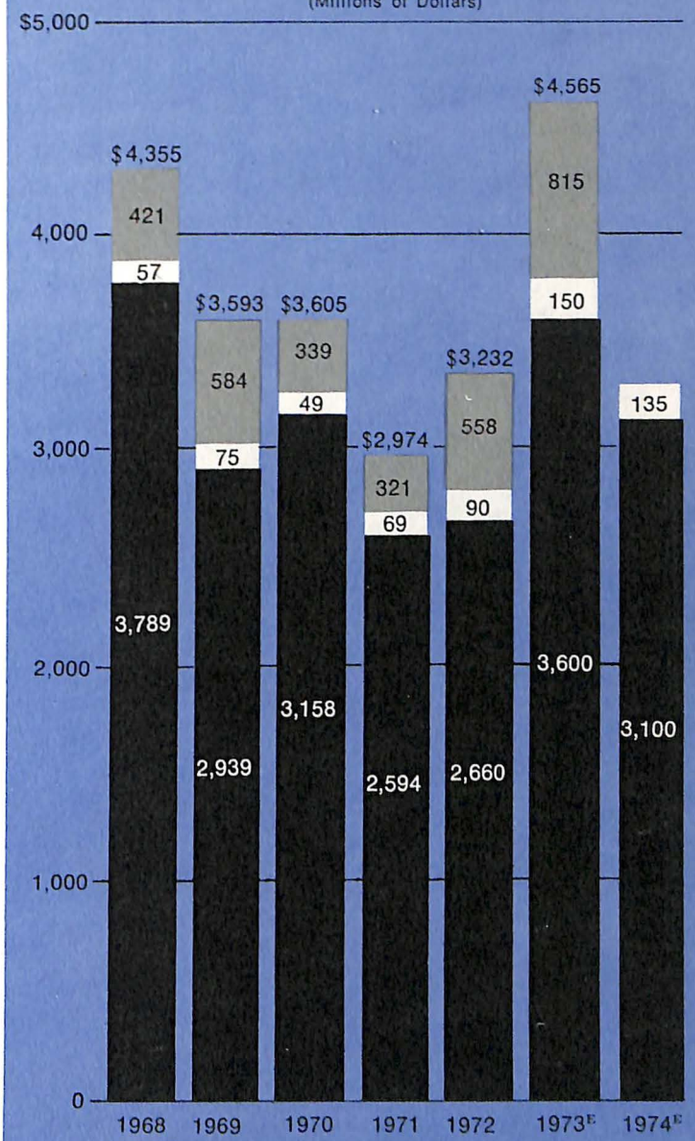
a Backlog reported to the Bureau of Census includes information furnished by 55 companies.

E Estimated.

Source: Bureau of the Census, Current Industrial Reports, MQ-37D.

VALUE OF SHIPMENTS OF CIVIL AIRCRAFT 1968 - 1974

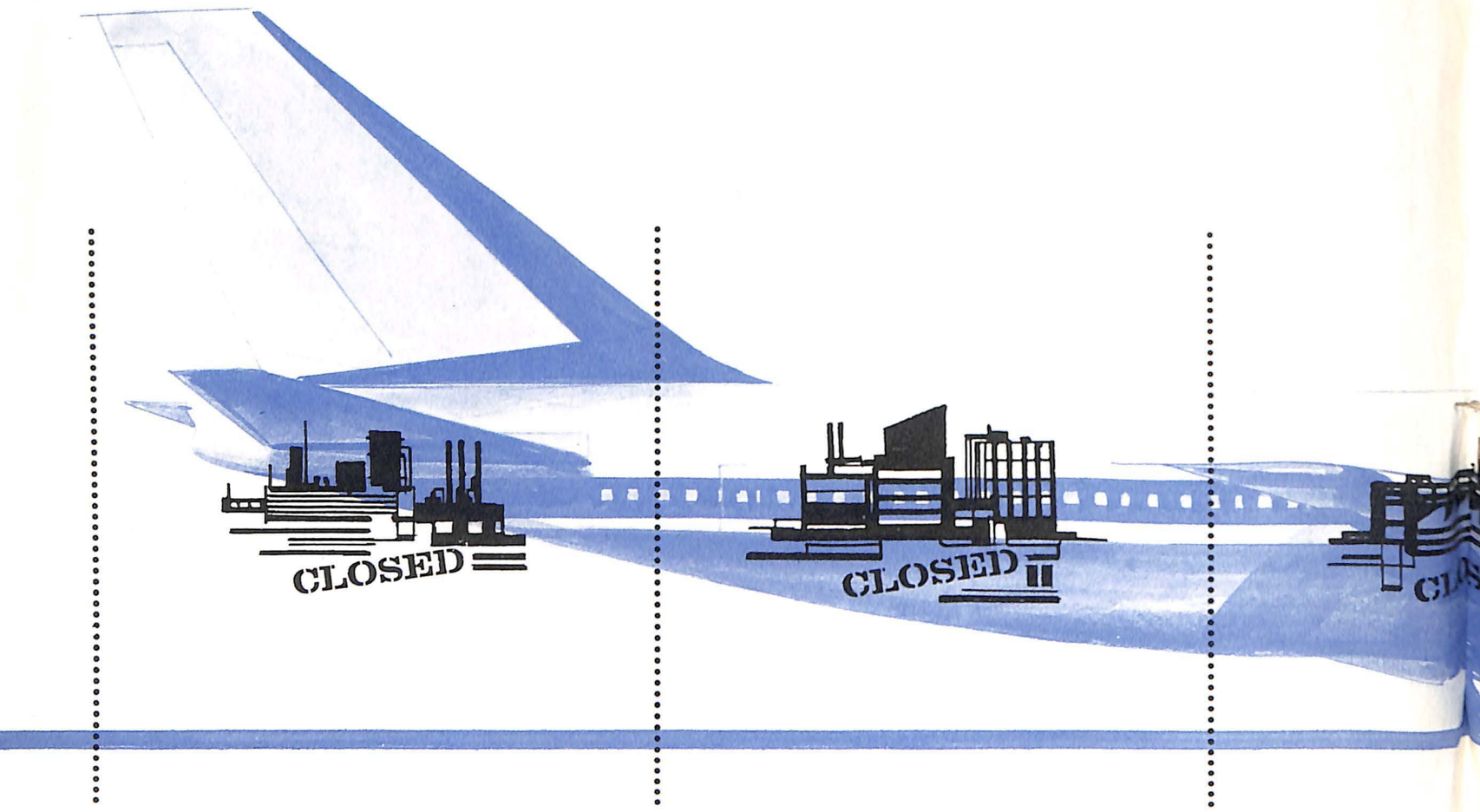
(Millions of Dollars)



E Estimates, Aerospace Industries Association.

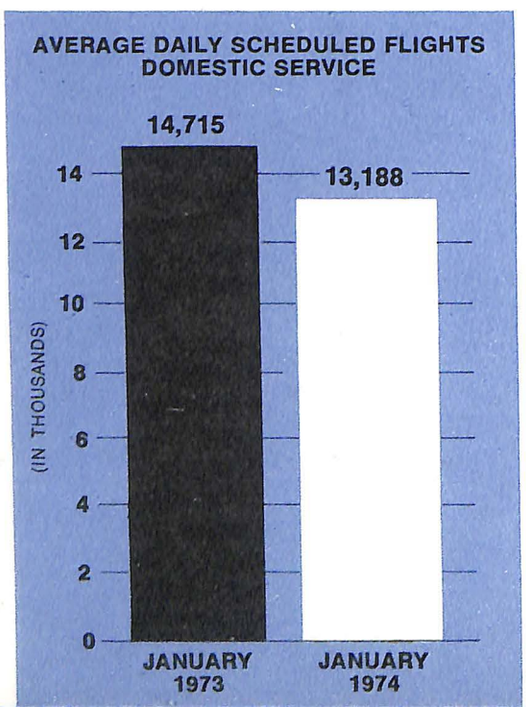
a TOTAL, based on Census releases, may differ from the sum of components which is based on different sources.

Sources: Bureau of the Census, Aerospace Industries Association, and General Aviation Manufacturers.



AIR TRANSPOR

By Paul R. Ignatius
President and Chief Executive Officer
The Air Transport Association



Making a meaningful assessment of scheduled air transportation is, in many respects, like making an assessment of the economy itself. This is so because air transport influences and is influenced by broad sectors of the national and international economy.

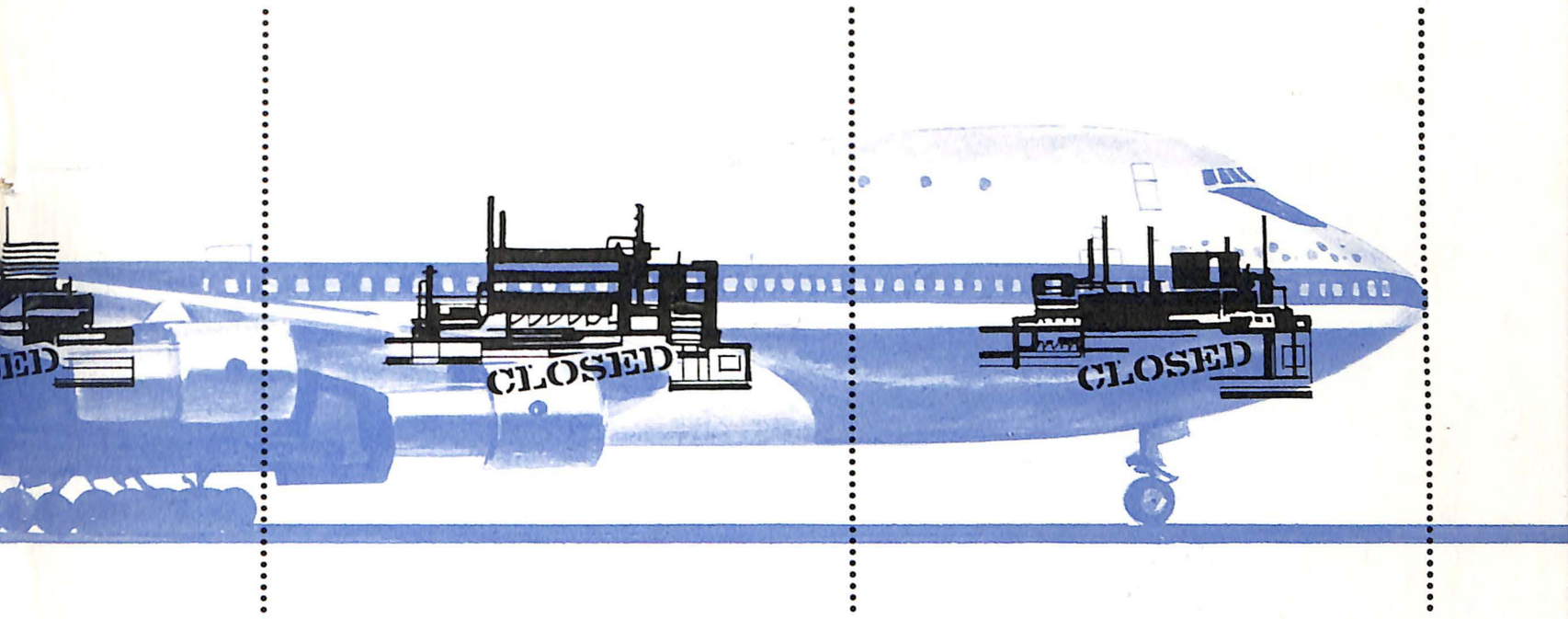
Measuring air transport's pervasive social and economic impact involves so many aspects of present-day life that it is, in no small measure, like making a report on contemporary society.

Dr. Gary Fromm's recent study, "The Value of Commercial Air Transportation To The United States", found that commercial air transportation contributes more than $30 billion of the country's annual gross national product. A few figures will help put this impact into perspective.

The U.S. scheduled airlines in 1973 flew a total of 161 billion passenger miles—equivalent to a trip of 767 miles for every man, woman and child in the United States.

The airlines last year carried more than 200 million passengers, nearly four million tons of freight and ex-

GROUNDING A $25 MILLION 747 CAN BE EQUATED WITH SHUTTING DOWN FIVE FACTORIES VALUED AT $5 MILLION EACH



TATION'S IMPACT

press and about 16 billion letters for the U.S. Postal Service.

This vital mass transportation was performed with a 2,250-plane fleet composed primarily of jet aircraft and valued at well over $12 billion. Orders have been placed for another 171 modern jet airliners valued at an additional $2.42 billion.

Air freight alone accounted for a billion dollars of the industry's operating revenue, a record year for air freight in revenue and volume.

Total operating revenue of the scheduled airlines was just under $12 billion, but earnings, hard hit by rising fuel costs, were less than $200 million.

Airlines have become mass transporters of people and now account for 78 percent of common carrier intercity passenger miles and for 95 percent of such service between the United States and places overseas.

By last autumn the Gallup Organization could report that 54 percent of all Americans over the age of 18 had flown aboard a scheduled airline and that one out of every four adult Americans had taken a trip aboard an airliner within the past year. In 1962, only a third of adult Americans had ever taken an airline trip. The foregoing statistics should tell us something about those intervening 12 years and, indeed, about all of the 70 years of powered flight.

Air transportation has played a big role in terms of technological advances, new services and products and in terms of new mobility for people throughout the world. At the start of 1974, airlines are in the forefront of efforts to cope successfully with a new challenge.

It is the challenge of keeping the country ecnomically and productively strong in a period of many kinds of energy shortages, particularly in supplies of petroleum based fuels.

At a time when fuel shortages make public transportation more important than ever before, airlines face uncertainties on fuel supply and a severe escalation of jet fuel prices that could, unless checked, drive air transportation beyond the reach of millions of citizens to whom it is essential. How the fuel question is resolved will tell us whether the facts and figures on air-

line service previously mentioned become service high-points to be looked back at longingly in years ahead or whether they will be replaced, as in the past, by a more shining list of service accomplishments. Because air transportation is so crucial to the welfare and strength of our country, I am optimistic that new growth records will be achieved in the next five year period.

I want to return to the fuel point in discussing the industry's prospects, but first let's look in more detail at air transportation's impact. This will give us a clearer picture of what the country will be losing, unless the fuel question is wisely resolved.

The men and women in the air transport industry have been increasingly active in telling the story of our contribution to the economy. They have been particularly successful in telling the story of the direct economic impact upon a community from its airport and the airlines serving it.

This is a story of local payrolls and local purchases, of money invested in homes, of local and state taxes

AIR TRANSPORTATION'S BENEFICIARIES AND BENEFITS

	Commercial Aviation Outputs	INDIVIDUAL AND FAMILY			
		WELFARE	VOCATION	RECREATION	WELFARE
PRODUCT	Speed	• Medical emergencies • Perishable foods • Air mail	• Accessibility to national business/professional meetings • Air mail	• Travel to distant places in short vacation period • Greater audiences for sports • Exhilaration of flight	• Distressed area emergencies
	Mobility	• Easy commutation to health climates and places	• Exposure to new ideas, methods and techniques • Job mobility	• Exposure to new peoples, customs, places • Wider choice of vacation spots • Visits to family and friends	• No highways, filling stations, billboards • No litter
	Capacity				• Supplies to isolated communities
	Technology	• Reduction of aircraft interior noise level • Reduction G-force effect		• Future extension and economy of travel	• Increased standard of living • Reduction in pollution and noise
OPERATION	Safety	• Decreasing accident rate • Safety devices			• Confidence and freedom from worry
	Economy		• Cost-time savings in business travel	• Family and group rates	
	Efficiency		• Schedule regularity and frequency		
	Convenience	• Clean, healthy interior • Individual care for aged, sick, and children	• Office convenience aboard and in terminals	• Passenger comfort, relaxation, entertainment, food and drink • Vacation information and planning	
INDUSTRY	Expenditures	• Contribution to higher standard of living			• Higher standard of living from GNP contributions
	Investment				• Industrial contribution to local areas • GNP contribution
	Export/ Import	• More varied life-style from goods interchange			• Tourism • Foreign product sales
	Employment	• Contribution to stable employment	• Opportunity in growing industry		• Jobs in local installation areas • Stable employment

paid and of local expenditures for food, clothing and recreation. Such economic impact studies have now been made in about 20 communities, ranging in size and location from Los Angeles to Providence, R.I.

Aerospace magazine first reported on these studies back in November, 1972. Hence, the detailed findings need not be repeated here. It should be noted, however, that as new studies are completed, economic impact findings continue to be significant.

The good results hold true, regardless of the area of the country. They are certainly true in the New York Metropolitan Area where the impact of the air transport industry is now running at $7 billion annually. They are substantial also in the Chicago suburbs where last year 12,000 airline employees—roughly half of the total based there—paid out part of their airline paychecks to meet the mortgage payments on homes valued at $400 million. And they are substantial in the Atlanta area where the international airport is the largest private employer in the state of Georgia.

SOCIETY			
INDUSTRY	**GOVERNMENT**	**SECURITY**	**INTERNATIONAL**
• Emergency shipments • Control and unity of decentralized industries • Air mail	• Quick response to problem areas • Control and unity • Official and diplomatic correspondence	• Quick response to civil disorder • Defense readiness	• Tourism • Official and diplomatic exchange • Air mail
• Lower inventories and costs • Distribution of products • Labor interchange	• Constant physical contact with agencies • Stability through government presence	• Control and unity of law-enforcement network • Quick military mobility	• Tourism
• Air freight	• Safe reliable movement of perishable or time bound equipment	• CRAF stand-by fleet: 333 aircraft • Capability for overseas airlift of 85% of military personnel	• Fast overseas air freight with reliability and security
• Growth stimulus • Competition stimulus	• Ever-increasing closure of distance gap	• Mutual benefits of research exchange between airlines and military	
• Lower insurance rates			
• Decreasing cost of freight • Cost-time savings: executive	• Cost-time savings for government personnel		• Mass trans-world travel now a reality
• Routing and delivery reliability • Computerized routines	• Computerized routines and personnel assistance in trip planning	• Quick response communications and transport network for law enforcement	• Efficient handling of complex, multi-lingual and national situations
• Pleasant conditions for business transactions • Time- and work-saving devices			
• Airline purchases • Research spending • GNP increase	• Taxes • GNP growth as stabilizing factor		
• Growth stimulus • Economic stability • GNP increase	• GNP • Savings due to airlines' military preparedness	• Military capability of installations and equipment	
• Airline export	• Balance of payments surplus	• International experience as military back-up	• Overseas sales of American products
• Employment used by airline industry suppliers	• Employment contribution to political stability	• Pilots as stand-by for emergency	• Jobs for American nationals abroad • Prestige

As we expected, the findings from these studies have proved to be of great interest and usefulness to the communities involved. More studies will be made. The airlines have long sought to delineate the industry's total contribution to the country. Although it may never be possible to do this completely, the Fromm study takes a big step in that direction.

The study divided the contributions of commercial aviation into two categories, the measurable and the non-measurable benefits. Although the latter benefits cannot be assessed in monetary terms, the study identified many of them.

It approached the non-measurable benefits by constructing a matrix on which to display the relationships between aviation's outputs and society's demands.

Aviation's outputs were listed as speed, mobility, capacity, technology, safety, economy, efficiency, convenience, capital investment, purchases of supplies, export/import and employment.

These aviation outputs are analyzed in relation to various demands of individuals, the family and society as a whole. It can be seen that for individuals and families, for example, air transport technology extends both the range and economy of travel and that the high-skill jobs in the industry broaden vocational opportunities.

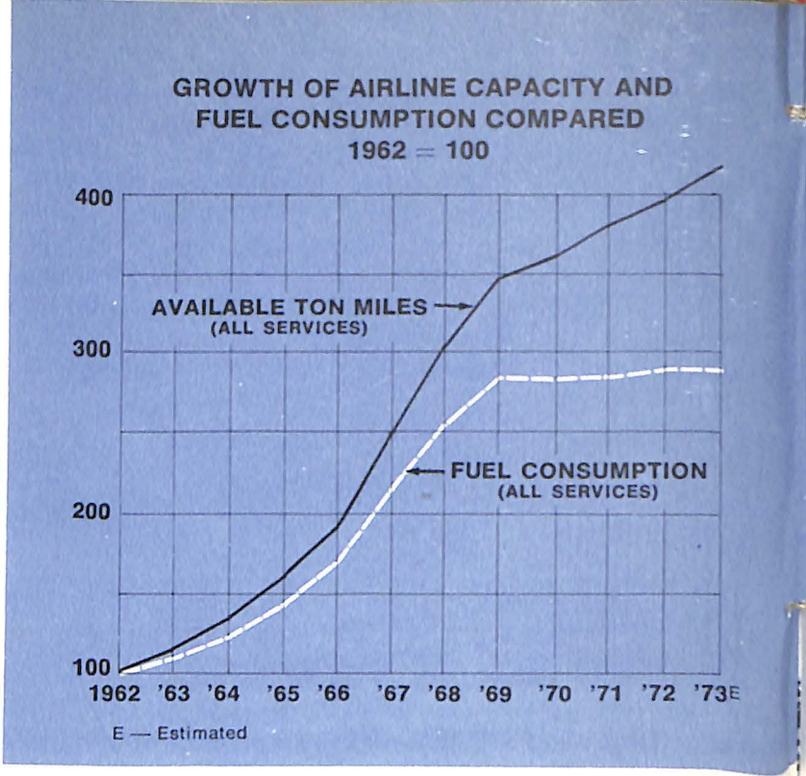
In the larger social sense, aviation's speed is seen expanding the scope and productivity of many of our most talented people in business management, the professions and the arts. With respect to the country's international posture, air transport is seen as facilitating important diplomatic exchanges. Also in the international realm, new airline capacity for the fast overseas delivery of freight is seen broadening U.S. export markets.

In strengthening our national security, airline capacity makes a significant contribution through the Civil Reserve Air Fleet composed of many of the most advanced airline aircraft. These aircraft and their crews are available quickly to meet military transport needs in time of national emergency, such as the recent Middle East crisis. It is estimated that U.S. taxpayers save more than $300 million a year because the military does not have to buy this stand-by airlift. (For a more complete view of the types of non-measurable benefits contributed to the country by air transportation, see the accompanying matrix.)

In approaching the measurable benefits of commercial aviation, the study looked at those things that can be seen in terms of billions of dollars contributed directly to the economy. It takes time to analyze such data. Hence, the study worked with data from 1970. Figures likely changed somewhat in intervening years but, in fairly good ballpark terms, they would continue to apply today.

The study was able to measure contributions of more than $30 billion from commercial aviation to the GNP. These are both direct and indirect contributions. Here are some of the principal ones:

- The principal output of commercial aviation, transporting people and cargo by air, had a money value of more than $10 billion. Given increased revenue in the intervening years, this figure would now be much higher.
- Using the average annual income of the airline business traveler to determine the value of his or her time, the study then compared the differences in elapsed time for various trips by air, rail, bus and private auto. These travelers' use of air, instead of surface transport, saved at least $8 billion of their time, a very real contribution. Rising incomes in the interim obviously would make this contribution much higher today. The study was unable to estimate the value of the time saved by the personal traveler. It is obvious, however, that this is another factor that would raise the total of the contribution.



- Capital expenditures are another important contribution air transportation makes to the economy. Sometimes the beneficial ripple effects of those expenditures are not given the attention they deserve. Direct capital expenditures for aircraft, engines, parts, plant and equipment ($3 billion in the study year) generate indirect investment of supplier industries (an estimated $6.6 billion in the study year). Continuing this type of economic benefit, the airlines last year took delivery on 145 jet aircraft valued at $1.71 billion. As noted earlier, another 171 aircraft, valued at $2.42 billion are on order. More than 100 of these will be delivered this year.

In addition to making these and other contributions to the economy, scheduled air transportation is now being called upon to make greater contributions. Shortages of gasoline have triggered the diversion of more intercity travel from the personal automobile to public transport.

Greater use of rail, bus and air all are important, but it appears that air transport offers the best and quickest means of absorbing more personal travel from the highways. The long lead times required to get new railway passenger cars and buses from the order stage to the people-carrying stage work against a rapid expansion of these modes. Air transportation, on the other hand, already has ample equipment to absorb more passenger traffic and freight.

There is evidence that government regulators are showing a growing awareness of air transport's importance in moving more people, goods and mail.

Originally, airlines were to have been cut back on fuel by 15 percent below 1972 levels. This allocation has been raised to 95 percent for the trunk airlines and to 100 percent for the local service carriers.

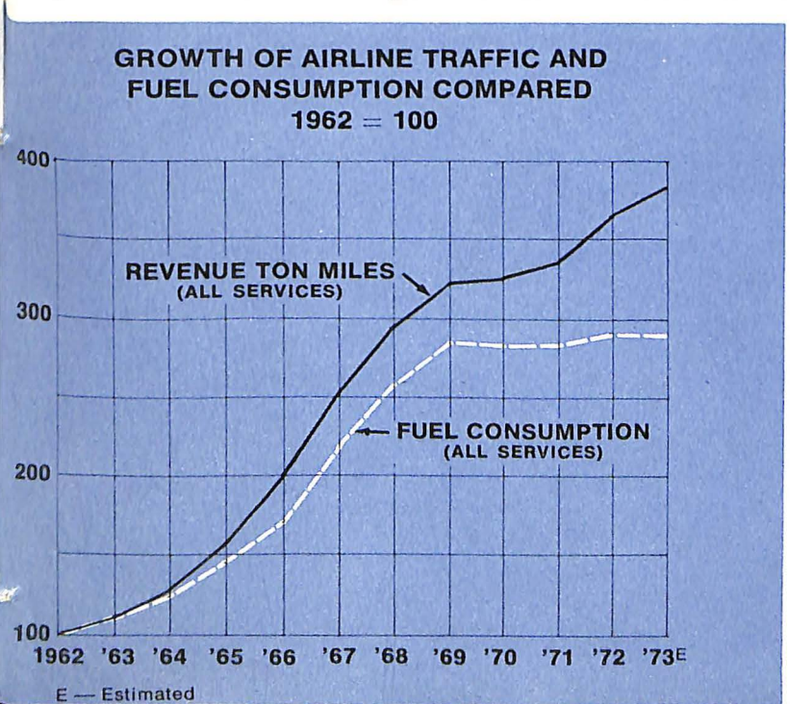
Other common carriers of people and goods, however, have been allocated all of the fuel they require and air transport deserves the same priority treatment as was intended by the Congress. Members of the Senate and House determined that the priority is justified not only because of the public need for air transportation, but also as a means of continuing the economic benefits air transport generates throughout the economy.

Grounding a $25 million 747, for example, ought to be equated with shutting down five factories costing $5 million each. Grounding additional aircraft, either because of the unavailability or high price of fuel, will cause hardship to travelers and a curtailment of economic activity.

The industry will continue to urge that airlines be given the same fuel priority as other common carriers. We also have been urging the establishment of effective supply regulations. Such regulations must be sufficiently detailed to protect deliveries under contract at reasonable prices, to insure technically and operationally acceptable fuel supplies and, critically important, to get the allocated supplies to the airline users when and where needed.

With the problem of fuel allocation eased, problems arising from the unbounded increases in jet fuel prices are taking on increased weight. Any one with a stake in air transportation—either as user, supplier or operator of a travel-related enterprise—should take a careful look at what's been happening to the price of jet fuel.

Traditionally, fuel has been the second largest airline cost item. In the years from 1960 through 1967 unit fuel costs went down about 24 percent, with the changeover to jet fuel from higher cost aviation gasoline. This was one of the benefits of the replacement of piston-powered aircraft with turbine-powered aircraft. But unit fuel prices began to rise when the changeover was essentially completed. They climbed 13 percent from 1967 through 1972. This was an increase of about 2.6 percent per year.



The big increases in jet fuel costs began in September, 1973. They rose 14.7 percent over the same month of the previous year. They were up 19.5 percent over the previous October; 23.4 percent over the previous November, and in December, an estimated 32 percent over December, 1972.

International air carriers face a much worse situation. Their fuel costs last September were up 20 percent over a year ago, 34 percent in October and 41 percent in November. The December figure exceeded 60 percent.

There is real danger that fuel costs will continue to spurt upward in 1974. Estimates are that the cost of jet fuel, unless controlled, will rise from 12 cents per gallon in 1973 to 24 cents per gallon in 1974.

A price rise from 12 cents per gallon of jet fuel to 24 cents would increase industry's fuel costs by well over one billion dollars a year or five times the earnings realized last year.

Obviously, fuel price increases of such magnitude would push air transportation beyond the reach of many of the people who need it most. Higher and higher fuel costs would strike severely at many who need to travel by air. Today, the average American family belongs to the jet set and we are striving to prevent cost increases that will knock them out of membership.

This is why the airline industry is urging that jet fuel prices be controlled. Further, more serious attention must be paid to the availability and cost of fuel for international air transportation where the fuel cost impact is most severe. Fuel must be made available from national resources to maintain international air operations at a level comparable to domestic operations, whenever bonded supplies are not available at a reasonable price.

Uncertainties about fuel supply and fuel price make projections for 1974 among the most difficult in airline history. Traffic and capacity should be in balance, promoting higher load factors. Financial performance should be favorably influenced by further belt-tightening. What happens to jet fuel prices and the industry's ability to recover added fuel costs will be of prime importance in determining how we do this year.

An optimistic outlook would have to be founded on three big assumptions. The first is that a way will be found to curb unreasonable increases in jet fuel prices. The second is that increased fuel prices will be recovered through increased revenues. The third is that the fuel shortage and, indeed, the energy shortage as a whole, will not have so negative an impact upon the economy as to dry up great chunks of intercity and international travel markets.

If these assumptions hold, 1974 could be a better year for the airlines than 1973; but earnings will still be far short of the rate of return on investment held reasonable by the Civil Aeronautics Board. Instead of $200 million, the airlines would require earnings of about $750 million to reach that level.

I hope these assumptions hold. The hope springs from far more than an interest in the industry's financial performance, although this is important.

Air transportation is so important to more than 200 million passengers, shippers and mail users that it must function in keeping with its full transport potential and it must do so from a posture of economic strength.

The scope of aerospace education spreads through education from the pre-primary to the post-graduate levels, and spans areas of study from general applications to special career occupations.

AEROSPACE EDUCATION: AN OVERVIEW

By DR. WAYNE R. MATSON
AIA Associate Director — Educational Services

THE AEROSPACE CHALLENGE

The scientific/technological revolution, which is perhaps most crystallized in our nation's aerospace activity, poses an unprecedented challenge to those who must equip tomorrow's citizens.

Today's student is confronted with a world all parts of which are accessible to him in a matter of hours; a world in which he is similarly accessible to others whether they wish him well or ill; a world in which his heroes—real, live men who can be looked at, talked to and shaken hands with—have walked in outer space; a world in which moon travel, and even interplanetary travel, are no longer dreams but are projects; a world in which technological advance is so rapid that the curriculum of a year or two ago is already old hat in certain disciplines, and vocational tooling can as quickly become obsolete; a world of challenging and inspiring technological advance with challenging and inspiring social, political and economic effects.

How do you prepare a student for such a world, much less the greatly more complicated one he will face as he enters his productive years?

> "To help avert future shock, we must create a super-industrial education system. And to do this we must search for our objectives and methods in the future, rather than the past." writes Alvin Toffler in his book, "Future Shock."
>
> Toffler believes: ". . . young people should be introduced to the wonders of outer space, living with or near astronauts, learning about planetary environments, becoming as familiar with space technology as most teen-agers today are with that of the family car."
>
> "Our children should be studying Arthur C. Clarke, William Tenn, Robert Heinlein, Ray Bradbury and Robert Sheckley, not because these writers can tell them about rocket ships and time machines but, more important, because they can lead young minds through an imaginative exploration of the jungle of political, social, psychological, and ethical issues that confront these children as adults."

Although it is true that only a relatively few of today's teenagers will design, construct or operate hypersonic aircraft or interplanetary vehicles, and relatively few others will expand further the scientific and technological horizons which they inherit in mid-revolution—all will have to cope with the implications of these advances.

The implications of the aerospace revolution to the educational field are staggering. Certainly there is a challenge to create a new climate of learning which reflects the needs of the aerospace age.

This need for educational reform has stimulated school systems throughout the nation to introduce the concept of aerospace education.

WHAT IS AEROSPACE EDUCATION?

Aerospace education is the study of aerospace and its impact on society.

The term AEROSPACE (from *Aero*nautics and *Space*) first appeared in print in 1958 and has come to denote both an environment and a field of activity.

As an environment, aerospace includes that total expanse extending upward and outward from the surface of the Earth (the atmosphere and space). As a field of activ-

ity it includes both aeronautics (the study of flight within the atmosphere) and astronautics (the study of flight in space).

AEROSPACE EDUCATION seeks to communicate knowledge, impart skills, and develop attitudes relative to the scientific, engineering and technical—as well as the social, economic, and political aspects of aerospace. The scope of aerospace education spreads through education from the pre-primary to the postgraduate levels, and spans areas of study from general applications to special career occupations.

Prof. Joseph Coulter of the University of Oklahoma, in proposing aviation as a minor in liberal arts, unrelated to engineering or business, stated:

> "The vast body of aerospace knowledge and its impact on the social, economic, political and technical well-being of everyday American living and on modern business is so great that failure to provide experiences in aerospace education is tantamount to curricular non-feasance."

Aerospace education generates spontaneous pupil interest in aircraft, rockets, missiles and space vehicles—special interest that can lead them into many exploratory enterprises that will help them understand the complex age in which they live and to assume responsibility for the improvement of everyday living.

Aerospace education is a means for the school to meet its responsibility to provide career guidance and education for vocational competence. The aerospace industries, government agencies, air transport industries and general aviation, expanding because of aerospace developments, require the services of several million trained people.

Aerospace education also serves an integrated curriculum, organized around a major interest employed as a frame of reference. Through the enrichment approach, standard course offerings are supplemented with pertinent aspects of the aerospace sciences which are major factors in many general study units.

Aerospace education provides an opportunity to supplement classroom instruction with popular educational experiences, such as trips to airports, air bases, aerospace manufacturing firms and National Aeronautics and Space Administration and Federal Aviation Administration installations. In addition, local, state, and national aviation

Aerospace education generates spontaneous pupil interest in aircraft and rockets — special interest that can lead them into many exploratory enterprises that will help them understand the complex age in which they live.

Aerospace education is a means for the school to meet its responsibility to provide career guidance and education for vocational competence.

agencies, aerospace industries, and other interested organizations provide major aerospace education resources.

Aerospace education fosters acceptance of in-service teacher education as a permanent and integral aspect of curriculum improvement. A study of the impact of aerospace progress upon modern life is important to all teachers.

Aviation and astronautics also are important areas of adult education. Expanding career opportunities in the aerospace industry stimulate many adults to seek training in technical vocations. Their broad effects stimulate others to study the influences of aviation and astronautics.

Aerospace education has been endorsed by educators

and industry because it is practical and universally applicable to almost every school. It has academic validity and a content of solid subject matter that makes it useful and meaningful as general education, even if a student does not pursue aerospace as a career.

In a three-year research project in California, teacher and curriculum consultants developed useful aviation education materials at every grade level relating to the teaching of economics, sociology, and anthropology. Because aerospace education is interlocked with so many areas of study, plans which emphasize aerospace education in the curriculum at all age levels are valid.

Aerospace education is being offered all the way from a one-week unit as part of a mathematics, science or social living course, through the entire spectrum of bibliographical services, separate credit courses and extra curricular activities, to such ambitious programs as those in public schools where students are trained through a level qualifying them for positions as airline pilots and mechanics.

Today in the United States teachers in more than 20,000 elementary schools are utilizing aviation and space units as a regular part of the curriculum for both career and academic study.

At the secondary level, there are more than 1,500 high schools offering credit courses in aerospace education.

At the college level, there are more than 600 colleges offering aerospace courses or complete programs ranging from introductory flight training to full degree programs in aerospace.

And for a number of years now more than 10,000 teachers each year have attended one of the 200 to 300 aerospace education workshops held at colleges and institutions throughout the country.

Aerospace education has been established as a proper discipline of the curriculum, meeting one or more of the seven cardinal principles of public education—by endorsement, by accreditation, and by experience.

The North Central Accrediting Association has approved aerospace courses for credit which will be acceptable either for high school graduation or for admission to member colleges. Other major organizations endorsing aerospace education for both students and teachers include the Aviation Education Committee of the American Association of Colleges for Teacher Education, the American Association of School Administrators, the American Council on Education, the National Aerospace Education Association, the American Legion (in five separate convention resolutions) and the Civil Air Patrol.

Every state already has approved courses in aerospace education or has given full authority for their inclusion in the curriculum.

CAREER EDUCATION

Nearly 2.5 million students leave the formal education system of the United States each year without adequate preparation for a career.

It is a rare high school that equips all its students to make the choice upon graduation of entering the job market with a saleable skill or of continuing their education.

At the college level, more persons are graduating with a bachelor's degree than there are jobs for degree holders. By the end of the decade, 8 out of 10 jobs in America will not require a baccalaureate degree.

More appropriate curriculums must be developed and they must be used more realistically if we are to meet the needs and desires of students and serve the purposes of society.

This need for educational reform has stimulated school systems throughout the nation to introduce the concept of career education. At the elementary level, students are acquainted with the variety of occupational opportunities in modern society and at the secondary level, academic work is being combined with specific training for actual jobs. For example, in one large high school in Dallas, aeronautics students work on airplanes on school grounds.

In a study of 400,000 teenagers, conducted by the U.S. Government, aviation ranked as one of the top career choices for boys and airline hostesses as one of the main career preferences for girls.

According to the National Exploring Development Committee, aviation consistently ranks in the top 10 in high school career interest surveys.

Although career education is a new and revolutionary concept in education, it is not new to those who have been involved in aerospace education.

Dr. Wayne O. Reed, former associate commissioner for Federal-State Relations, United States Office of Education, stated:

> "Aerospace education has already done much to help both children and adults to find the answer to the question: What shall I become? All who have had a part in helping students to explore and study and even practice in this field—teacher, technician, scientists, skilled artisans, and all others who have given moral support and put their shoulders to the wheel—all can take satisfaction in knowing that much of what has been done can serve as models for education in other fields."
>
> He further states: "The concepts of aerospace education, with their emphasis alike on skills and on well balanced development of the individual person, and with their emphasis alike on science and the humanities—these concepts seem now to have been made to order to reinforce and support the concepts of career education."

RELEVANT EDUCATION

A fundamental purpose of education is to prepare for a productive and rewarding life. Yet, in schools throughout the country, young people complain that curriculums are dull and irrelevant; that their education is not opening pathways to a fulfilling adulthood. Substantial numbers of students score below their grade level in basic skills. High dropout rates, absenteeism, academic failure, drug abuse, vandalism, and assaults on administrators, teachers, and other pupils signal their discontent.

On the other hand, a growing body of research evidence continues to indicate that aerospace education programs, particularly those involving a flight program, are successful in:

- Motivating students to achieve academically;
- Motivating students to attend school more regularly;
- Motivating the students to become involved in a greater percentage of their classroom time in instructional and less disruptive and resistant behavior;
- Elevating the level of self-esteem and aspiration of the pupils;
- Improving the chances of further education for the pupil;
- Altering the perception of the teachers and parents of these youth as regards their scholarship ability.

In one survey the students participating in 17 high school aerospace education programs stated they liked their courses because the subject matter did not rely on traditional classroom activities. Both teachers and students reported an improved ability to utilize concepts in other subject areas related to aerospace and the students indicated a high interest in the vocational-occupational aspects of aerospace and, importantly, aerospace appealed to a broad cross-section of the student body.

In another thrust outside the traditional school structure, Lloyd Haynes, actor on TV's "Room 222", has established an organization called *Education Through Aviation* where industry, education, government and private individuals support his efforts in aviation education with minority groups in the Los Angeles area. Lloyd has taken a group of under-achieving and unmotivated teenage students and helped them improve their grades in all subjects by exposing them to aviation. Students volunteer their time on weekday evenings and weekends to attend class and earn flying time at Santa Monica Airport.

Aerospace education plays a vital role in every class at August Martin High School in New York City. Previously the school was a dumping ground for black and Puerto Rican minorities with the poorest attendance record of any school in the city system and with so many other problems that it was scheduled to be closed until the Aviation Development Council and other interested parties expressed an interest in developing a high school curriculum there with every subject related to aviation. Today, August Martin High School has the highest attendance record of any school within the New York City system, and is planning additional curriculums in aerospace education.

Examples of success in aerospace education are as many and varied as the field of aerospace itself. At Parkside High School in Jackson, Mich., junior and senior students constructed a single place biplane during four semesters of classroom work as a part of their Industrial Arts Program. Although modest by the standards of today's sophisticated aircraft and space vehicles, the aircraft building project represents an aerospace education achievement for the aerospace leaders of the future.

A number of teachers have made comments similar to the following: "I have not, in all my years of teaching, so thoroughly enjoyed a course as much as our aerospace course. I don't mean to take anything from my other courses, for they have in recent years become more exciting too; but aerospace seems to have a powerful effect on these young people. Student enthusiasm for the aerospace course greatly outweighs anything I've experienced in any other class. This is partially due, I believe, to something we're hearing a great deal about today—relevancy. Aerospace is a relevant course. Students relate to it because it's a practical application of the things they learned, or are learning, in their other subjects."

COOPERATIVE EDUCATION

All levels of education have grown to the point where nearly one-third of the entire population—more than 63

Aerospace education provides an opportunity to supplement classroom instruction with popular educational experiences, such as trips to airports, air bases, aerospace manufacturing firms and NASA and FAA installations.

million people—now are involved in education on a full-time basis.

Dr. John I. Goodlad of the University of California in Los Angeles and educational psychologist M. Francis Klein reported that in a study of 67 schools in 13 states highly publicized and recommended educational innovations of the past decade have not reached the classroom. One of their key solutions for closing the gap between schools as they are and as they should be is to reconstruct schools continually through partnership programs with industry.

As the former commissioner of education, Francis Keppel, said, "Education today is too important to be left solely to the educators."

While educational spending in public and private schools (including colleges) was about $90 billion last year, industry spent almost $15 billion for manpower training and re-education programs for their employees. Working together industry and education stand to gain much more than they contribute.

With the aerospace industry's help, teachers already are utilizing a variety of approaches at the elementary, secondary and college levels.

The aerospace industry supports aerospace education, recognizes the importance of industry/education cooperation in general, and has become increasingly involved in a variety of cooperative programs with the educational community in one or more of the following ways:

- Helping to keep students and faculty members current on the state-of-the art in the industry;
- Establishing access to industrial personnel and industrial planning, technology, training materials and training programs;
- Arranging regular tours of facilities as well as special company visits for both students and instructors;
- Developing visitation programs to schools of representatives from industry and from selected departments;
- Arranging work-study programs with schools where students actively work at the company during assigned periods of the school year;
- Assisting in the preparation of teachers for scientific and technical fields;
- Maintaining communications with the educational community so as to keep them informed as to the types of services and materials they have to offer as well as the types of employees they desire;
- Encouraging the formation of industry/education councils.

The aerospace industry recognizes that the majority of jobs in the years ahead will not require a college education and is helping to change the attitudes of students, teachers and parents toward career education.

The industry also is working to design new ways of dividing jobs into trainable separate components, to update the teaching curriculums in the technical fields and to provide faculty members to technical schools.

It is striving to bring the industrial community into the planning of the educational system and to develop a better awareness on the part of guidance counselors as to changing job needs.

Outward-looking educators have sought aid from the industrial community. Industry, motivated by self-interest and by a sense of community responsibility, increasingly is searching for ways to help schools and students prepare for the future.

AIA

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"Air transportation has played a big role in terms of technological advances, new services and products and in terms of new mobility for people throughout the world."—See *Air Transportation's Impact*, page 6.

aerospace

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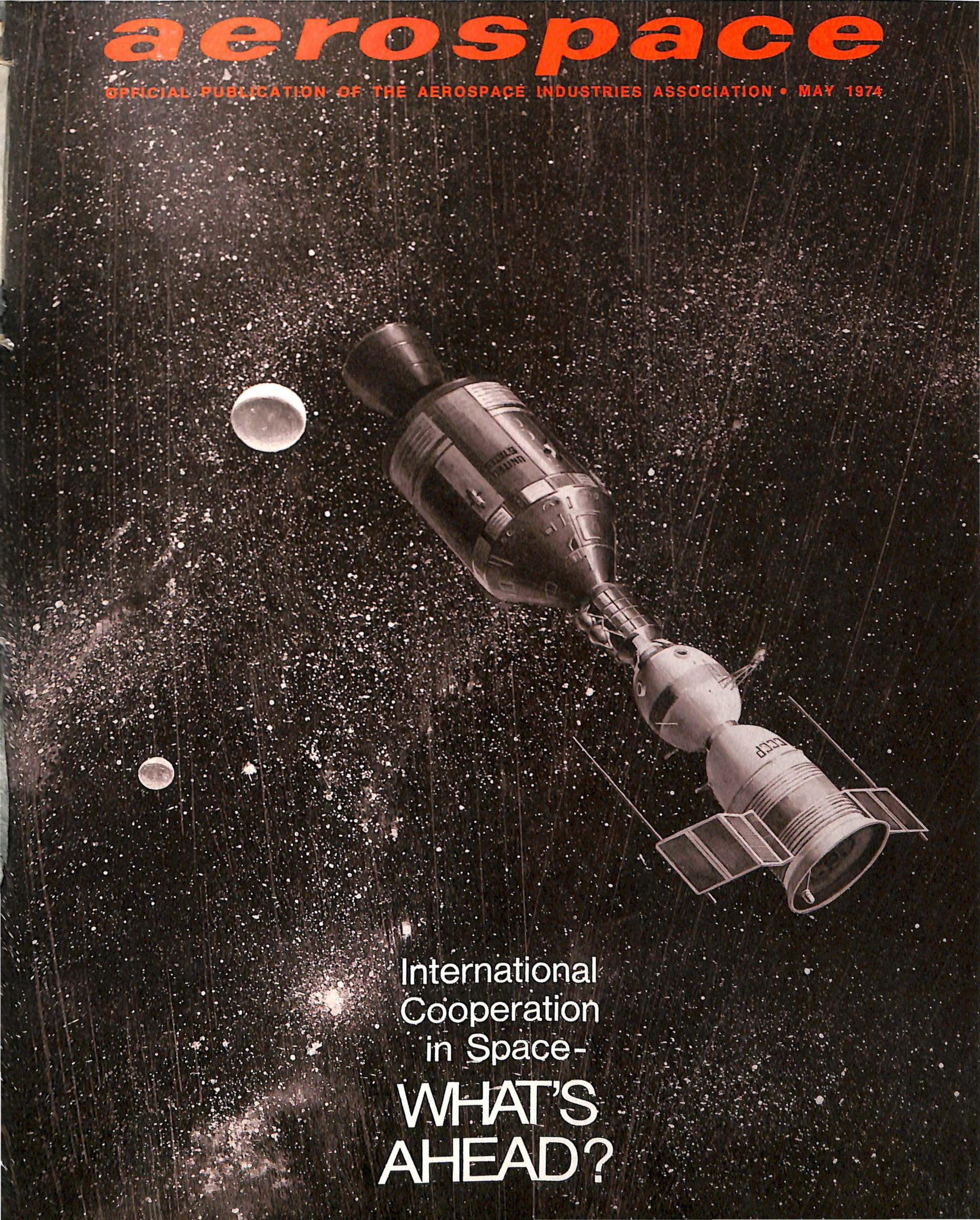
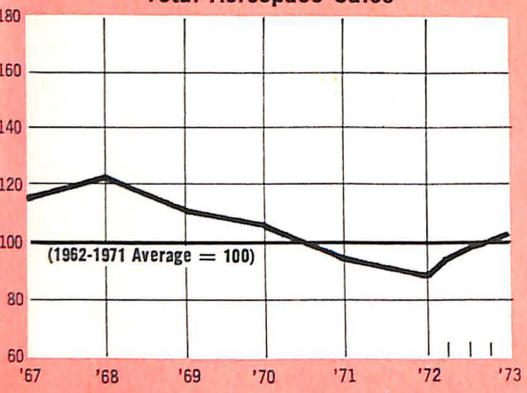


International Cooperation in Space- WHAT'S AHEAD?

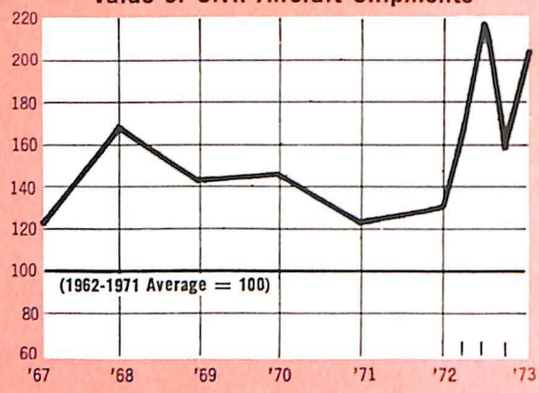
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

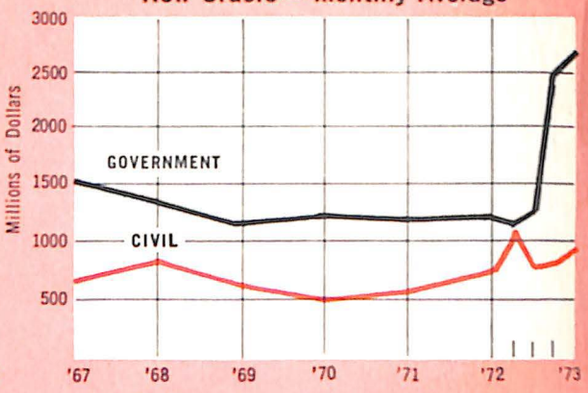


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1962-1971 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	23.5	4th Quarter	21.4	23.5	24.3
	Billion $	Quarterly	5.9	1973	5.7	5.6	6.5
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,240	Dec. 1973	1,045	1,254	926
Aircraft	Million $	Monthly	733	Dec. 1973	657	677	560
Missiles & Space	Million $	Monthly	507	Dec. 1973	388	577	366
Aerospace outlays: Total	Million $	Monthly	1,147	Dec. 1973	969	1,021	1,062
Aircraft	Million $	Monthly	665	Dec. 1973	531	516	576
Missiles & Space	Million $	Monthly	482	Dec. 1973	438	505	486
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,057	Feb. 1974	625	1,299	903
Aircraft	Million $	Monthly	631	Feb. 1974	328	1,093	598
Missiles & Space	Million $	Monthly	426	Feb. 1974	297	206	305
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	270	Feb. 1974	227	411	192
Expenditures	Million $	Monthly	277	Feb. 1974	244	256	232
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	22.7	Dec. 1973	26.9	29.2	29.7
U.S. Government	Billion $	Quarterly	13.6	Dec. 1973	15.3	16.3	16.7
Nongovernment	Billion $	Quarterly	9.1	Dec. 1973	11.6	12.9	13.0
EXPORTS							
Total (Including military)	Million $	Monthly	204	Feb. 1974	359	374	582
New Commercial Transports	Million $	Monthly	59	Feb. 1974	140	100	303
PROFITS				4th			
Aerospace — Based on Sales	Percent	Quarterly	2.6	Quarter	2.2	2.9	2.6
All Manufacturing — Based on Sales	Percent	Quarterly	4.9	1973	4.4	4.6	4.7
EMPLOYMENT: Total	Thousands	Monthly	1,286	Feb. 1974	942	956	948
Aircraft	Thousands	Monthly	699	Feb. 1974	512	513	508
Missiles & Space	Thousands	Monthly	144	Feb. 1974	94	99	97
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.48	Feb. 1974	4.85	5.17	5.20

* 1962-1971 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

NEGLECTING THE FUTURE

BY KARL G. HARR, JR.
President, Aerospace Industries Association

To people and industries heavily involved in technology, the energy crisis held special significance. It provided an example of what can happen when we choose to draw too heavily on current resources while neglecting the nurturing of resources required to fulfill future needs.

Concerned observers believe that we are running a similar risk on the broader front of technology. The concern isn't new. In 1971, the president of Stanford Research Institute stated that "the United States must soon face the fact that it is living on its research and development capital and the account is beginning to run low." That he was so right is borne out by these facts:

- since the mid-1960s, our national investment in R&D has fallen from three percent of GNP to 2.4 percent — the smallest percentage since 1958.
- measured in constant dollars there has been a decline in Federally-supported research and development of 20 percent since 1968.
- since 1967 the growth rate of non-Federal R&D has remained constant in current dollars at about 7 to 8 percent annually.
- looking at Federal R&D from another perspective, the ratio of Federal R&D expenditures to total Federal expenditures declined from 12.6 percent in 1965 to 6.6 percent in 1973.

It is against this background that industry last month presented its claim that the government should reimburse all reasonable costs incurred by its contractors for their independent innovative efforts and the preparation of bids and proposals. In a comprehensive study conducted by senior industry executives the relationship of these necessary business costs and the maintenance of U.S. preeminence in high technology and industrial competitive capability is well documented.

Those who share industry's concern about the erosion of our national technology base will find of interest a report on this study on page 2.

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CONTENTS

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

Publication Office: 1725 De Sales Street, N.W., Washington, D. C. 20036

An in-depth study:

INDUSTRY DOCUMENTS

IR&D/B&P

Northrop efforts in the lightweight fighter aircraft area led to the development of the N-156 configuration concept, the basic model of the F-5 fighter series. IR&D and B&P funds were used in the N-156 project, and the Air Force later contracted for the F-5A and B as part of the Military Assistance Program. There were also direct sales of F-5 aircraft to foreign countries, an important factor in the U. S. balance of trade. Above is an F-5E Tiger II, another outgrowth of the original N-156 project.

Basically many Americans are aware that in our free-enterprise system the economic health of the United States is based on the economic health and growth of industry. A fundamental requirement for corporate profitability and growth is the development of future products and services through company-initiated research and development (IR&D) and bid and proposal (B&P) efforts and the recovery of the cost of such efforts in the prices of the products and services.

And yet an interesting phenomenon exists in relation to IR&D—the periodic attacks by a limited number of critics within the Congress upon the very heart of our free enterprise system, company-initiated and funded IR&D and B&P efforts. The irony of such attacks is the simple, basic economic fact that no company can continue to exist in our economy without on-going, self-initiated research and development. It is an essential ingredient for maintaining its business vitality.

At a time when knowledgable observers are concerned that a serious erosion of the nation's technological base is taking place, major industrial contractors to the Government are reacting vigorously to threatened erosions in their own independent technical efforts.

Central to contractor concerns are the repeated challenges to their recovery of reasonable costs incured in two important industrial efforts, the conduct of independent research and development (IR&D) and the preparation of bids and proposals (B&P).

- *Independent Research and Development* is a term devised by the Department of Defense and used by Federal agencies to differentiate between a contractor's research and development technical effort performed under a contract, grant, or other arrangement (R&D) and that which is self-initiated and self-funded (IR&D).
- *Bid and Proposal* is a term devised by DOD and used by Federal agencies to describe a contractor's technical and supporting effort directed at preparing and submitting proposals (solicited or unsolicited) to a customer to meet an identified customer requirement.

More Understanding Needed

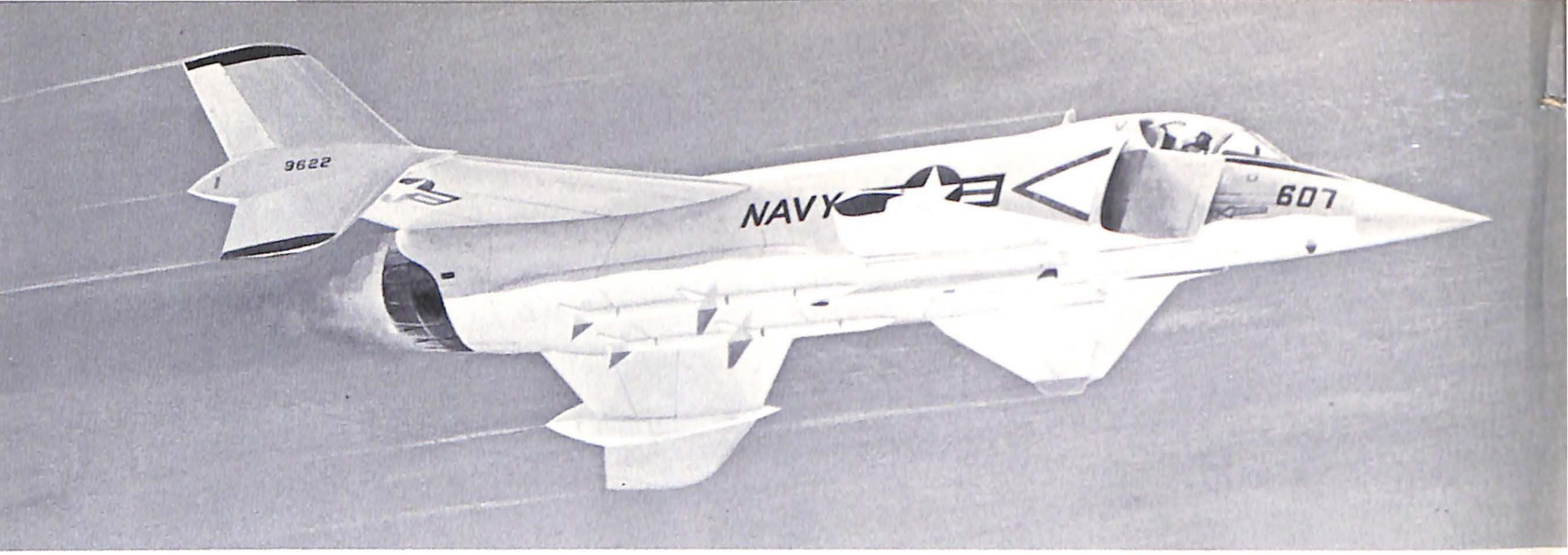
Troubled that all interested parties do not fully understand what IR&D and B&P efforts really are, what benefits they produce and why they are essential, an in-depth study on these subjects was released last month by three major industry associations. The study was prepared by a Tri-Association *ad hoc* committee composed of member company senior executives under the auspices of the Aerospace Industries Association (AIA), the Electronic Industries Association (EIA) and the National Security Industrial Association (NSIA).

The major study was undertaken in light of the fact that as basic as they are to the economic health and to the security of the nation, IR&D and B&P efforts are the subjects of never-ending challenge by a few critics who contend that the costs for such efforts may be unnecessary and possibly should be eliminated. Also, despite the fact that the General Accounting Office (GAO), acting for the Congress, has made many studies on the subject, that office once more has been requested to make a comprehensive and exhaustive review of the subject.

The course leading to the current request is interesting:

Congress has continued its surveillance of IR&D and B&P and has asked both the GAO and the Department of Defense (DOD) on numerous occasions to furnish information as to the effectiveness of Public Law 91-441 which governs these areas. The GAO issued a report in April 1972 and another in April 1973 which concluded that DOD was "being reasonably diligent" in implementing the requirements of the law.

Moreover, a year ago, Senator Thomas J. McIn-



yre (D-N.H.), Chairman of the Research and Develop-ment Subcommittee of the Senate Armed Services Committee, gave an excellent review of the IR&D/B&P picture, generally indicating a well-managed activity. These conclusions were bolstered by repeated confirmation of DOD and the National Aeronautics and Space Administration (NASA) that both IR&D and B&P were not only greatly beneficial to their operations, but wholeheartedly endorsed as necessary costs of doing business with the Government. However, in September, 1973, Senator William Proxmire (D-Wisc.), Chairman of the Senate Subcommittee on Priorities and Economy in Government, again questioned the amounts being "paid" by DOD for IR&D. While he addressed IR&D primarily, he included B&P costs in his figures. Industry notes that this lumping together of IR&D and B&P costs and then drawing conclusions relating only to IR&D activities is a misinterpretation of data.

Soon after, the two Senators jointly called for a new GAO investigation, furnishing a list of 22 questions to be asked in seeking information from DOD and NASA. The thrust of the questions posed to the GAO clearly demonstrated to industry that the vital nature of IR&D/B&P still is not understood. Therefore, senior executives of companies with membership in AIA, EIA and NSIA decided it was incumbent upon them to initiate a comprehensive study representing the ultimate in documentation of what these two industrial efforts are all about.

arameters of IR&D/B&P

The result appears, and indeed is, formidable: 312-page volume of technical papers on which a econd volume, entitled "A Position Paper on Independent Research and Development and Bid and roposal Efforts" is based. The Tri-Association Committee responsible for these documents believes that ney can contribute significantly to the deliberations f those in government who once again may be faced ith making decisions, legislative or regulatory, concerning industry-initiated technology.

The larger and basic volume cited above contains industry's findings and postures on six parameters of the recurrent issue:

- Economic Considerations Regarding IR&D and B&P Expense.
- Alternative Methods of IR&D and B&P Cost Reimbursement.
- Benefits Derived from IR&D Effort.
- Benefits Derived from B&P Effort.
- U.S. & Foreign Nation Support of Industrial Technical Effort.
- Industry Response to the 22 Questions Posed to the GAO.

Pressures Against IR&D/B&P

The study points out that historically each of the attacks on IR&D and B&P has resulted in additional restraints upon industry efforts in these areas. It speculates that repeated requests to the GAO for study after study can understandably be interpreted by the Department of Defense and other government agencies as an indication that Congressional support for IR&D and B&P is lacking and therefore intent exists that such efforts should be reduced.

Should gross misunderstanding of IR&D/B&P be permitted to continue, precipitate legislative action might occur. In industry's view, this would be contrary to the best interest of the country and its government. It could ultimately increase costs of weapon systems and some consumer products as well. It would most certainly jeopardize American industry's pre-eminence in competitive technological developments.

For a number of reasons the amount of IR&D costs that DOD has had to allocate to defense contracts has remained practically the same for the last five years. The net effect has been that the number of man-hours of IR&D effort that the inflated dollars could actually buy has declined by approximately 28 percent in that period. Similarly, industry allocations of dollars to self-initiated IR&D have increased, but only at a rate that is about holding a steady level of real effort.

Other Nations on Opposite Tack

Based on available statistics, many of the world's industrialized nations are giving greater recognition to research and development than the U.S. Generally, they are increasing their ratio of R&D to Gross Na-

The thrust augmented wing is an aerodynamic concept involving propulsion, aerodynamic lift and flight control surfaces to attain vertical/short take-off (V/STOL) capability in high performance aircraft. Rockwell International initiated an IR&D project in 1970 to further develop and incorporate earlier basic technology work. The IR&D effort explored totally new and integrated aircraft systems. This work enabled Rockwell International to respond quickly to a Navy request for proposal for such an aircraft, and a contract was awarded to develop the XFV-12A prototype (left) which is scheduled to begin flying later this year.

Honeywell in 1957 recognized that a proximity fuze design could be a potential breakthrough in altimetry techniques. IR&D funds were used to build a model which led to the instrument being used by the Air Force in 1964 in the F-111 program. As a result of additional altimeter IR&D investments in 1966 it appeared possible to develop a solid state altimeter which would dramatically reduce the size, weight and cost of previous models. An IR&D investment in 1968 produced a model which has had wide application in aircraft and missiles. At right is a mockup of an advanced radar altimeter which Honeywell is building under an Army contract. It will provide pilots with both analog and digital information.

tional Product while ours is gradually decreasing. Their productivity is reaching new highs while ours is lagging. Numerous foreign governments have developed far-reaching and often generous R&D incentive policies while, according to the U.S. Department of Commerce, "the U.S. is perhaps the only advanced nation in the free world which has not undertaken national programs to stimulate technology development in the civilian sector."

Foreign governments have recognized the need to encourage industry to conduct research and development in order to provide a necessary technological base to compete in the international marketplace. In most cases such encouragement is in the form of direct subsidies. U.S. companies neither ask nor believe that subsidies or direct payments of any kind are desirable. However, the vital need for IR&D and B&P efforts and the contribution of such efforts to our nation's technological base should be recognized and encouraged by the Government's acceptance and reimbursement of the IR&D and B&P elements of cost equitably allocated to government contracts.

Insistence by the Government on paying anything less than its full share of these basic costs is, in effect, a subsidization of the Government by American industry and its non-government customers.

Pay For What You Buy

In simplest terms, what the three associations are saying is this:

- If in-house industry efforts develop the transistor, printed circuits and micro-miniaturized circuits for communications should not the Government pay its share of these development costs when it buys a product that incorporates them? A civilian does when he buys a solid state television or hi-fi set, or a pocket radio or calculator.
- If the Government states a specific need and industry responds with proposals and supporting bids to develop a "thing" that will weigh so much, move so fast, do certain jobs, shouldn't the thousands, even hundreds of thousands of dollars spent to develop an acceptable bid and proposal be a part of the cost of the finished product? Industry considers it simple logic that the cost of a manufacturer's research and development efforts undertaken to improve an established commercial product or process, or to develop a new one, becomes a part of the price of that or some future products or processes. A business generates income by offering products or services which customers are willing to purchase. The prices of those products or services include a profit, indispensable in a free-enterprise economy. The price also includes the costs of labor and materials used in producing and marketing the product and allocable shares of the many indirect (overhead) expenses necessary to operate the business.

Included in these indirect expenses, for example, are managerial and clerical salaries and wages, payroll taxes, depreciation and maintenance of property used in the business, utilities, insurance, taxes and company-initiated research and development and bid and proposal costs.

The business firm expends its own funds for all of these elements of cost, but it is the customer who in fact "pays for" only his allocable share in the price he pays for the product or service. This is true whether the buyer purchases a pound of hamburger, an automobile, a television set, a filling in a tooth, or a military system. Conversely, the customer pays for none of these costs (including research and development and bid and proposal efforts) unless and until he actually buys the product or service.

Benefits of IR&D

Among the harshest of allegations is that no benefits or innovative break-throughs derive from IR&D and no evidence exists that IR&D creates competition. As discussed thoroughly in the report, this simply is not true. During past years, in preparing for Congressional hearings, DOD has assembled a few isolated examples. Unfortunately this annual compilation and presentation to Congress of limited examples of IR&D benefits has apparently led to a widespread misunderstanding that IR&D is a DOD program—and that perhaps the total outputs from and benefits of this work can be readily tabulated and easily displayed.

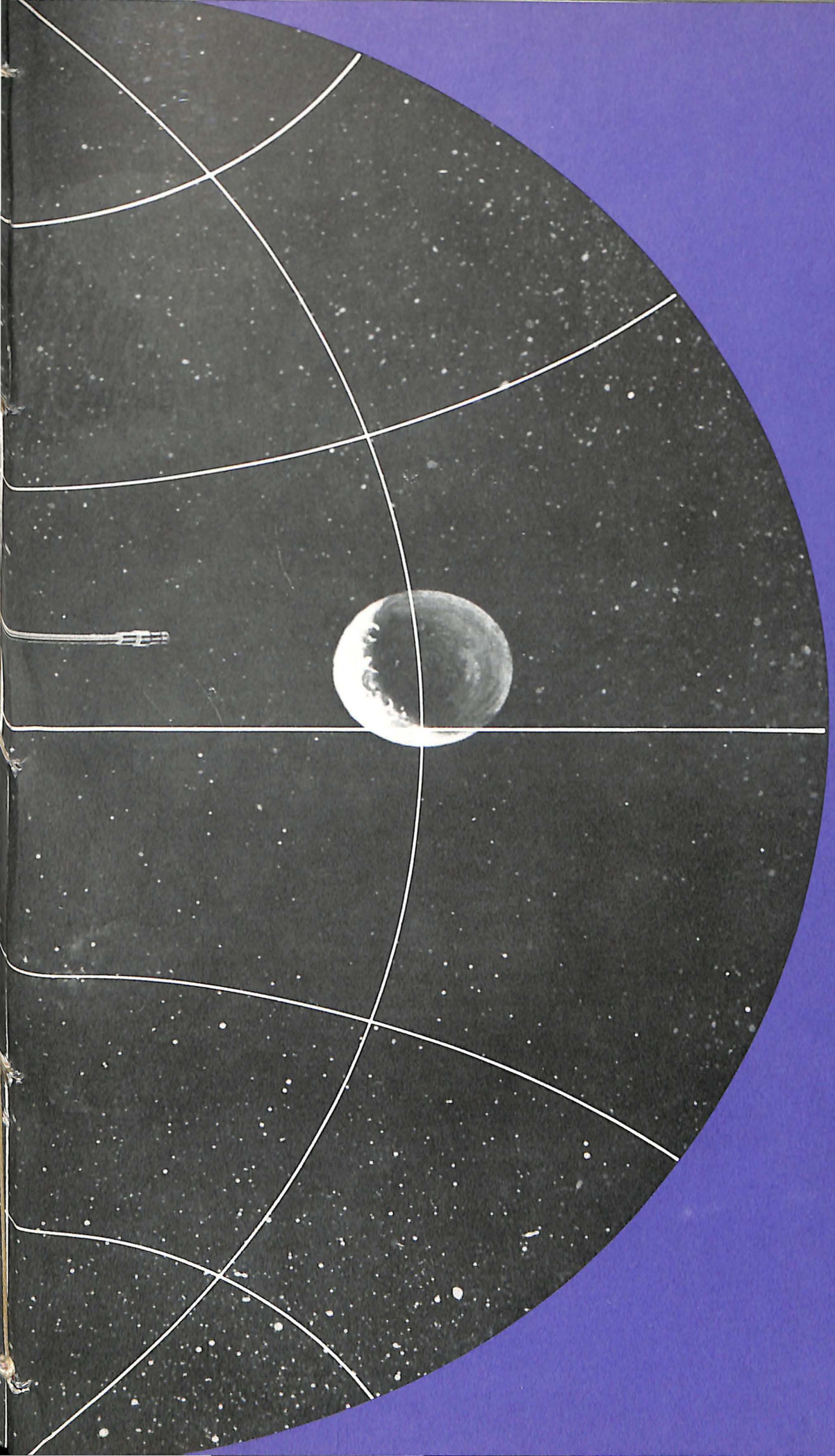
These attempts to display the benefits of IR&D

International Cooperation in Space-

WHAT'S AHEAD?

BY ARNOLD W. FRUTKIN
Assistant Administrator for International Affairs
National Aeronautics and Space Administration

The next major step in international cooperation in space will be the docking, by Russian and U.S. crews, of the Apollo (U.S.) and the Soyuz (Russian) spacecraft. Artist's conception on front cover shows the two spacecraft docked. At right, is a drawing of an international ionosphere satellite in Earth orbit. This was the first international cooperation venture in space, a joint United Kingdom-United States project.

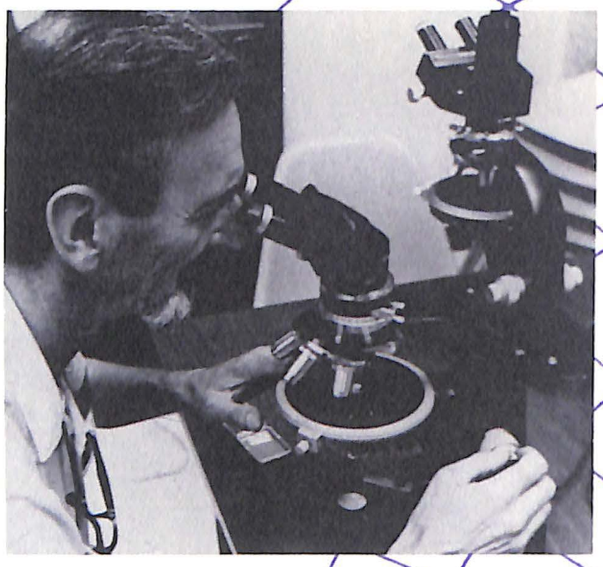


In February of this year, Dr. James C. Fletcher, Administrator of the National Aeronautics and Space Administration, made a thorough and thought-provoking speech before the National Space Club in Washington, D. C. We were intrigued by some of his remarks: ". . . such bases on the Moon would be too expensive for one country alone . . . . manned expeditions to Mars will likely be organized on an international basis . . . . by 1991 I anticipate that it will be clear to all that if it is desired to proceed on the major space missions of the future, there is no alternative to international cooperation — no alternative that is both feasible and appropriate in a world at peace."

Stimulated by these remarks, *Aerospace* magazine is pleased to present the following article by The Honorable Arnold W. Frutkin, Assistant NASA Administrator for international Affairs, who discusses the near term future of international cooperation in space. —*Editor*

In 1969 NASA identified two significant "gaps" in its international activities and designated the filling of these gaps as prime objectives for its international efforts in the '70s. The first gap was the absence of European participation in a major US space hardware program, such as the development of a space transportation or payload platform system. The second was Soviet participation in a major project of mutual value.

The 1973 commitment by nine European nations to develop the Spacelab for sortie-mode missions of the Shuttle fills the first of these gaps. The second was filled when the President's 1972 Summit accord incorporated an agreement between NASA and the Soviet Academy of Sciences providing for the design and develop-



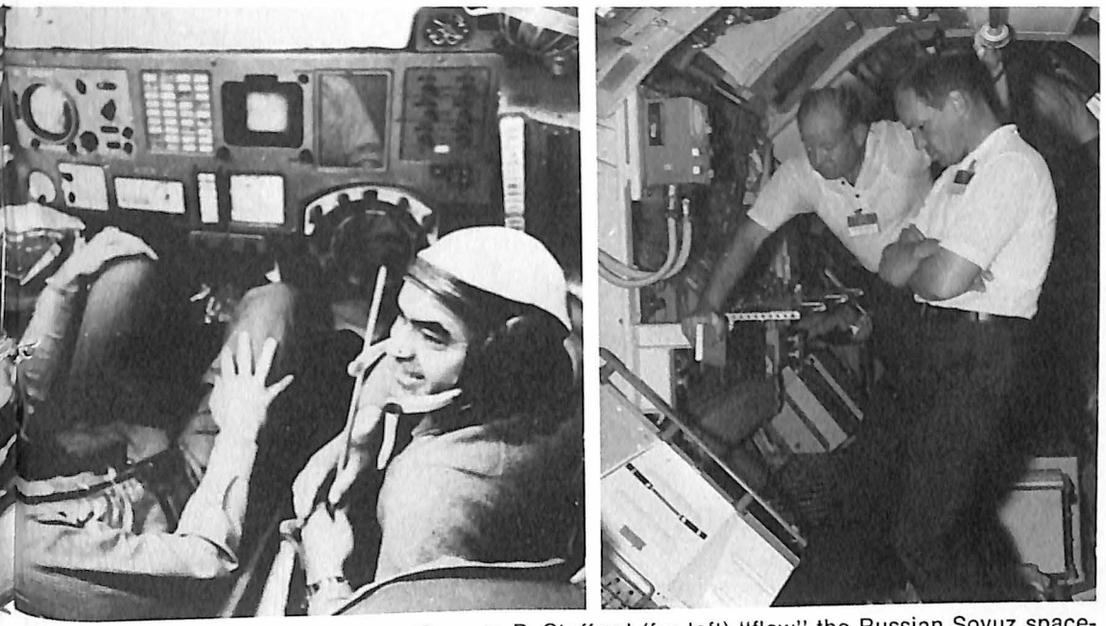
A Cambridge University (England) scientist looks at a thin slice of lunar material brought back by an Apollo mission. The U.S. has shared with scientists all over the world the lunar samples brought back by the manned Apollo program missions.

ment, test and demonstration in flight of compatible rendezvous and docking systems for the manned spacecraft of the two nations. In addition, the summit accord incorporated the Low/Keldysh agreement of January 1971 which provides for interchanges in space science and applications in the planetary, lunar, space medicine, and natural environment fields.

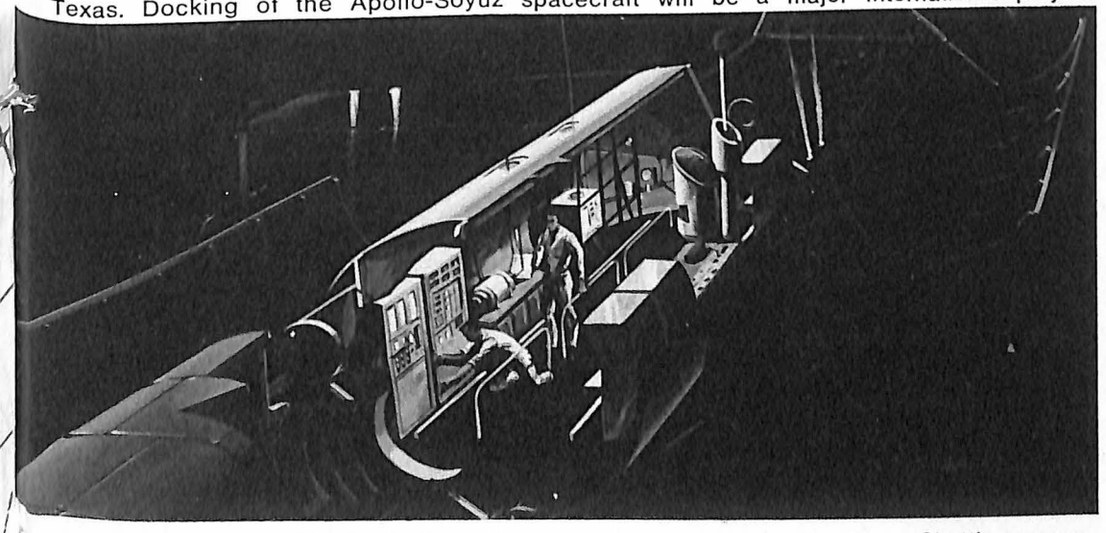
The significance of these two major projects, apart from their intrinsic importance, derives from the fact that they are the first space developments of major proportions to be undertaken by the Soviet Union and the Europeans respectively with the United States. The Apollo-Soyuz Test Project (ASTP) will constitute the first joint US/USSR manned flight mission; Spacelab, which will provide the first opportunity for Europeans to participate in manned flight, will represent a European contribution equivalent to about $350 million, an unprecedented joint civil effort.

Since the first cooperative international satellite project, the United Kingdom's Ariel 1, was launched by NASA on April 26, 1962, the agency has conducted a vigorous international program which has included the launching by NASA of some two dozen satellites designed, built, instrumented, and funded by other countries, each nation bearing its own costs. Similarly, 26 foreign experiments have been selected on their merits and carried on NASA satellites, over 800 cooperative sounding rocket flights have been completed, nearly two dozen coun-

This is one of the antennas set up by the National Aeronautics and Space Administration for acquiring data from space. This one is located near Madrid, Spain. Many nations around the world assisted in providing tracking sites.



American astronaut Brig. Gen. Thomas P. Stafford (far left) "flew" the Russian Soyuz spacecraft simulator during a visit to Moscow. At right, Russian cosmonauts check out the Apollo multiple docking adapter during a visit to the Johnson Space Center, Houston, Texas. Docking of the Apollo-Soyuz spacecraft will be a major international project.

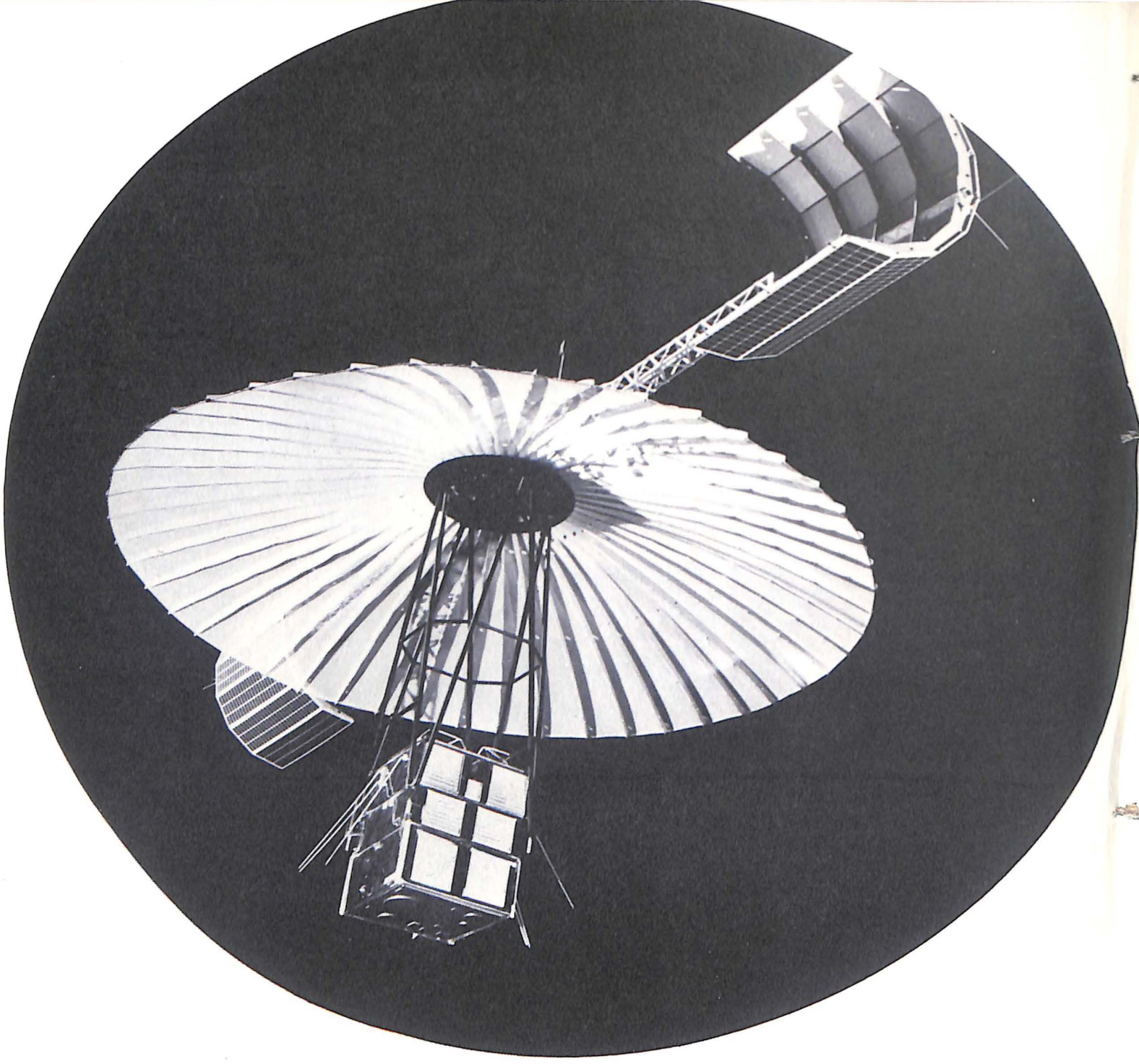


The Sortie Can will serve as a key element in the Space Shuttle program. It will provide a practical mechanism through which international cooperation and participation in space research can be achieved.

tries have operated or made significant contributions to the operation of NASA's global tracking and data acquisition stations, and some 80 countries have participated in a variety of ground-based activities necessary to or enhancing US space research projects.

Still other US space activities enabling significant participation by scientists and agencies of other countries include:

- Development of a year-long Satellite Instructional Television Experiment scheduled for 1975 when India will beam public service TV programs to the ATS-F satellite for rebroadcast to TV receivers in 5,000 villages.
- Lunar sample analysis by 20 countries and the European Space Research Organization (ESRO).
- Provision of ground stations by 12 countries for the cooperative testing of experimental communications satellites.
- Participation by 8 countries in communications experiments involving the Applications Technology Satellites (ATS).
- Cooperation in advanced aeronautical research with Canada, France, Germany and United Kingdom, principally in the VSTOL field.
- Launching 13 foreign satellites on a reimbursable non-profit basis, beginning with ESRO's Highly Eccentric Orbiting Satellite (HEOS) in December 1968. Of the 9 foreign satellites NASA is launching this year, 5 will be placed in orbit under contracts in which the foreign countries purchase the launch services.



The ATS-F is the first of a revolutionary new generation of communications satellites. This satellite is expected to pioneer educational television, data relay, air traffic control and other information transmission systems of the future.

One of the most extensive and most promising of current cooperative projects is the world-wide remote sensing program, which has used both the Earth Resources Technology Satellite (ERTS-1) and the array of instruments in the Earth Resources Experiment Package which was carried aboard Skylab.

Some 140 earth resources studies, based on these two programs, are now being conducted by investigators in 37 nations and two international organizations. The early findings indicate that remote sensing from space is not only a valuable tool for mapping inaccessible regions and for updating and correcting existing maps, but is also useful for monitoring agricultural, environmental, hydrologic, marine and other changing phenomena, and for locating areas likely to contain untapped natural resources.

The reports submitted to NASA by foreign scientists, whose countries finance their analyses, include many results of great promise. An investigation in Saudi Arabia has revealed that breeding areas for the destructive desert locust can be detected with data from ERTS. Amazon basin islands as large as 200 square kilometers (80 square miles), but not shown on existing maps, have been observed by Brazilian investigators using ERTS, while roads, rivers, and villages in the region are reported to be misplaced by tens of kilometers on existing maps.

The ERTS investigations in geology have uncovered many features of the

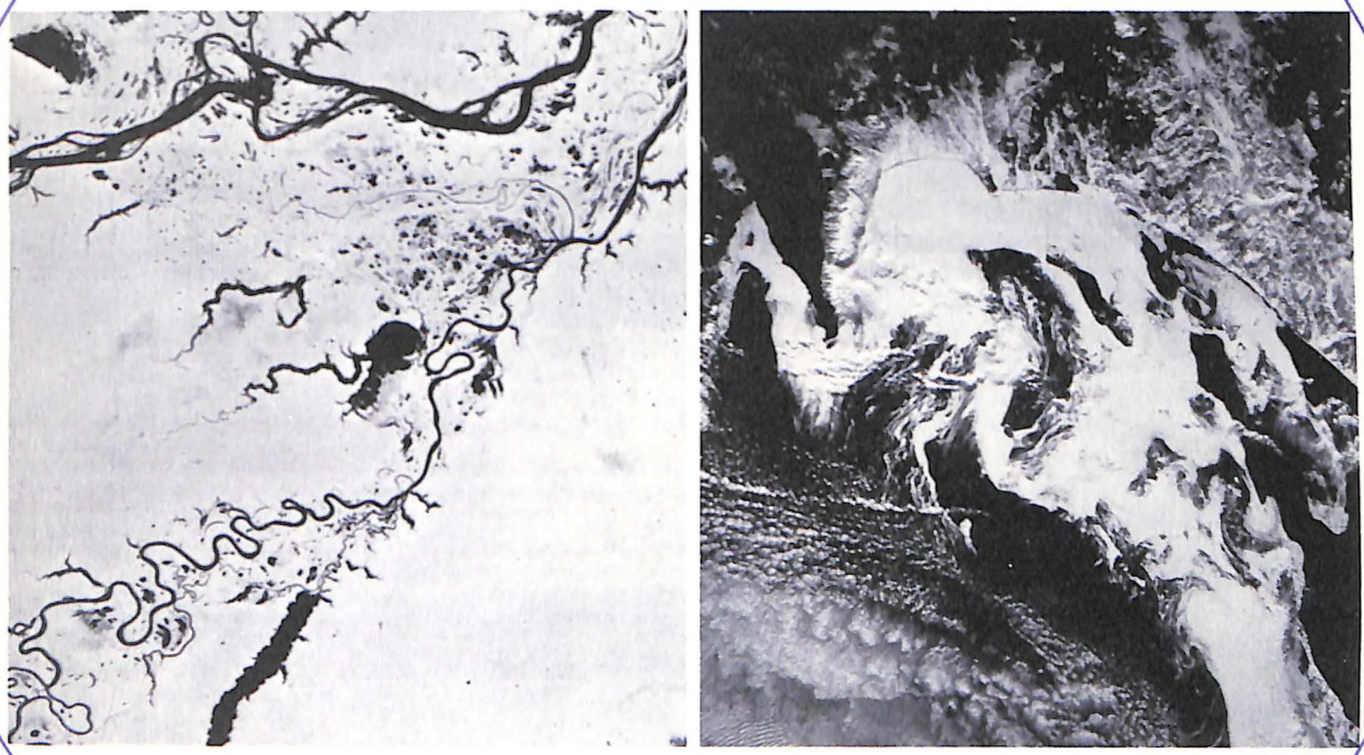


Photo imagery by the Earth Resources Technological Satellite (left) demonstrates its ability to show photographs of a large portion of the Earth's surface — the Amazon and Perus Rivers in the heart of the jungles of Brazil. At right, is a photograph made by the crew of the Skylab 4 mission showing ice flows in La Perouse Strait, Hokkaido Island, Japan.

Earth's crust that were simply not known before. Such discoveries in Bolivia, Iran, and many other nations point the way to great improvements in the techniques used to explore for natural resources and to better siting of roads, dams, power projects, settlements and the like.

For the future, NASA can look toward still newer international objectives. These may include possibilities such as:

1. Contributions to the development and beneficial exploitation of space applications on an international as well as a national scale and hopefully, with a magnitude and success-level comparable to that of Intelsat.

2. The development of patterns of international use of the Space Shuttle system in such a way as to optimize its efficiency and economy as the central space transportation system of the 1970's.

3. The continuation and expansion of collaboration between the Soviet Union and the US in selected space projects of increasing mutual value.

4. The engagement of Japan in meaningful joint space programs, thereby bringing into the ambit of international cooperation the only advanced industrial nation which has not yet participated in a meaningful way.

5. Continued emphasis on the substantive rather than simply the cosmetic aspects of cooperative programs as the approach best calculated to succeed and to advance the cause of international cooperation as such.

Hardly a day goes by in which the helicopter isn't featured in newspapers and television news programs for its role in public safety, crime-fighting, rescue and emergency service. It is perhaps most familiar to millions as an integral part of television entertainment programs. Two of its uses—convenient business transportation and front-line military service—are also well established in public consciousness.

Especially newsworthy is the fact that untold numbers of human lives have been saved because a helicopter could lift a victim quickly from an accident scene to a hospital heliport only a short stretcher run from a well-staffed emergency room.

In its 28 years of commercial service, particularly in times of disaster, such as floods and storms, the helicopter has been universally welcomed. But when the waters recede and the snow is gone it too often is considered a noisy nuisance, and even today is not permitted to land inside the city limits of many of our metropolitan and suburban population centers.

As with many technical innovations, there are vocal critics of the helicopter—mostly those who object to the "tapokata" flap of the rotor blades—when it is proposed that a heliport be located in or near their neighborhood.

It is obvious that these critics have not heard or seen the new generation of quiet helicopters. And it also is obvious that objections are more emotional than substantive, because the sound of a helicopter during the minimum time required in landing, or lifting off and leaving an area, can't approach the level and duration of the noise of a power mower in the hands of your friendly neighbor.

Energy and *ecology* are two of the lesser known areas in which the versatile helicopter, first envisioned by Leonardo da Vinci almost 500 years ago, are of growing importance today.

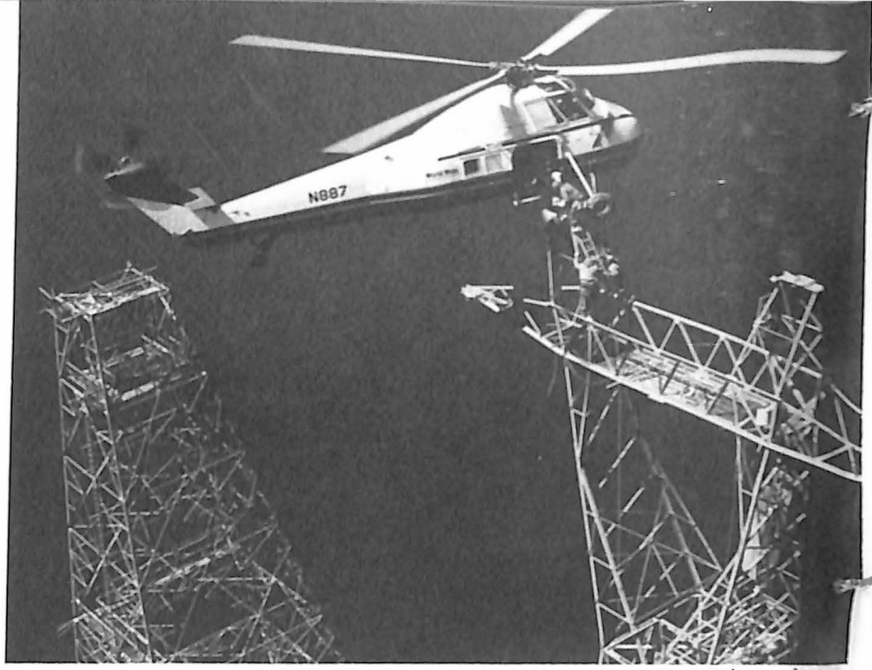
A senior executive of the helicopter industry has said:

> "More than half of the commercial helicopters in the U.S. today already are engaged in locating, capturing, distributing, propagating and conserving energy, agricultural or forestry products—three of this nation's highest priority commodities."

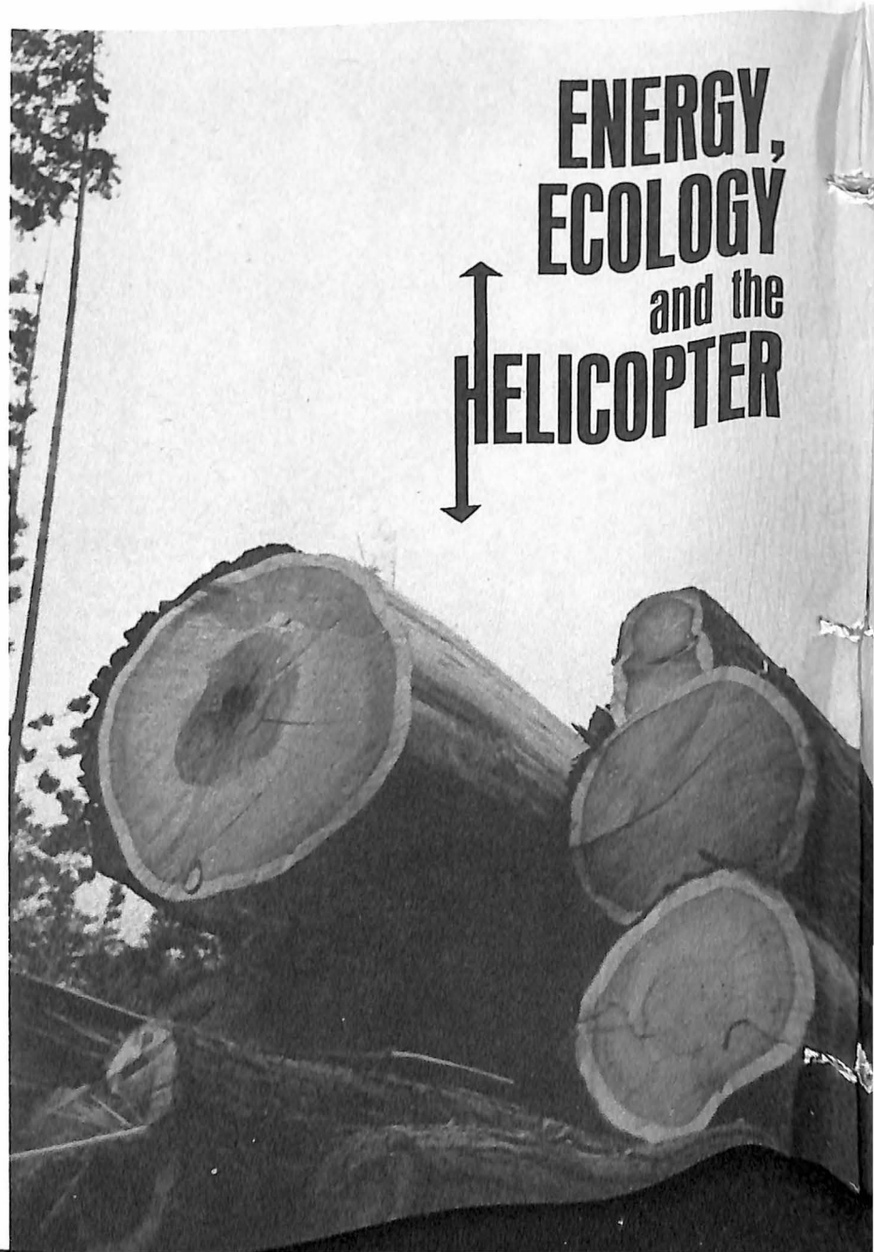
Consider the Field of Energy

- *At Sea:* Without the helicopter what would be the cost in time, transportation and danger if every one of thousands of off-shore oil production platforms had to be serviced by surface transportation? As a matter of fact, could crews be found to drill the wells in the first place if they had to roll and pitch their way up to 200 miles out to sea and back periodically in a boat or small ship?
- *On Land:* How would crews and equipment get into and out of remote and rugged areas opened by the Government for fossil energy exploration without building immensely costly roads that would have their impact on the scenery and, more importantly, on the ecology for years to come?

Using maps, photographs and data from aerial surveys, including infra-red photography from satellites, helicopters are moving geologists and prospecting crews into otherwise inaccessible areas where there may be energy resources, including minerals such as



Power line transmission towers are erected across mountains, rivers and ravines by helicopter. Here a Sikorsky lifts a section for precision placement. This heavy lift job is done in less time and at less cost by the helicopter. Again energy needs and the ecology are served.



A Bell JetRanger helicopter, equipped with fixed floats, prepares to hook up a water cannon, used to clean loose rock from the side of a steep cliff. The helicopter relocated the equipment in two hours. It would have taken a full work crew two days to do the job.

The Sikorsky Skycrane®, today's "logger", is proving cost effective and ecologically protective. Roads are not needed because the helicopter can fly crews over rough terrain into forest areas where it picks up and flies out timber cargoes. The helicopter leaves the surrounding forest untouched, free of scars and gashes.

uranium that can be tapped for the power that will be needed as world demand grows.

And the movement of energy, in the form of gas, oil, coal, electricity and communications, would be a much more difficult, expensive and time-consuming job were it not for the helicopters that carry in the crews, the machinery, the supplies, the pipe, the towers, and that even help string the transmission lines. Obviously such activity serves to protect the ecology as well.

Today, ecology and energy are partners in progress, and sometimes it is almost impossible to categorize an activity as being in one field or the other.

Consider The Field of Ecology

• *Clean Air:* One of today's battles on the home front is the fight for clean air. The helicopter is proving to be of prime importance to ecologists across the country who are combating the blight of air pollution.

For instance, Los Angeles County's area of more than 4000 square miles (an area the size of Delaware and Rhode Island combined) is under the airborne watch of an Air Pollution Control District (APCD) Bell helicopter. As soon as emissions from ground installations are sighted, the helicopter pilot flies over the immediate area. His observer starts a stopwatch wired to the doorframe and then takes a picture with his Polaroid color camera. The pilot radios APCD headquarters to dispatch a ground crew to investigate the site.

From the 1000-foot vantage point overhead the helicopter pilot can sight possible violations that could not be seen from the ground. He also can track noxious odors to their sources and provide aerial photos to use in court to prosecute violators.

During the first year of the Los Angeles County experiment the helicopter crew made 1.6 million plant observations. There were 3755 non-violation emissions recorded, 1452 odors were detected and traced to source, 165 open fires were spotted, and 63 violations were serious enough to result in legal citations.

The helicopter also is used to provide air samples in conjunction with 12 fixed monitoring stations on the ground. The aerial data, correlated with ground readings, can provide information on the distribution and dispersion of pollutants moving through the atmosphere.

The helicopter also can measure meteorological data, such as the inversion layer. The layer, a lid of warm air, often traps and concentrates pollutants that produce "smog" which covers the 1500 square-mile basin in which most of Los Angeles County's residents live.

• *Clean Landscape:* Also in California, a state-financed program is clearing the shoreline of scores of wrecked and abandoned automobiles. The helicopter, a transport-sized Sikorsky, makes child's play of picking up such junk from the rocky shoreline and hoisting it to waiting trucks on the road above. Congressman Alphonzo Bell of California is planning to introduce legislation in the U.S. House of Representatives to create a similar program nationwide. This makes sense from two viewpoints: the ecology and environment, and the rapidly rising value of scrap metal.

• *Clean Water:* The U.S. Army has loaned the Environmental Protection Agency three Bell Huey heli-

copters for a unique reconnaissance program that is permitting scientists to study 1100 lakes throughout the country. The scientists are looking for entrophication—premature aging of lakes caused by pollution and subsequent lack of oxygen in the water. From a boom extended out of a hovering helicopter the scientists can lower sensitive instruments to sample and test various depths of a lake and its in-flowing and out-flowing streams. They determined conditions both good and bad that can affect the future of the water and what can treat its ills where they exist.

• *Feast or Famine?* It is estimated that by the year 2000 the world population may be seven billion people —nearly double today's population. In order to feed this multitude, both land and the seas must be made more productive.

• *More Food:* The Department of Agriculture reports that weeds and grasses still cost the U.S. farmer several billion dollars annually. Only 30 percent of our cropland is treated to reduce weed losses. In addition, there are at least 686,000 known species of insects, plus an additional 9000 species of ticks and mites. All of these are competing with man for food and living space. The future could depend on how well we fight insect enemies and protect insect friends.

• *Crop-saving:* The fight against famine may depend in large part on helicopter application of pesticides, herbicides and fertilizers. The helicopter's rotor downwash, its abilities to cover tight corners, to fly at low speeds, and to reload at the site increase its effectiveness as an aerial applicator.

In the Wenas Valley in the state of Washington the U.S. Department of Agriculture has made low-level attacks on the apple codling moth. The "troops" dropped from a low-flying helicopter were male codling moths who had been sterilized at a laboratory by a 20-minute exposure to gamma rays. These "soldiers" eliminate the enemy, the ladies of the species, because when they mate with a female the resulting eggs are sterile.

• *Saving The Forests:* In the mid-50's, the U.S. Forest Service began testing helicopters in the fight against forest fires. Helicopters have proved to be effective not only in hauling and spraying fire retardants, but in flying in smoke jumpers and ground fire-fighting crews. The Forest Service does not own or operate any helicopters, but contracts for this specialized service with commercial operators around the country. In 1973 these helicopters flew an estimated 30,000 hours on such duty for the Forest Service, which maintains approximately 300 heliports and more than 5000 unimproved helistops to help protect the more than 186 million public areas under its jurisdiction.

Some state governments also hire helicopter operators to fly forest fire patrol. For example, in Pennsylvania, commercial helicopter operators fly whirlybirds equipped with 250-gallon containers of fire retardents on patrol throughout the mountainous terrain from April through May—the critical time in Pennsylvania for forest fires.

• *Lessening Man's Impact:* In an increasing number of special areas, often in the wilderness, where man's activities could have an adverse effect on the ecology, the helicopter is a primary tool because it can help get so many jobs done with the least damage to the environment.

• *Recreation:* Now when the U.S. Forest Service grants permits for ski lifts to be built in national forests, particularly in the Rocky Mountain area, it requires all construction material to be flown in by helicopter.

• *Harvesting Timber:* In logging, the helicopter is proving cost-effective and ecologically protective. Before the helicopter "logger" the conventional way to harvest timber was to cut a road into the logging area, fell the trees, slash off the branches and then drag the logs out by tractor. Networks of crude roads and barren areas hacked acoss our mountains and valleys still constitute visible scars in our national forests.

The advantage of the helicopter, from an environmental standpoint, is that it flies up and over the trees and rough terrain to take crews into the forest area, and then picks up and flies out its cargo of timber, leaving the surrounding forest untouched—no scars, no gashes, no gouges, no lasting damage.

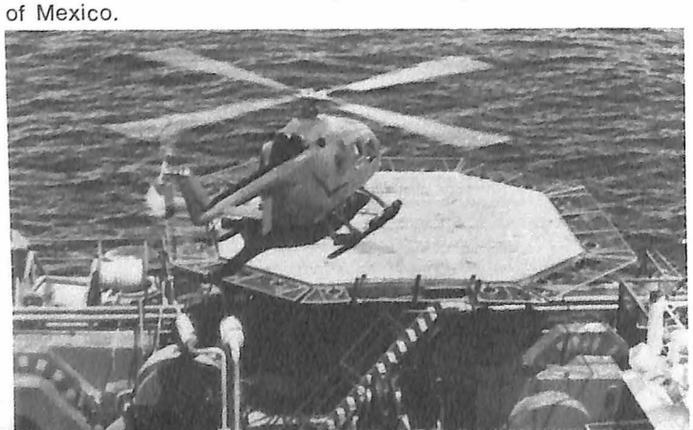
Although the feasibility was long known, it was in 1971 that a lumber company and a helicopter operator conducted a successful eightweek logging operation in Oregon, using a Sikorsky S-61. The next step was to test the larger Sikorsky Skycrane.® The objective was to harvest 3.5 million board feet of selected timber from a tract in Oregon's Siskiyou Forest region. The area, cut by steep ravines susceptible to landslides and soil erosion, was virtually inaccessible to conventional logging operations. The Skycrane,® operating six to eight hours a day, six days a week, harvested 27,000 tons of timber in a seven-week period.

This project demonstrated a timber harvesting system of unequalled flexibility and productivity, while meeting the Forest Service's need to preserve the environment and to protect forest resources for the public. As a result, many areas of our timber reserves have been re-mapped to provide for selective logging by helicopters only.

In addition to lumbering there already are large areas of the United States for which the Government has ruled that pipelines, communications lines, microwave transmission towers and power transmission cables and towers can be installed only by crews, equipment and materials flown in by helicopter.

There can be no doubt but that the vehicle that can lift a load—people, tower sections, equipment, crews, cables, pipe, church steeples—you name it—is going to have an ever-growing beneficial impact on our ecology and on our search for energy for years to come.

Helicopters have been serving off-shore oil rigs for 25 years, moving crews, supplies, parts. The farther companies move off shore, the greater is their need for helicopters. Below, a Boeing Vertol BO-105C twin-jet helicopter serves as the daily "bus" for oil crews to an oil production platform in the Gulf of Mexico.



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Pipeline work is a cinch for helicopters. A Bell helicopter lifts cement across rocky terrain. Helicopters will have a major role in the construction of the 800-mile Alaskan pipeline. (See *Energy, Ecology and the Helicopter*, p. 14)

aerospace

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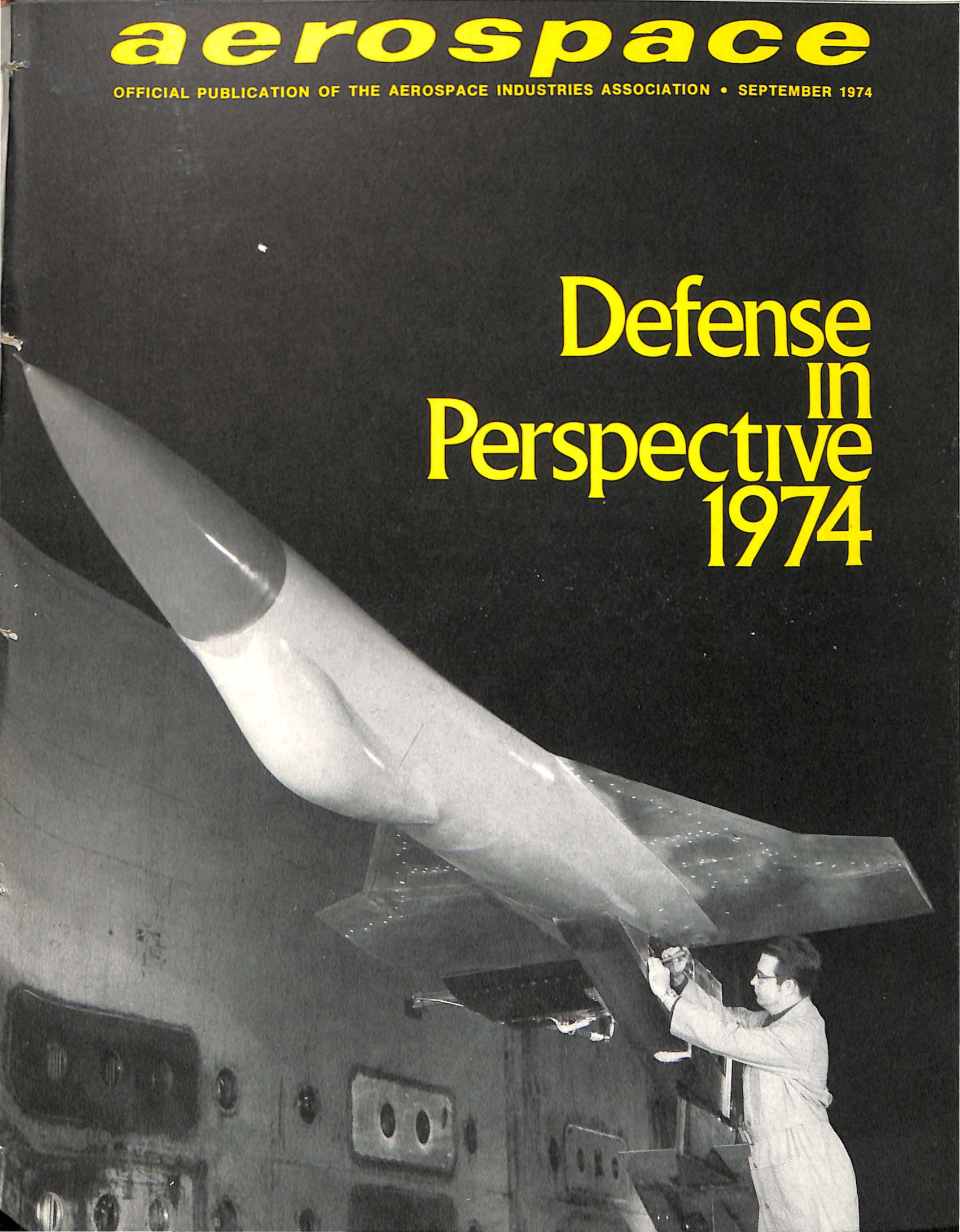
Defense in Perspective 1974



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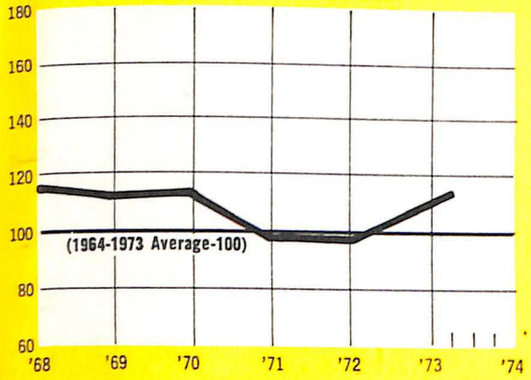
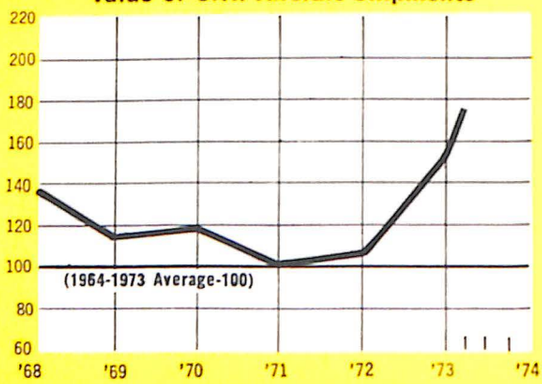
CURRENT

Total Aerospace Sales

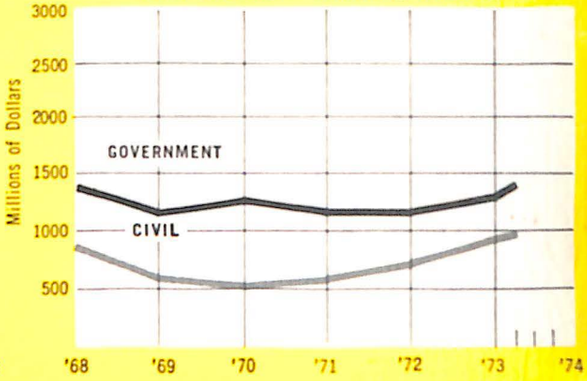


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA.
Non-government prime orders for aircraft and engines.

ITEM	UNIT	PERIOD	AVERAGE 1964-1973 *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	24.1	1st Quarter	22.2	24.3	24.9
	Billion $	Quarterly	6.1	1974	5.6	6.5	6.2
AEROSPACE SALES: Total (1958 Dollars)	*Billion $*	*Annual Rate*	*15.8*	*1st Quarter*	*14.8*	*15.3*	*15.3*
	Billion $	*Quarterly*	*4.0*	*1974*	*3.8*	*4.1*	*3.8*
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,194	Mar. 1974	1,098	1,367	1,049
Aircraft	Million $	Monthly	716	Mar. 1974	526	990	691
Missiles & Space	Million $	Monthly	478	Mar. 1974	572	377	358
Aerospace outlays: Total	Million $	Monthly	1,129	Mar. 1974	1,195	936	1,109
Aircraft	Million $	Monthly	669	Mar. 1974	610	460	615
Missiles & Space	Million $	Monthly	460	Mar. 1974	585	476	494
Aerospace Military Prime Contract Awards: TOTAL	Million $	Monthly	1,061	Mar. 1974	1,225	903	772
Aircraft	Million $	Monthly	667	Mar. 1974	721	598	517
Missiles & Space	Million $	Monthly	384	Mar. 1974	504	305	255
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	283	Feb. 1974	289	411	192
Expenditures	Million $	Monthly	287	Feb. 1974	302	256	232
BACKLOG (55 Aerospace Mfrs.): Total	Billion $	Quarterly	25.5	1st	28.4	29.7	30.7
U.S. Government	Billion $	Quarterly	14.5	Quarter	15.5	16.7	17.4
Nongovernment	Billion $	Quarterly	11.0	1974	12.9	13.0	13.3
EXPORTS							
Total (Including military)	Million $	Monthly	249	Mar. 1974	569	582	757
New Commercial Transports	Million $	Monthly	77	Mar. 1974	275	302	294
PROFITS				1st			
Aerospace — Based on Sales	Percent	Quarterly	2.7	Quarter	2.0	2.8	3.4
All Manufacturing — Based on Sales	Percent	Quarterly	4.9	1974	4.5	5.6	5.6
EMPLOYMENT: Total	Thousands	Monthly	1,213	Mar. 1974	924	951	950
Aircraft	Thousands	Monthly	669	Mar. 1974	507	510	509
Missiles & Space	Thousands	Monthly	128	Mar. 1974	89	98	99
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	3.86	Mar. 1974	4.87	5.21	5.22

* 1964-1973 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

Source: Aerospace Industries Association

RIGHT ON, SECRETARY DENT

BY KARL G. HARR, JR.
President, Aerospace Industries Association

Karl G. Harr, Jr.

Long after the content of this edition of *Aerospace* was planned, an editorial by the Honorable Frederick B. Dent, Secretary of Commerce, appeared in "Commerce Today" that by coincidence virtually set the scene for the two major articles published in this issue.

Secretary Dent observed that "while we are deeply occupied in problems and issues such as the state of the economy and world diplomacy, we must not invite shortfalls in other areas of vital national interest. One such area is the nurture of science and technology."

The Secretary then cited the "cold shower shock" we experienced when the oil embargo caught us woefully behind in the field of energy-related research and development.

Finally, he stated that "our status internationally is also dependent upon maintaining our superiority in sophisticated technology. The contribution of the aerospace industry is just one example of the role of technology in our trade with other nations. Without billions of dollars in aerospace exports we would have had a deficit trade balance every year since 1968. In national security, too, the essential ingredient of our strength is the sophistication of our research and development, an element of our strength which is respected throughout the world."

In this issue we are privileged to bring to our readers fresh and informative views from responsible people in the fields of aeronautics and national security, both highly dependent upon the constant and effective marshalling of the best resources in research and development and in science and technology that this nation can command.

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COVER: One of four different model configurations being tested (upside down) in a supersonic wind tunnel at the USAF Arnold Engineering Center to determine optimum location for engine inlets on possible tactical aircaft of the future.

The purpose of AEROSPACE is to:

Foster understanding of the aerospace industry's role in insuring our national security through design, development and production of advanced weapon systems;,

Foster understanding of the aerospace industry's responsibilities in the space exploration program;

Foster understanding of civil aviation as a prime factor in domestic and international travel. and trade;

Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

AEROSPACE is published by the Aerospace Industries Association of America, Inc.; the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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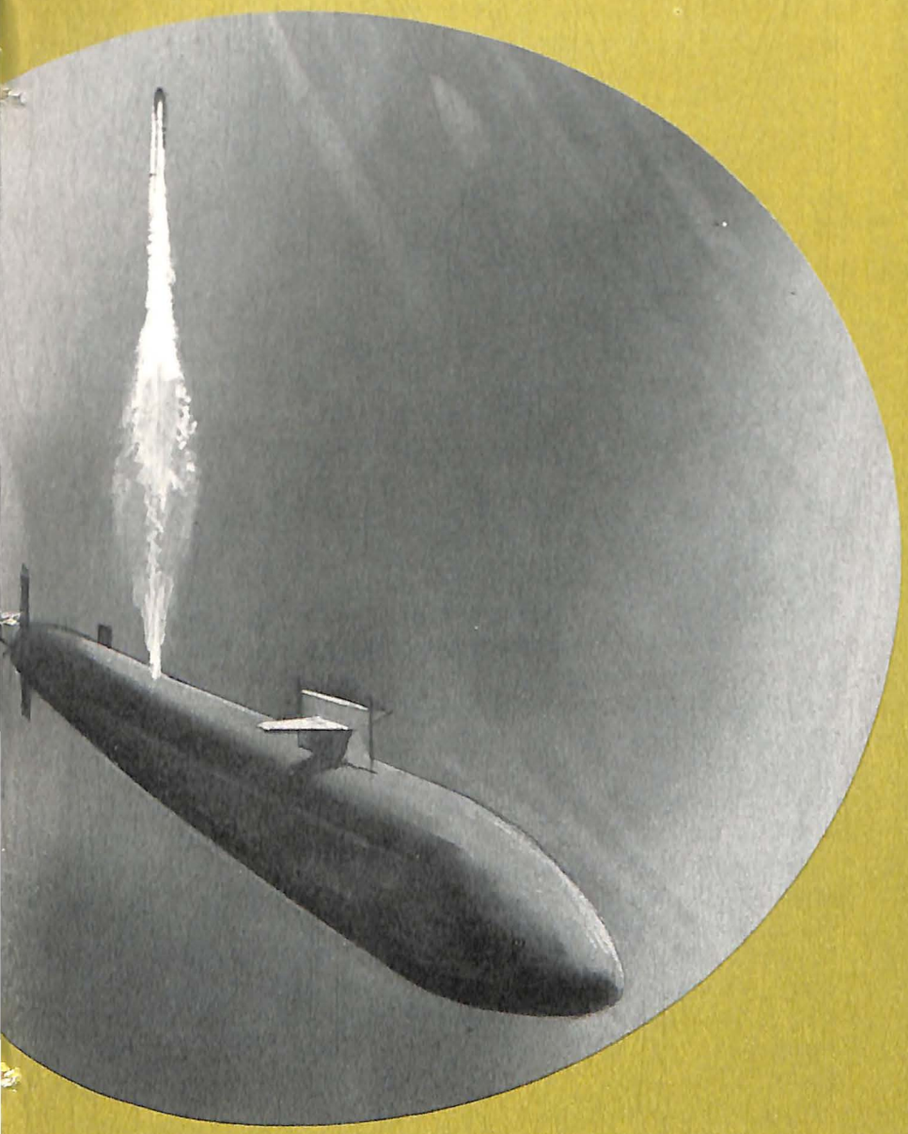
Honorable Malcolm R. Currie
Director of Defense Research
and Engineering

Defense in Perspective-1974

By JAMES J. HAGGERTY



Our basic strategic deterrent weapons are known as the *Triad*—bombers, land-based missiles and sea-based missiles. The B-1 bomber, the Minuteman III intercontinental ballistic missile, and the Trident submarine each is impressive. "But," says Dr. Currie, "by combining them we present any aggressor with a literally unsolvable problem."

For many years the United States has effectively carried out its responsibility of serving as the major defense bulwark of the non-Communist world. Peace and security virtually demand that the nation continue to accept this responsibility for as far into the future as anyone can see. Yet today there are those who express real concern as to the ability of the United States to maintain a defense posture adequate to its obligation.

There are two principal reasons. The cost of defense, as with everything else, continues to mount; it is in part inflation, in part the inherent complexity of advancing technology. Concurrently, changing national attitudes have dictated increasing attention to a variety of domestic areas. As a result of these factors, defense funding has declined as a portion of the total and thus produces a lesser level of deterrent force. The decline has narrowed the margin of American defense superiority over the Soviet Union.

In this atmosphere it is more than ever essential that the Department of Defense make maximum efforts to squeeze the last iota of defense effectiveness out of each available dollar. Nowhere is this more important than in the critical area of research and development, whose effective conduct today is the key to tomorrow's defense capability.

During recent years the Department of Defense has made substantial progress in tightening the management of its R&D program. Important changes have continued during the last year under the leadership of Dr. Malcolm R. Currie, present Director of Defense Research and Engineering. Recently Dr. Currie was asked to review the current national security situation and discuss the goals and management policy for defense research and development. In the following question and answer discussion, Dr. Currie outlines his R&D philosophy and provides some very interesting appraisals of Soviet/American weapons status and trends, together with the outlook for United States R&D in coming years.

Question: **What does the Department of Defense (DOD) see as the present day basic objectives of national security in 1974 and the years immediately ahead?**

Answer: Our objective is to avoid war but at the same time protect American interests throughout the world and, ultimately, to reduce the overall size of forces through negotiation.

You can see that deterrence of all kinds of wars comes first. In order to deter effectively, we have to maintain deployed forces which quite clearly make it impossible or difficult for any aggressor to achieve his objective without paying an inordinately great price.

In strategic deterrance, this Administration is relying on the maintenance of *essential equivalence* in weapons and capabilities *vis-a-vis* those of our strongest potential adversary across the whole spectrum of potential attacks.

This means the Soviet leaders should be able to look at our forces and what we can do and understand that if they were to initiate use of strategic nuclear weapons we would be fully able to reply effectively. We would thus hope to remove any temptation to resort to nuclear weapons in any situation for fear the retaliatory response would clearly put the attacker in a worse position than before the exchange. So our first objective is always to preserve equivalency in order to prevent them from having any significant overall edge.

Our second purpose is to insure that some third country, some ally of the U.S., will not look at the strategic balance and be influenced by Soviet pressure. So the essential equivalence must also be readily perceived by other countries. *We cannot have an effective deterrence across a wide range of possible events—from all out attacks to diplomatic crises—unless we have weapons and a support structure which are clearly adequate in quality and number to our requirements.*

The situation is analogous on the tactical side; again we want to avoid war and again we must have deployed weapons and a support structure which back up our deterrent policy. In the tactical area, our weapons must be clearly competitive with those of any potential adversary. They have to be at least as good, and I think better, in quality—or performance—and they have to be substantial in numbers.

Question: **What then is the proper role of defense R&D in achieving the broad objectives?**

Answer: Today's R&D is the key to tomorrow's weapons quality—and to a certain extent to weapons numbers. The objective of the defense R&D management team is to provide a continual flow of deployable new technology; to insure that the added performance is truly needed to carry out deterrence and combat missions, and to further insure that these options are available at the lowest possible price. In R&D, we continually must assess the future and invest our resources so that the taxpayers get a full return—in added security—for their money.

Question: **That is why you talk about a consciousness among our R&D managers of "return on investment"?**

Answer: Yes, in Industry the necessity for return on investment (ROI) is an extremely effective management tool as well as a stockholder's check on his corporation. There are many business practices that should, can, and are being adapted successfully to the management of defense R&D. ROI is just one. Design-to-Cost is another. I could name several if you like.

Question: **Yes, but later. I would like to ask first, whatever became of the Vietnam "peace bonus" of billions of dollars for use elsewhere. Why, in fact, has the DOD budget continued to increase since the war?**

Answer: You will recall that our participation in the war did not end suddenly but was gradually reduced over a period of years. As our participation was reduced, our war associated costs were reduced substantially. In effect, we have had the peace dividend. But as those costs went down, the total cost of maintaining an effective defense went up. Inflation, in other words, ate up much of the saving; manpower costs went up too, both uniformed and civilian. We did reduce force levels substantially, but it costs more today to maintain that smaller force in peacetime than it did to keep a larger force and fight in Southeast Asia a few years ago.

Military personnel strength went from 3.5 million in FY 68 to 2.1 million this fiscal year. Army strength went down from 19⅔ divisions to 13⅓; major surface combat ships from 338 to about 200 and Air Force tactical aircraft from 2800 down almost to 2200. And during all those reductions in strength, the cost of military personnel went up from $20 billion to almost $26 billion and operation and maintenance from $21 billion to more than $26 billion. That's how the peace dividend was eaten up.

On the other hand, defense spending has gone down substantially as a percent of the Gross National Product and as a percent of total federal spending. Total national income has increased and federal, state and local revenues have risen, so the total spending and total capabilities of the nondefense agencies, federal, state and local, have gone up enormously in recent years.

Question: **What has been the impact in defense technology of this squeeze—the DOD percent of GNP (Gross National Product) going down; available dollars, essentially level or going down and costs sharply up?**

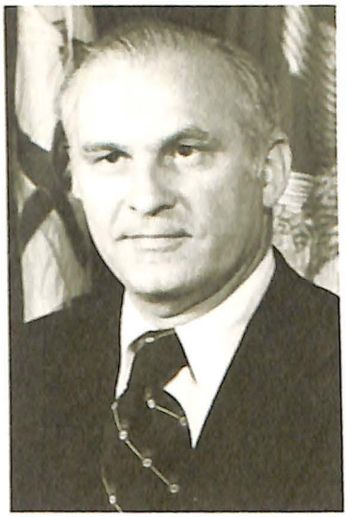
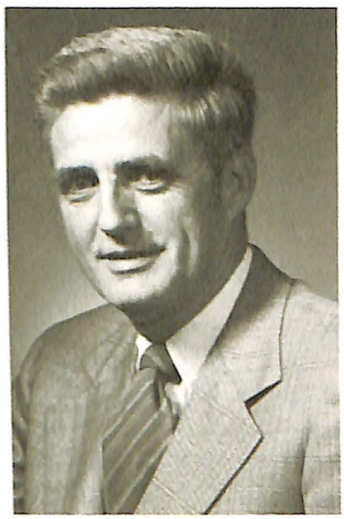
Answer: The most serious result of the squeeze for the past 5 or 10 years has been a challenge to our technological superiority. We have always relied on superior weapons to make up for an inherent shortfall in numbers of weapons and soldiers, but for some years now, the Soviet Union has been on a most impressive surge in defense technology.

We know that their efforts are tremendous and that despite the squeeze on their civil sector, defense-related R&D seems to get whatever it needs to take advantage of available science technology. We see the results of this effort in the new weapons which are tested, deployed and even exported by the Soviets. Many of these are first class weapons by our standards or any standards. I have examined some of them, and I know that they haven't skimped on technology or on workmanship.

The result is that the margin of technological superiority that we use to depend on is no longer comfortable. In fact, if we do not find ways to reverse the trends we could eventually lose that superiority in deployed weapons. The Soviets show no sign of wanting to ease off. All of the indicators remain impressively upward.

We have tried deliberately to change our trend in the submission of the Budget Request to the Congress for this fiscal year. For the first time in several years, the Budget Request for defense R&D does try not just to stay even with inflation and manpower costs, but it seeks an actual increase in level of effort of some 3 or 4 percent. I regard this as an important reversal of a dangerous trend. Whether inflation and Congressional reductions will



"Today's Research and Development is the key to tomorrow's weapons quality—and to a certain extent to weapons numbers." In addition to Dr. Currie, the nucleus of the powerful Defense R&D Management Team is composed of Robert N. Parker, Dr. Currie's Principal Deputy Director for Defense R&E, and the three Service Assistant Secretaries for R&D: Norman R. Augustine, U. S. Army; David S. Potter, U. S. Navy, and Walter B. LaBerge, U. S. Air Force. Dr. Potter, now Under Secretary of the Navy, still is working with the team.

permit this increase is in grave doubt today.

While seeking more money, we are making, I believe, very effective efforts to get more useful defense technology for the money. We are managing better. We are controlling costs and managing our programs in ways that not only improve our ability to get needed improvements for less money but make it easier for our overseers in the Congress to see the methods and results of our improved management.

Question: **What are the management changes that are being instituted now?**

Answer: The emphasis goes primarily to more effective implementation of basic management policy, not so much to changes in that policy. Some of the key management features that I am enforcing are better cost estimates, independent cost estimates to prevent optimistically low program baselines, better cost control, emphasis on design-to-cost and ownership costs during development, better long range planning, affordability, strong program management and a sound program plan—all in the general DSARC framework (the Defense Systems Acquisition Review Council that controls major development projects). It is the DSARC process where we are evolving a forceful and effective management technique for our major systems. The DSARC involves not only the Office of the Secretary of Defense principals—DDR&E and certain Assistant Secretaries of Defense—Installations and Logistics, Comptroller, Program Analysis and Evaluation —but also our service counterparts and the program managers.

And here is where the process creates a constructive interaction with the Services in program planning, establishment of alternatives and ultimately in better program decisions. The reaction in Congress is also very important—the DSARC process has created much greater confidence there in DOD management. We are giving the program manager more responsibility and authority to run the program but we also hold him accountable for the results. Program management is becoming a desirable career path in the military services. Program accomplishments are measured by test and evaluation to determine the pace of our development programs, not by a predetermined IOC (Initial Operating Capability) date.

We force vigorous competition—during development, in production, at the system level, at the subcontractor level, at the component level—whenever economically feasible. We look for viable options, different technical approaches, improvements to existing systems and the consideration of foreign systems to afford more than one possible solution. This is difficult from a management point of view, but the payoff is enormous—it takes management guts to follow through, but I am committed to it.

Question: **Are these changes having their impact?**

Answer: The research and development process is a long slow one. It takes 7 to 8 years from conception to the time that a new system is ready for a production decision. So it takes a long time to see progress in this business. But the new policies have already resulted in restructuring of many programs. They are having a real—and I hope lasting—impact. Programs are being laid out better and more realistically. Many of our current innovations are adapted from the business world, and I know they work there, and I know of no reason why they won't work here. I do see signs that current innovation is being successful. But if you want to know for sure how well my efforts are going, then come back 5-10 years from now and ask my successors. I can tell you how well my predecessors did.

Question: **How well did they do? Looking back those 10 - 15 years, do you see progress in the management of research and development and acquisition?**

Answer: I see substantial progress. There have been some ups and downs and some steps forward and steps backward, but the people who have watched the process for a decade or more say that they see real progress, and I agree with them. Really, we do not do so badly. Comparatively, we do pretty well. Compared with 10-15 years ago we identify and control costs better; we have better trained program managers and we use them more effectively; we terminate fewer projects for developmental problems—terminations now are largely the losers in a prototype competition, and of course that is good.

We have less production trouble stemming from inadequate development and test. Our testing—and this is very significant—is more realistic and more independent, and we really use the results to control the progress of the system through development. We use our formal control tools better. The programming/planning/budgeting system is really used now to identify deficiencies and needs. Then we use the DSARC well to identify, track and control the system solutions to the deficiencies. So we do provide optional solutions—developed and proven systems ready for a decision either to produce or put on the shelf—and the candidate systems are more clearly related to a combat need.

So if you compare today's DOD with yesterday's DOD, I think you have to say that we are doing substantially better. And if you compare today's DOD with other of today's Federal Departments, I think you will have to say that we are doing at least as well or better than any of them.

Senator Proxmire praised our performance in two Senate speeches a couple of months ago. You know that he is not generally one of our fans. His specialty is finding and publicizing the defects in our management, particularly management of research and development and acquisition. But he is also a fair and knowledgeable man. He told the Senate that he wanted to publicize the good side of Government management, and I am proud that he singled out the DOD for the greatest praise. Let me read you what he said, "No Agency or Department of Government has made greater strides in increasing its effectiveness over the past 17 years than the Department of Defense." Now he did not say that we went from terrible to merely bad. He said, in fact, "They have done well in many respects and deserve credit for it." He even said that in the past 15 years "the Department of Defense has faced and solved more management problems with greater success than any business in the world." We have a long way to go. Senator Proxmire and I can also agree that we still have many management opportunities and that we must and can continue to make progress. But you asked me about progress, and damn it all, we are moving and people ought to know that.

Question: **There have been efforts in the Congress to reduce your 9.3 billion dollar budget request for research and development in FY 75. What is your reaction to the cuts? Will they seriously affect DOD operations and in what areas?**

As with strategic systems, tactical warfare on and over the battle area is being given concentrated "look-ahead" attention. Late in 1969 General W. C. Westmoreland, then Army Chief of Staff, said "I see an Army built into and around an integrated (battlefield) control system that exploits the advanced technology of communications, sensors, fire direction and the required automatic data processing." Today Dr. Currie sees "Precision weapons, sensors, real-time gathering and processing of battlefield information, modern command and control, electronic warfare (as) changing the nature of future tactical war." Many systems fitting these concepts already are in various stages of development. A few of these are for future tactical operations (TOS), tactical fire direction (TACFIRE), air defense command and control (Missile Minder), air traffic management automated center (ATMAC), SAM-D (surface-to-air missile) command and control group (CCG), combat service support (CS_3), and the Army Security Agency control and analysis system (CAS).

Answer: Congress has not finished its action, so I do not know for sure today what the outcome will be. This is my first full budget cycle on the Hill. I have been impressed by the knowledge of the members of Congress and their staff people, and I have been impressed by their desire to be responsible and their willingness to listen.

Whatever the outcome, I know it will not be based on irresponsibility or whim. If there is any one thing that has disappointed me in the whole Congressional budget process, it is the difficulty that both sides have in keeping from getting bogged down in relatively unimportant detail. I try, and most members of the Defense-oriented committees try, to review the broad objectives and principles, and we try to see the sweep of programs and the relationship to deficiencies in achievement of military mission objectives. But we tend to spend too much of our limited time talking about small details.

The very fact that there are almost 600 individual program elements, each an aggregate often of a large number of separate programs, and that I must explain and justify them for each Committee to review and assess seems to insure that we will use our time inefficiently. It is hard to change this, but I hope to help some during next year's budget testimony by emphasizing to a greater degree the relationship of research and development efforts in the large to military mission outcome.

Congress and I will certainly disagree on some items and I am deeply concerned about my goal of permitting the total research and development effort to turn the corner and increase slightly beyond mere compensation for inflation and higher cost. Insofar as the major programs are concerned—like the strategic initiatives or the big tactical programs, I am hopeful today about the final Congressional outcome.

Question: **On the strategic initiatives and "essential equivalence" how do they relate to SALT (the Strategic Arms Limitation Talks) and do they in themselves contribute to the arms race?**

Answer: I don't want to talk specifically about SALT. Negotiations will continue, and I believe that substantial controls and even reductions are possible in the future—particularly if I don't say anything that could tend to get in the way of the negotiators. So I won't try to explain any of the specifics of the U.S. position.

But in general, the strategic systems which we have under development are square with our national SALT objectives and negotiating position. They are the sort of initiatives which should demonstrate to the Soviets that they cannot gain any significant strategic advantage over us in the future and, therefore, that arms control is desirable from their point of view.

At the same time, if SALT regrettably does not make more progress, then we will need these strategic programs to insure that the Soviets cannot upset equivalence in the future. The Soviets are moving rapidly with new strategic programs—within the limits set by the SALT I interim agreement. If we stand still, we will lose equivalence. So we can't stand still without risking serious erosion of our margin of deterrence.

Question: **What are the Soviets after in strategic forces?**

Answer: We can't be sure. We can't know what is in the minds of the men in the Kremlin. We hear what they say and see what they do, and what they say and do are consistent with each other. But we don't know where they are headed. They may be striving to get equivalence in their own eyes and in the eyes of third countries, and they may stop their buildup soon and negotiate realistic controls and reductions. Or, it may be that they take quite seriously their historic claims that the flow of history is on their side and if they push hard enough they can achieve a usable margin of political and military power over the capitalistic countries. Perhaps they want to extend their influence beyond their own borders and do it through a combination of political and military pressure as they have done with some of their neighbors.

If you look at our own Defense program—our research and development—you will see that we have covered both possibilities. If the Soviets want equivalence and then mutual arms reduction, we are ready to negotiate and slow down and reduce. If they are out to grab for whatever they can get, then we have programs which will close out any possibility of their success. So I feel the administration programs make sense

Question: **Why do we have three kinds of basic strategic weapons—the "Triad"? Are they necessary? Can we preserve the Triad?**

Answer: We have three kinds of deterrent weapons—bombers, land-based missiles and sea-based missiles—instead of just one because in strategic deterrence we must have a large hedge against failure. In tactical warfare we can lose a battle or even a war, and the U.S. itself could recover and survive and flourish. But if we lose a strategic battle, we could literally lose our country, our people and everything that is important. So we must make every effort to insure that there are no chinks in our deterrent armor.

We field complementary systems. Each alone is impressive and might even be effective as a deterrent. But by combining them we present any aggressor with an unsolvable problem. If, theoretically, he could overcome MINUTEMAN, the bombers would still be on their way and after a few hours would be able to inflict incredible punishment. If he could intercept most of the bombers, our submarine-launched missiles could come in from various directions and destroy him. We hopefully give him no openings. And surely no President, no Congress and no American could feel secure unless our safety is insured by multiple deterrent systems or by effective arms control.

I believe that the Triad will be preserved. We have a follow-on bomber, the B-1, which is being brought along in development successfully. We are working on a new generation sub-launched missile system—the TRIDENT system—and it is far along in development. We do not need a decision now on full-scale development of a follow-on land-based missile, but we are actively studying future options and we will be ready to select one if required.

Question: **How do our tactical weapons compare in performance with those of the Soviet Union?**

Answer: First, I want to remind you that while quality is essential, numbers are too. We must be competitive in

both, and what counts in both is what is deployed, not what is in the laboratories or in plans. So we have the difficult job of providing necessary performance at a cost that permits us to buy substantial numbers of individual weapons. We are doing that.

The Middle East war demonstrated last fall that the systems conceived and developed by past Defense Department leaders anticipated properly the real and important requirements. The experience and perceptions from the war led us to shift relative emphasis in some R&D areas, but in general, the war showed that most of our current development programs are on the right track. We have been addressing the right problems. We had identified the right battlefield deficiencies and needed technological advances. In general no single weapon on either side demonstrated an ability to dominate the battlefield and overwhelm the other side. Success in an engagement went to the side which used skillfully a combination of complementary weapons.

Question: **You have said that we can foresee a revolution in tactical warfare. Are you saying then that the revolution is not yet here?**

Answer: The revolution is real but gradual. That is, I believe that if 10 to 15 years from now you look backward you would see that some of the weapons used in Southeast Asia and in the Mid East revolutionized warfare the same way the introduction of tanks and radar revolutionized warfare in the past. Precision weapons, sensors, real-time gathering and processing of battlefield information, modern command and control, electronic warfare—all those things—will change the nature of future tactical war. Since we have begun to use some of those new developments successfully, we are in a revolution. We must insure through wise research and development that we stay out front in this revolution. We believe we are doing this.

Question: **Is in-house research and development expanding at the expense of industry? What are the trends? Why?**

Answer: First of all I want to assure you that the preponderancy of DOD RDT&E (Research, Development, Test and Engineering) is spent with industry, universities, and non-profits. About $7 billion of the $9.3 billion program we asked Congress for this year would go to those performers.

At the same time, there has been a greater share of the RDT&E budget going to the in-house institutions, particularly those involved in technology base activities. There are two principle reasons: first, in the mid-60's there was a deliberate effort to increase work of the DOD R&D institutions in order to improve the quality and competence of our scientists and engineers; and, secondly, the cost of maintaining our in-house institutions has risen sharply without corresponding increases in the DOD RDT&E budget. This has had the effect of reducing the total out-of-house effort.

I came from industry, and I'm sensitive to the balance between our effort in-house and out. I have underway an evaluation of the defense in-house laboratories addressing, among other things, this very topic. Also in the technology base area, I have issued instructions to the effect that any increase in the funding levels must be applied to the out-of-house program.

A word of caution: The DOD will continue to need a highly competent force of scientific and engineering people to manage the most technologically complex RDT&E program in the world; and, DOD will continue to maintain large test range and test facilities for evaluating RDT&E efforts—these items are heavily in-house and RDT&E funded.

Question: **In your formal statement of priciples for Defense R&D, you say that you strongly support Independent Research and Development and that the benefits "must be clearly visible." How can they be clearly visible? For instance, much of the work is proprietary in nature. How can it be visible without hurting the company which put its own resources into IR&D work?**

Answer: The work must be visible to the Department of Defense people who monitor research and development and to the Congress which oversees all of our efforts. It is possible for a company to track for our benefit and Congress's the use of IR&D funds, the relevance to military missions of the projects and the benefits which eventually accrue to the public. I know from personal experience that the benefits are immense. There are few public investments which pay off more effectively. But if the Department of Defense and the Congress cannot see and assess the benefits, then our support of IR&D will be reduced. Many companies are now making their IR&D work more visible to the Congress. Our IR&D review teams are getting the cooperation of the companies, and I believe that the review is very effective.

Question: **What are the most promising technology areas for future military systems?**

Answer: I could say smart weapons, guidance systems for ballistic missiles and more silent submarines and continued emphasis on space technology, but I think the most progress is made when we make improvements in the basic components—like materials and electronic devices. You need stronger metals to send subs deeper, you need heat resistant material to make better gas turbines, and you need new integrated circuits and other basic devices to make better computers.

Take electronic devices for example. From tubes to transistors to integrated circuits, the last two and a half decades have seen us move from racks and racks of equipment to a few drawers of integrated circuits to do the same job. As one important example of how we can emphasize device R&D, I am increasing electronic device R&D spending by 20% in FY 76. It has lots of promise.

Question: **Is Design-to-Cost working? How can you effectively set a cost ceiling at the beginning of a development program when the completion of development lies several unpredictable years in the future?**

Answer: It is working quite well on some of our newer defense systems. I have seen instances of performance being traded for reduced costs, getting rid of "nice to have" features and concentrating on the minimum essential basic system requirements. Design-to-Cost has really begun to have a pronounced impact on the development process in making cost a coequal design parameter with

performance. We are getting closer to a commercial-type approach where cost is a paramount consideration right from the beginning of a new product concept.

Setting realistic Design-to-Cost goals at the beginning of a development program is certainly a difficult task. For this reason we normally delay setting firm Design-to-Cost goals on high technology programs until the completion of advanced development. We believe that our improved independent cost estimating capability will allow us to set better cost goals. If we find that a design-to-cost goal was set too low, the required cost vs performance trade-offs allow options—we can of course terminate the program, decide to accept lower performance or request that Secretary Clements (Deputy Secretary of Defense William P. Clements, Jr.) approve a higher Design-to-Cost goal. We are not only forced to look at program alternatives but also to document our position to the Secretary. I think this discipline in the development process is a key feature in making Design-to-Cost really work. At this stage we are not establishing rigid, by-the-book rules for Design-to-Cost—it is an evolving approach to cost control that should be tailored to best fit the individual program.

Question: **Whatever became of commonality? Do you still seek it?**

Answer: The avoidance of duplicative development is one of my major functions. I am continuing increased emphasis on Joint Service and Joint Agency programs to eliminate duplicative development. In the DSARC reviews, we are stressing use by one Service of sub-systems and components developed by another Service. Also, we are assuring that foreign developments are considered as solutions to our needs. The advantages of commonality are many—cost reduction, elimination of duplicate development; simplified operations; logistics support and training; and, expedited availability.

Recently I was able to identify over 40 current joint programs and this represents approximately twice the number we had last year.

Question: **Can you compare Total Package Procurement with the present approach?**

Answer: We are just about 180 degrees away from total package procurement. You will remember that in TPP, on the basis of paper studies the configuration was determined, the specifications written and the fixed price contract was signed for the development, procurement and support of a total defense system, prior to the start of development. The competition was over before the development even began.

Now we develop defense systems on a step-by-step basis with at least three critical milestone checkpoints. At these checkpoints program progress and alternatives are reviewed and the DSARC recommends to the Secretary the terms and conditions for the next phase of the program. Hardware vs paper is emphasized in advanced development with competition utilized to the utmost. Fixed price contracts are not used until such time as the program risk has been reduced to an acceptable level and there is a sound basis for cost estimates. We just don't start full-scale development or enter production until we have accomplished the critical validation and full-scale development milestones as determined from test and evaluation.

Question: **Will the present development approach allow any increase in industry profits?**

Answer: Regardless of the development approach, I strongly support higher profit for a good job and likewise low or no fee for a poor job. It bothers me that there are sometimes other factors at work, and the desired profit-performance relationship is not realized. I believe that our current development approach will help correct this problem especially in the area of better cost estimates which means more realistic contract target costs. Yes, I believe industry will have the opportunity to realize somewhat higher profits under our present development approach. I want good performance, strong management, superior track record and—above all—*integrity* to be rewarded. We have a long way to go here but we are determined to take positive steps in this direction.

Question: **You have stressed the vitality of the technology base. What are you doing to insure this vitality?**

Answer: Let me cover several items that make sense if you are going to have a viable technology base.

First of all you need good planning, and I insist that my staff and the staffs of the Services work together on preparing Technology Coordinating Papers on the various technical areas. This takes care of overlap and duplication; it establishes priorities; it identifies weaknesses; and, it focuses work to optimize our return on investment.

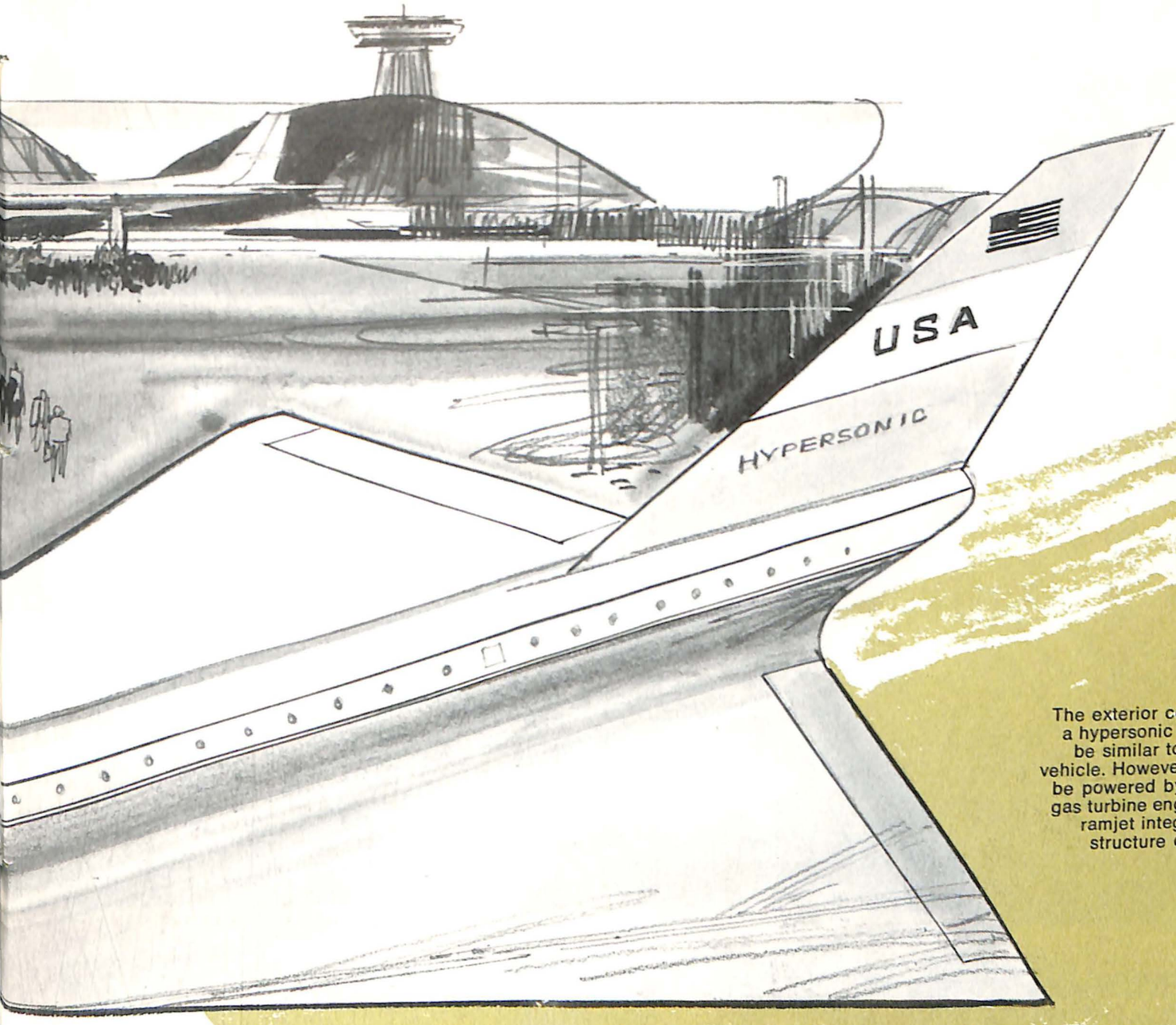
Secondly, we need to develop a large number of technology demonstrations which will give our future forces a relatively large number of options to choose from if and when the need arises. There aren't near enough resources to develop completely everything we could use, so my view is: initiate and carry through to a demonstration a large number of projects with potential application. This is relatively inexpensive compared to engineering developments and it gives us the options we need for the future.

Question: **Are you satisfied with the level and the thrust of the basic research programs funded by DOD?**

Answer: I'm not satisfied, of course, and I am making changes, but, first, let me say that historically DOD-supported basic research has been fundamental for many decades, not just to national security but to the economic well-being of our country, too. And it will be into the future. For the past ten years or so, the other federal agencies have been increasing their support of basic research, and our funding has been about level, so our percent of federal support for basic research has gone from about 28 percent 15 years ago to about 10 or 11 percent this fiscal year. But I want to sustain and improve our support and if possible increase it. DOD people have to be involved out on the forefront of scientific knowledge, and they can only do this through active participation.

I'm concerned that inflation has driven down the real level of our participation in basic research, and we are re-examining our efforts with the help of the scientific community. Now is the time to begin an important dialogue between scientists in DOD and outside, in industry and universities. It's a time for leadership in this area, and we're taking the initiative right now.

WHAT'S AHEAD IN AVIATION



The exterior configuration of a hypersonic aircraft would be similar to a supersonic vehicle. However, it would not be powered by conventional gas turbine engines, but by a ramjet integrated into the structure of the aircraft.

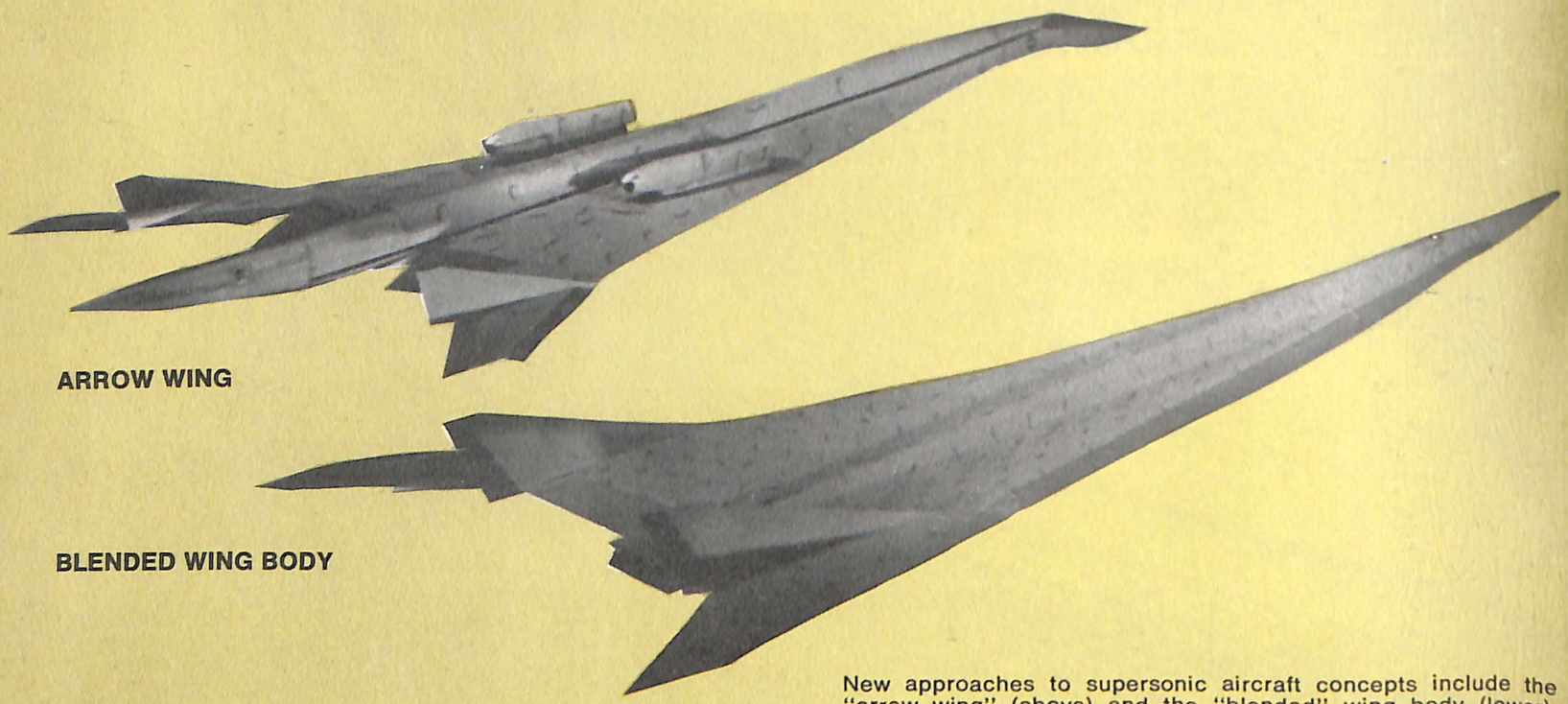
Only 47 years ago, the late Gen. Charles A. Lindbergh made a solo flight across the Atlantic ocean. In 1973 *scheduled* airlines of the world reported they flew more than 386 billion revenue passenger miles, which is the equivalent for some 14 *million* comfortable trips around the world.

So what's ahead in aviation?

Research and development projects in the U.S. aeronautics area are setting high sights that will revolutionize air transportation. Many are in the initial study phase; others have progressed to prototype hardware. All look promising.

Strong, persistent technological challenges from abroad, many of them subsidized by government in whole or in part, have made it mandatory that the U.S. continuously, energetically and imaginatively pursue these new avenues. At present some 80 percent of the jet transport aircraft flying on free-world airlines are U.S.-manufactured — a significant contribution to the national balance of trade. But this situation cannot last without a significant effort in the areas of short-haul, supersonic and even hypersonic development.

SUPERSONIC CRUISE AIRCRAFT RESEARCH CONCEPTS



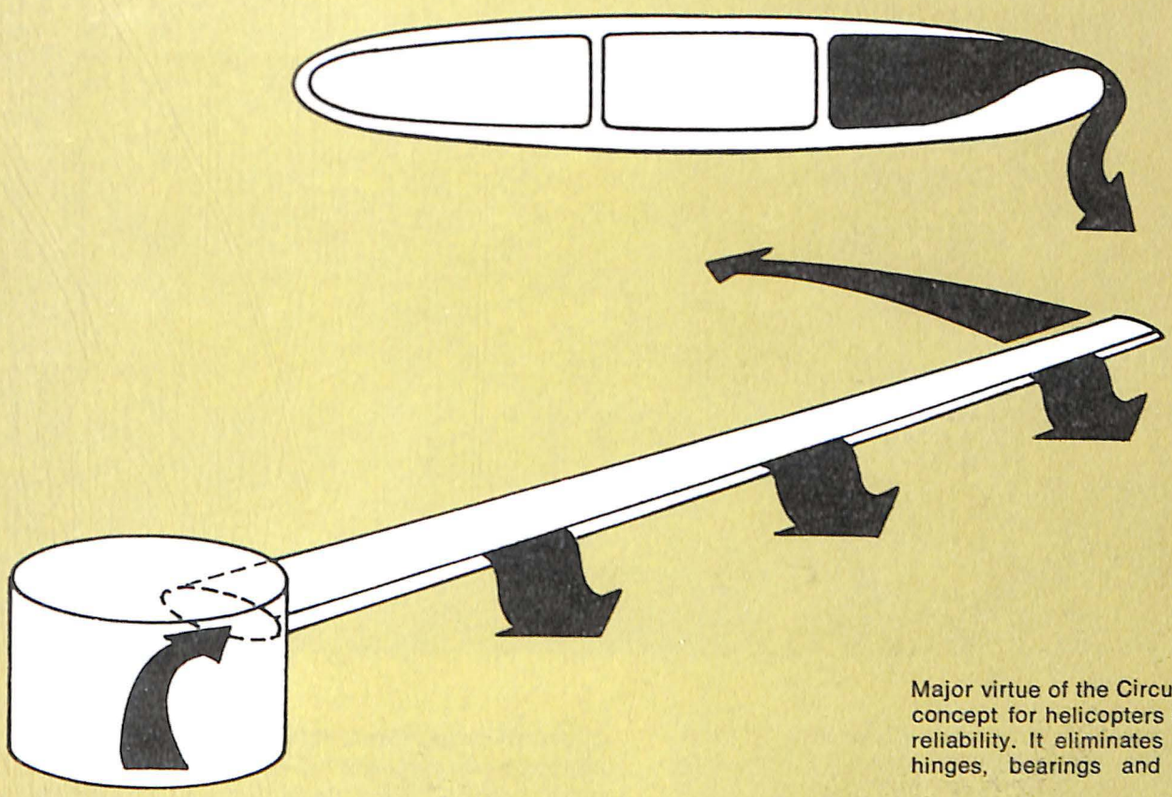
New approaches to supersonic aircraft concepts include the "arrow wing" (above) and the "blended" wing body (lower). They offer major gains in aerodynamic efficiency compared with the delta wing on current supersonic transport designs.

The Senate Aeronautical and Space Sciences Committee, chaired by Senator Frank E. Moss, last month completed hearings on new ideas for aircraft of the 1980's and 1990's. Witnesses before the committee outlined plans that are underway to retain this nation's leadership in future aircraft.

Two witnesses, Gerald G. Kayten and J. Lloyd Jones, representing the National Aeronautics and Space Administration, made particularly impressive presentations. Major points included:

- The next generation of long-haul transports must be designed for economical operation at fuel costs predicted to be more than three times the pre-1973 level. They will use only one-third to one-half as much fuel per available seat-mile as the aircraft they replace. These transports will utilize supercritical wing technology to reduce both drag and weight.
- Composite materials will be used extensively, providing a significant weight reduction. Active controls, fast acting and computer coordinated, will allow reductions in inherent aerodynamic stability and in loads imposed on the structure, thereby reducing both weight and drag.
- Fuel-conservative engines will incorporate advances in the technology of compressors, turbines, inlets, nozzles, seals, combustors, fuels and lubricants and some (in later models) will use advanced cycles. A drastic reduction in engine size will accompany the change from current engines to fuel-conservative, advanced-technology turbofans of conventional cycle.
- Installed weight reductions and overall efficiency gains combine to produce an effective fuel-consumption decline of 15 percent. One concept of an energy-conservative advanced-cycle engine incorporates a regenerator, which uses exhaust heat to raise the combustor inlet temperature. This engine is predicted to use 30 percent less fuel than the current-technology turbofan engine. New engines will utilize advanced engine components and will be significantly quieter and cleaner than current engines.
- Vertical take-off and landing (VTOL) aircraft of the future will combine vertical ascent and descent capability with more efficient horizontal flight than is possible with today's helicopters. Apart from considerable improvement possible in the helicopter itself, two concepts appear quite promising for future application — the tilt-rotor and the lift-fan.
- In the tilt-rotor concept the aircraft operates as a conventional helicopter in vertical take-off and landing but attains high-speed flight on wing lift, tilting the large rotors to act as propellers. In the lift-fan concept, gas generators are used to drive vertical-axis fans in the nose, and perhaps also in wing tip pods, for STOL and VTOL (Short and Vertical Takeoff and Landing) operation. Civil applications may provide efficient and rapid access to such remote locations as off shore oil rigs and wilderness sites, as well as city centers, or at least small areas only a short cab-ride from home or hotel.
- As approach and landing procedures become more precise and tightly scheduled, corresponding improvements will be made in cockpit displays and automatic landing systems. Augmentation of the pilot's available in-

CIRCULATION CONTROL ROTOR CONCEPT



Major virtue of the Circulation Control Rotor concept for helicopters is its simplicity and reliability. It eliminates the need for many hinges, bearings and mechanical parts.

formation and reduction of his workload will improve both energy conservation and safety.

• One of the primary measures of a transportation system's merit is the product of the payload and the distance it is carried. On the basis of this productivity criterion alone, supersonic transportation appears inevitable, whether or not the first-generation European and Russian entries prove economically successful.

When development of an American supersonic transport is undertaken, it will have to offer large advantages over the most advanced subsonic jets, and over the initial and improved versions of the Concorde, and the TU-144, in order to compete successfully in the world market. It also will have to overcome the environmental concerns which figured in cancellaton of the original U.S. SST prototype program, which was aimed at a second generation SST. The supersonic cruise aircraft research now in progress could lead to a second-generation SST with at least a 100 percent increase in payload capability, a 25-30 percent increase in range, and a 25 percent increase in speed relative to the Concorde, with noise levels well below current Federal regulations, and with objectionable engine emissions reduced by 90-95 percent relative to present-day engines.

• Some predictions are based on new conceptual approaches which were not far enough along when the first-generation designs were being solidified, and which still require considerable work to assure technological readiness. These include, for example, the arrow-wing planform and the "blended" configuration which offer considerable increases in aerodynamic efficiency compared with the more familiar delta shapes.

• Perhaps the greatest air transport growth in the future will occur in the air freight field, where even the most conservative projections indicate a tremendous increase in demand between now and the end of the century. This increase will necessitate considerable new development and several of the advanced concepts now being studied are directed at the cargo requirement. The advanced cargo vehicle concepts are influenced by the need for compatability with advanced handling concepts in containerization, automation, and computerized control that will serve advanced surface systems as well as air modes.

• Much of NASA's effort is devoted to generating technology in support of military requirements. One of these efforts is directed at developing concepts for substantial improvements in advanced fighter maneuverability. We have been working toward perfecting the techniques of remotely piloted research vehicles (RPRV's) to minimize cost and risk in flight testing selected high combat maneuverability design concepts. At the same time, the military services are experimenting with remotely piloted vehicles (RPV's) for missions such as battlefield surveillance, and even in the attack role. It is possible that RPV's may in the future be found useful for specialized civil applications such as monitoring severe storms, forest fire detection, fire fighting, disaster assistance and remote area deliveries.

• The hypersonic transport can be envisioned as a follow-on or perhaps even as an alternative to second-