

Civil Aviation

The nation's bicentennial year also marked the 50th anniversary of the U.S. commercial airline system. In 1926 it took some 30 hours to negotiate the single transcontinental route linking the West Coast with the northeastern United States; regular service was available to about 40 American cities. At the close of commercial aviation's semicentennial year, U.S. scheduled airlines were operating about 13,000 daily flights connecting more than 600 airports in the U.S. and overseas; they were carrying more than 500,000 people and handling some 7,500 tons of mail and freight daily.

Although final figures were not available at deadline, estimates by the Air Transport Association indicated that airline traffic increased sharply in 1976,

about nine to 10 percent above the previous year. Financially, it was a turnaround year for the scheduled airlines. The industry expected to show a 1976 profit ranging between \$325 and \$375 million, which compares with a loss of \$84 million in the preceding year.

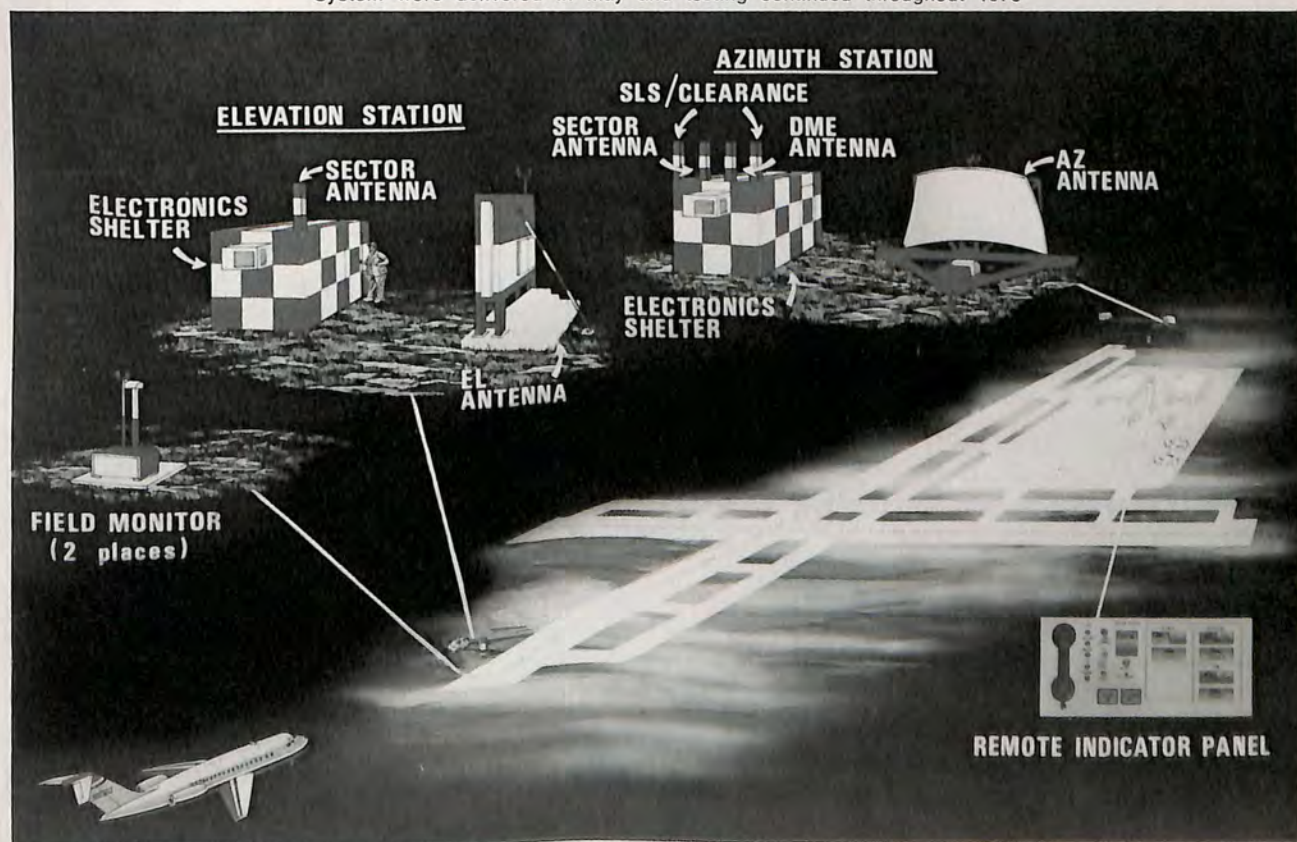
Despite the improvement, earnings in 1976 fell far short of what ATA considers essential to maintain a modern, adequate fleet of airlines and to provide a continuing high level of service. To meet those needs, the airlines require profit margins of about 5½ percent on sales; the 1976 figure was expected to be on the order of two percent.

During the year, airline expansion focused on increasing capacity of the existing fleet by greater utilization of current

aircraft as opposed to introducing new equipment. Orders for new transports were significantly below the levels of the latter sixties and early seventies. As of October 1976, orders for jetliners to be delivered between now and 1980 amounted to \$1.6 billion. These new aircraft will be used primarily to replace older airliners.

At year-end, the average age of aircraft in the scheduled carrier fleet was eight years, compared with four years at the start of the decade. This indicates a high level of replacement need in future years, coupled with substantial capacity growth to meet projected traffic demands. ATA predicted that combined replacement/growth needs in the decade of the eighties would require equipment outlays of \$60

First test units of the Federal Aviation Administration's Microwave Landing System were delivered in May and testing continued throughout 1976



billion, or average annual funding six times greater than the amounts planned for the remaining years of the seventies.

A highlight of the year's commercial aviation activity was the introduction of supersonic passenger service to the United States—but not on American-flag airlines. Operating under a 16-month demonstration approval granted by the Secretary of Transportation, British Airways and Air France inaugurated Concorde SST service to Washington's Dulles International Airport on May 24. First out-bound flights, to London and Paris respectively, were made the following day. At year-end, both airlines were operating at load factors of 80 percent or better on the transatlantic runs.

Another operational highlight of the year was the record round-the-world flight of a Pan American World Airways Boeing 747SP. Introduced to airline service by Pan Am in April, the SP (for Special Performance) is a foreshortened, extremely long range version of the 747 designed for nonstop flights on extra-long routes like Pan Am's New York-Tokyo run. On May 1, the 747SP departed New York and demonstrated its exceptional range capability by flying 8,088 miles nonstop to New Delhi on the first leg of the record trip, which was a scheduled revenue flight. From New Delhi, the jetliner flew a second segment of 7,520 miles to Tokyo, then a 7,621-mile final jump to New York. Total elapsed time for the global circuit was 46 hours 50 seconds, including ground time at New Delhi and Tokyo and a two-hour strike-induced delay at Tokyo. The 747SP beat the earlier round-the-world record by more than 16 hours.

The Federal Aviation Administration reported that the level of air traffic increased during fiscal year 1976. During the year, FAA air route traffic control centers handled almost 24 million aircraft movements under instrument flight rules, an increase of 1.4 percent over the previous year. In terminal areas, airport traffic control towers handled 62.5 million takeoffs and landings, up six percent. Instrument operations at airport towers amounted to slightly more than 28 million, up eight percent.

During the year, FAA continued to modernize the National Airspace System by providing increased automation of air traffic management in the 20 air route traffic control centers in the continental United States, and by completing installation of advanced automated radar systems at the nation's 63 busiest air terminals.

In addition, ground-based "conflict alert" systems were in operation at all 20

centers by the end of fiscal year 1976. The conflict alert system employs computers to "look ahead" along an airplane's flight path to search for potential course conflict and to alert the appropriate air traffic controller automatically when possible conflicts are noted. Equipment for the more difficult task of alerting conflicts in terminal areas was under development during the year; first tests were planned for 1977.

While improving performance and reliability of the existing air traffic control system, FAA was working on methods of upgrading the system to meet requirements of the 1980s and beyond. Among key developments in this area are the Collision Avoidance System and the Microwave Landing System.

In 1976, FAA completed testing of three types of airborne Collision Avoidance Systems and selected as most feasible the Beacon Collision Avoidance System (BCAS). FAA contracted for further development of two different versions of BCAS.

In development for several years, the Microwave Landing System (MLS) is an advanced approach and landing guidance system for air terminals designed

to replace the Instrument Landing System (ILS) which has been the standard international landing aid for more than a quarter of a century. MLS offers greater precision and reliability, and it represents an enormous improvement over ILS in flexibility; where ILS provides guidance along a single path, MLS makes possible a wide variety of approach and landing techniques to increase the traffic capacity of an airport.

Among several alternatives, the U.S. selected a microwave system known as TRSB (for Time Reference Scanning Beam). Following contract award for four prototypes in 1975—to development teams headed by The Bendix Corp. and Texas Instruments—the first MLS was delivered in May 1976 to FAA's National Aviation Facilities Experimental Center. Testing continued throughout the year.

The American TRSB is one of three candidate microwave systems submitted to the International Civil Aviation Organization for international landing aid standardization; the United Kingdom and West Germany have proposed different systems. ICAO will select one MLS as the world standard.

A 747SP commercial jetliner set a new round-the-world record in May





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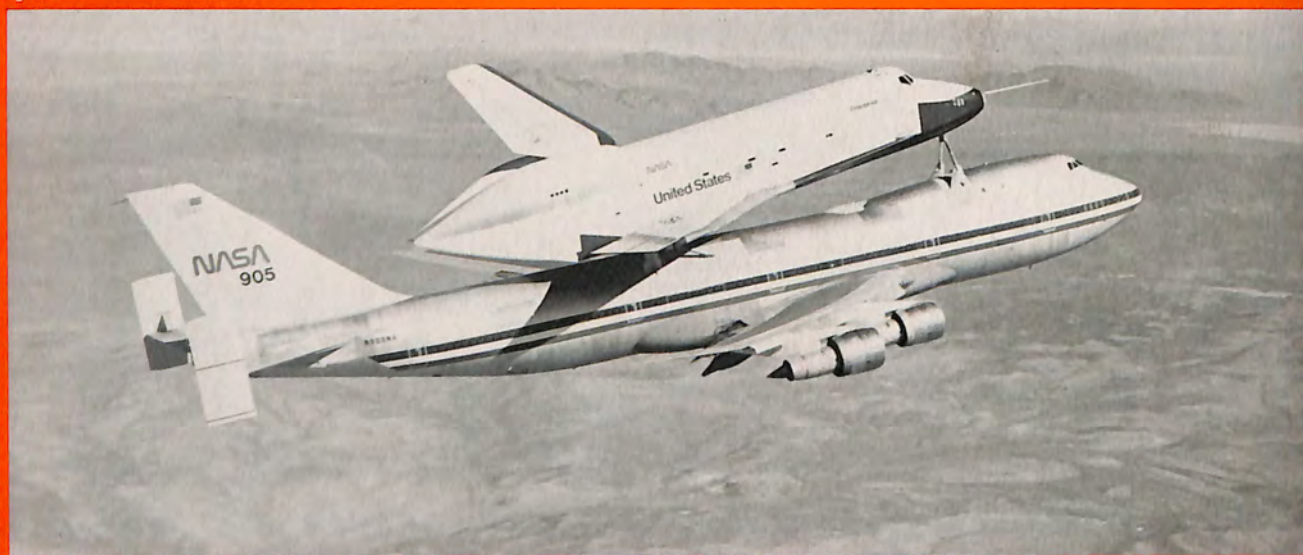
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GOALS FOR AMERICA

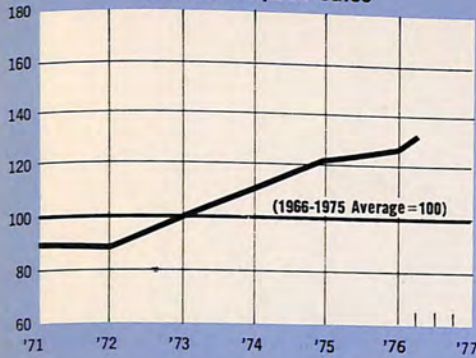
**President Carter and key Administration
leaders report on their Goals for America**

AEROSPACE ECONOMIC INDICATORS

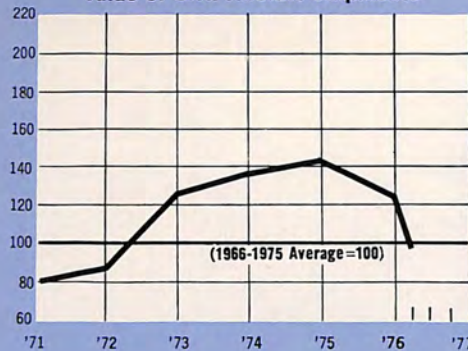
CURRENT

OUTLOOK

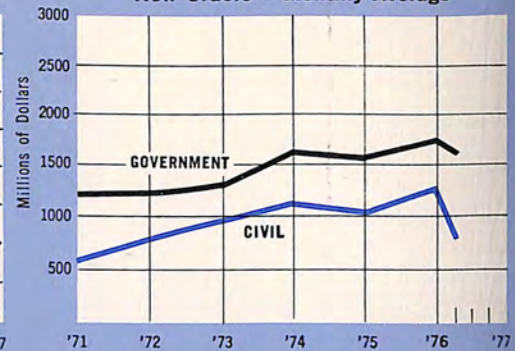
Total Aerospace Sales



Value of Civil Aircraft Shipments



New Orders — Monthly Average



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

ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD 1st QTR. 1977
AEROSPACE SALES: TOTAL	Billion \$	Annually	26.6	29.9	31.5	31.7
	Billion \$	Quarterly	6.4	7.4	8.5	7.6
AEROSPACE SALES: TOTAL (In Constant Dollars, 1972=100)	Billion \$	Annually	27.3	22.8	23.1	22.9
	Billion \$	Quarterly	6.9	5.6	6.2	5.5
DEPARTMENT OF DEFENSE						
Aerospace obligations: TOTAL	Million \$	Quarterly	3,792	3,643	6,882	4,812
Aircraft	Million \$	Quarterly	2,361	2,320	3,799	3,286
Missiles & Space	Million \$	Quarterly	1,431	1,323	3,083	1,528
Aerospace outlays: TOTAL	Million \$	Quarterly	3,411	3,382	3,546	3,473
Aircraft	Million \$	Quarterly	2,031	2,048	2,208	2,011
Missiles & Space	Million \$	Quarterly	1,380	1,334	1,338	1,462
Aerospace Military Prime Contract Awards: TOTAL	Million \$	Quarterly	3,327	3,828	5,948	3,921
Aircraft	Million \$	Quarterly	2,109	2,966	3,478	2,594
Missiles & Space	Million \$	Quarterly	1,218	862	2,470	1,327
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million \$	Quarterly	780	749	1,032	816
Expenditures	Million \$	Quarterly	789	640	825	724
BACKLOG (70 Aerospace Mfrs.): TOTAL	Billion \$	Quarterly	28.6	34.4	39.6	39.4
U.S. Government	Billion \$	Quarterly	15.9	22.6	24.1	23.8
Nongovernment	Billion \$	Quarterly	12.7	11.7	15.6	15.6
EXPORTS						
Total (Including military)	Million \$	Quarterly	1,038	1,774	2,167	1,672
New Commercial Transports	Million \$	Quarterly	345	413	542	368
PROFITS						
Aerospace — Based on Sales	Percent	Quarterly	2.7	3.3	3.2	4.0
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	5.2	5.0	5.0
EMPLOYMENT: TOTAL	Thousands	End of Quarter	1,166	908	898	885
Aircraft	Thousands	End of Quarter	650	490	485	476
Missiles & Space	Thousands	End of Quarter	114	87	85	83
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	End of Quarter	4.38	6.35	6.69	6.93

* 1966-1975 average is computed by dividing total year data by 4 to yield quarterly averages.
† Preceding period refers to quarter preceding latest period shown.



As the United States embarks on its third century, a new President and a new cabinet have assumed the nation's leadership and begun the job of revitalizing an America beset with domestic and international problems. There is a task of formidable dimension, for rarely in its history has the nation been confronted by a broader or more stubbornly resistant array of difficulties.

How the new Administration proposes to meet its many challenges; what it will set as our national goals, and what approaches it plans for their achievement are the subject of this volume.

In this special issue, *Aerospace* magazine departs from its customary format to present an exclusive report on the nation's goals. It is a particularly authoritative report, comprised of first-hand statements by those federal officials primarily responsible for charting and directing our national programs.

Such statements offer a unique perspective. Collectively, they constitute a document of singular importance to all Americans. Aerospace Industries Association is privileged to be the instrument of its dissemination and we thank our distinguished authors for their explicit and informative contributions.

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

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CONTENTS

- 2 GOALS FOR AMERICA
By PRESIDENT JIMMY CARTER
- 4 AGRICULTURE GOALS
By BOB BERGLAND
Secretary of Agriculture
- 6 COMMERCE GOALS
By JUANITA M. KREPS
Secretary of Commerce
- 8 ENERGY GOALS
By JOHN F. O'LEARY
Administrator, Federal Energy Administration
- 10 HEALTH, EDUCATION, AND WELFARE GOALS
By JOSEPH A. CALIFANO, JR.
Secretary of Health, Education, and Welfare
- 12 LABOR GOALS
By RAY MARSHALL
Secretary of Labor
- 14 NATIONAL AERONAUTICS AND SPACE GOALS
By ROBERT A. FROSCH
Administrator, National Aeronautics and Space Administration
- 16 TRANSPORTATION GOALS
By BROCK ADAMS
Secretary of Transportation
- 19 TREASURY GOALS
By W. MICHAEL BLUMENTHAL
Secretary of Treasury
- 23 DEFENSE GOALS
By HAROLD BROWN
Secretary of Defense

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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GOALS FOR AMERICA

In the following excerpts from President Carter's Inaugural Address, the President sets the course his Administration will follow in the coming years:

Within us, the people of the United States, there is evident a serious and purposeful rekindling of confidence, and I join in the hope that when my time as your President has ended, people might say this about our nation:

That we had remembered . . . and renewed our search for humility, mercy and justice;

That we had torn down the barriers that separated those of different race and region and religion and where there had been mistrust, built unity, with a respect for diversity;

That we had found productive work for those able to perform it;

That we had strengthened the American family, which is the basis of our society;

That we had ensured respect for the law, and equal treatment under the law, for the weak and the powerful, for the rich and the poor;

And that we had enabled our people to be proud of their own government once again.

I would hope that the nations of the world might say that we had built a lasting peace, based not on weapons of war but on international policies which reflect our own most precious values.

These are not just my goals, and they will not be my accomplishments, but the affirmation of our nation's continuing moral strength and our belief in an undiminished, ever-expanding American dream.



Agriculture Goals



BY BOB BERGLAND
Secretary of Agriculture

During the past 5 or 6 years, people all over the world have had a very striking education in what agriculture is all about.

Consumers got the first lesson—in 1973 and 1974—when a series of worldwide events produced an unprecedented foreign demand for U.S. farm products. Faced with rising food prices and shortages, consumers discovered that milk and meat come from cows, and bread from wheat, not from the supermarket. They learned that the source of food was not the warehouse, but the farm. They learned that farm production can't be turned on and off like a factory assembly line; and they learned that when this year's stock is gone, you wait until next year's crop for new supplies—and if you want beef, you wait even longer.

That situation produced a lesson for decisionmakers—beef price controls, the soybean embargo of 1973 and subsequent tinkering with exports in 1974 and again in 1975 taught that you cannot cope with the broad problems of food and agriculture on an ad hoc, crisis-to-crisis basis.

Farmers, during this period, gained new insights into the income potential in



Pens of beef cattle fill acres of land near Greeley, Colo.

foreign markets when expanding exports sent farm income to new highs. Farmers increased their acreages and farm investments, and the share of U.S. agricultural production going into export rose from 15 percent to more than 20. In some crops the share going into export was even higher—half or more for wheat, soybeans and rice.

However, farmers also learned that surging foreign demand can cut two ways: Rising grain costs pushed some livestock producers into bankruptcy, and forced others to cut back production in order to survive. Grain farmers, after an exciting

period of expansion, today are finding that net income is declining as prices retreat, while costs continue advancing.

Farmers are discovering that export markets are not an automatic annual source of demand growth—that demand for U.S. products varies with production in other countries, those countries that export as well as import.

Measured in 1972 dollars, farmers' 1976 realized net income—their purchasing power—was almost 10 percent less than it had been in 1972. In the same period, food prices for consumers rose by more than 40 percent, and, although the share of consumer income spent for food remained less than 20 percent on a national average, that is no consolation to people with low incomes.

Everyone, myself included, relearned the lesson that a rampant boom in agriculture is always followed, to one degree or another, by a bust in a cycle that puts extreme stress on farmers and consumers alike.

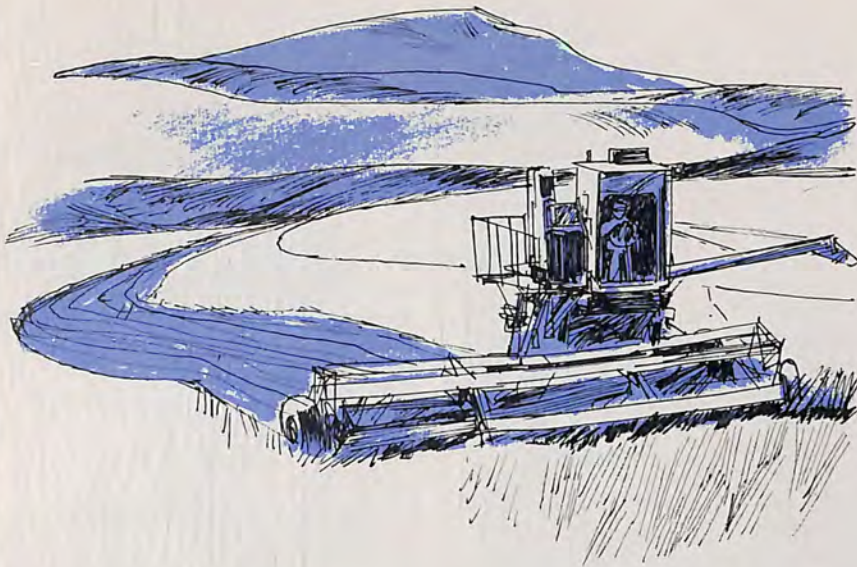
The liberal and practical education we have received in agriculture since 1972 has been translated into goals that the Department of Agriculture is gearing up to achieve. Our overall objective is to protect those who produce our food and fiber and those who consume it—both domestic and foreign consumers alike—from wild swings in prices and supplies, and to protect our competitive position in foreign markets.

This overall objective has been carved into five more specific goals:

1. Protection for farmers against economic disaster, with a system of price support loans, plus income support payments when warranted by world supply and demand conditions.
2. Protection for farmers against natural disaster, with a rational program for speedy and adequate help.
3. Protection for consumers and other grain users against inadequate supplies, with a program that maintains a supply balance against periods of shortfall or oversupply.
4. Protection for the poor in this country against hunger and malnutrition, with reform of the Food Stamp Program.
5. Affirmation of U.S. agriculture's global commitment to supply food on commercial terms to those countries that want it to support a better standard of living and to those countries that must have it to survive.

If these goals are to be reached, close cooperation will be required among this Administration, Congress, producers, consumers, and business community, and our trading partners overseas.

Implicit in the spelling out of these goals



Agriculture researchers check method of planting soybeans that does not require cultivation.

is the confidence that they can be achieved.

Farm prices can be protected by placing a floor under market prices for grains, soybeans and cotton. The floor would be related to both market price and farmer costs. At the same time, farm income can be protected with an income support level for all grains, oilseeds, and cotton that is related to the direct cost of production, plus a return for management and for land ownership. In establishing market price supports, it will be necessary to fix them at a level that permits U.S.-produced commodities to continue to be competitive in domestic and export markets.

Perhaps the most vital single tool in achieving our goals is a grain reserve mechanism—a flexible, farmer-held grain reserve. Farmers would be provided with incentives to hold their grain off the market until prices reached a specified level, at which point the incentives would be taken away thereby prompting movement of the stored grain back into the marketplace.

This type of reserve program will: (1) help reduce the wild swings in domestic and world commodity prices; (2) assure

that food supplies are available to meet domestic and international commitments; (3) permit farmers to benefit from future price increases; and (4) provide safeguards for consumers and the national economy against sudden surges in food expenditures and rekindled inflation.

We have already moved to create such a reserve, initially for wheat and rice, on a unilateral basis. This is a partial, positive step leading to the development of an international system of reserves that will not leave the matter of food supplies—and price—to chance.

And that leads directly into the issue of world food security within which is embodied this country's responsibilities to its trade and aid clients.

To achieve long-range food security there must be increased food production, which means the world must expand the production capability of efficient, low-cost producers, and give them access to world markets. Trade and trade liberalization have an important role to play. World food production can increase more rapidly be-

cause capital investments are concentrated in the areas which yield the highest returns. This will boost the chance that per capita food consumption in all countries can be increased over a period of time.

For the short term, food security must rely extensively on reserve stocks of food.

The world may well be closer today to implementing a food security program than ever before. Certainly, the United States stands ready to do its share which includes: (1) maintaining our own productive capacity; (2) cooperating fully in international efforts to increase food production in developing countries; (3) a willingness to participate in an international agreement in which other nations would share obligations both for reserve stocks and adjustment measures; (4) continuing our efforts to seek trade liberalization for agricultural products; and (5) seeking alternatives that will assure our priority food aid contributions are uninterrupted during periods of high prices.

Finally, any delineation of this Department's goals would be incomplete without bringing in the problem of energy conservation.

USDA's primary energy objective is to encourage agriculture and food system energy users to conserve energy in order to assure that essential users will have priority for basic energy needs. We are also intensifying our research to develop more efficient utilization of our diminishing fossil energy resources, and we are expanding research on alternate energy sources, including solar and other constant and renewable resources.

In the final analysis, we can probably shape the Department's multiplicity of goals into a single thrust—to secure for more people in the world an adequate supply of the right kinds of foods. This objective is achievable depending on the extent to which governments and their peoples—including our own—are willing to commit the necessary resources and determination.

Tomato harvesters and trailers pick a crop in Yolo County, Calif.



Commerce Goals



BY JUANITA M. KREPS
Secretary of Commerce

Everyone seems to have a favorite simile or metaphor to describe the Department of Commerce. Some have referred to it as a conglomerate. Others, disparagingly, have called it the Old Grey Lady of Fourteenth Street. My predecessor summed it up by saying, "We're not in charge of much but we're involved in just about everything."

When I was asked recently to outline to the President and his Cabinet the directions I thought Commerce should take, I compared the Department to Noah's ark—the only difference being, I said, that the Department of Commerce has just one of everything.

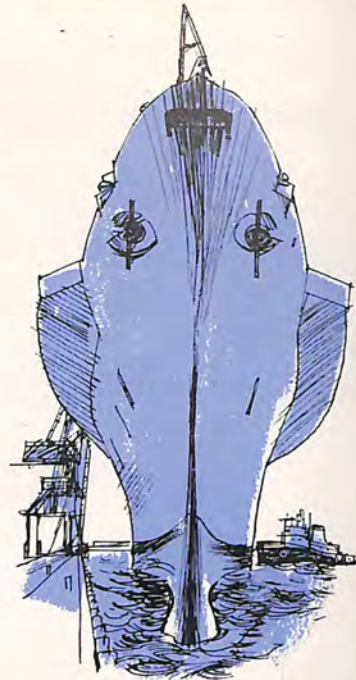
The comparison has nothing to do with my feeling of being deluged by decisions and paperwork. Rather, it relates to the great number of seemingly unrelated activities canopied under the Commerce tent, to mix the metaphor even more. Under that tent and on that ark, there are such agencies as the Maritime Administration, the Domestic and International Business Administration, the National Bureau of Standards, the Census Bureau, the National Oceanic and Atmospheric Administration, the Economic Development Administration, the National Fire Prevention and Control Administration, the Office of Minority Business Enterprise, the United States Travel Service and the Patent and Trademark Office.

One might ponder what oceans policy has to do with telecommunications research or fire prevention with trade and travel promotion. One also might wonder why Commerce is in the business of producing the cascade of numbers used by government and the private sector to appraise the economy's performance.

The seeming illogic of Commerce's organizational maze begins to make sense, however, if we view the Department's role in relation to the country and not by its apparently disparate, constituent parts. And if you accept what I believe to be Commerce's two basic roles:

The first is to try to ensure that conditions in the marketplace are conducive to the sorts of behavior theory tells us to expect of a free economy. That does mean generating economic information so that buyers, sellers and job seekers can locate the opportunities they need. It means providing patent protection without which investment in new technologies would not occur. It means trying to protect lives and properties from fire damage and from natural disasters such as floods and hurricanes.

It means disseminating information on new technologies. It means helping acquaint domestic sellers with foreign markets. It means setting standards. And it



means providing information about the weather and the environment. In short, it means providing a great number of services, many of which are so vital that people cannot imagine a world without them and therefore take them for granted.

Commerce's second role is that of policymaker, particularly at the micro-economic level. In some cases, this means dealing with dislocations arising from the migration of population and industry, obsolescence of public and private facilities, shifting consumer preferences and seasonal travel patterns, energy and environmental problems,



Fire fighting and fire protection is a concern of the Commerce Department's National Fire Prevention and Control Administration.

The National Marine Fisheries Service works to make fishing a viable U.S. industry.



capital shortages, or outmoded government regulations.

Naturally, many gaps exist in our economic information system. So one of our major objectives must be to use more effectively the enormous statistical and informational resources within the Commerce Department to assess the state of the economy, its impact on people and firms, and the trends that signal new problems and opportunities. To do so, we will be working with the Office of Management and Budget and other agencies to reorganize and consolidate widely dispersed statistical activities into a more effective Federal reporting system.

We must also improve our measurements of social well-being and the quality of life. We have requested funds so Commerce's Bureau of Economic Analysis can develop quality of life measurements that can be integrated into the national account framework, so the Census Bureau can develop further social indicators,



Domestic and International Business Administration sponsors trade fairs around the world.



Commerce's National Bureau of Standards works in many fields of scientific inquiry.

so that we can determine our gains or losses not only in terms of gross national product but also in terms of environmental quality, work conditions, quantity and use of leisure time.

We must also strengthen our reporting system to measure particular segments of the economy—including industry-by-industry data, regional data, urban area data, and data on world trade, tourism, and international investment patterns.

To improve the conditions of the marketplace, we will try to redouble efforts to create an environment conducive to new investment, to increased productivity, and to employment. In many instances, this will require reform of government programs and regulations that needlessly impede business development, as well as direct assistance on our part to enable business to operate to its full potential.

All these objectives will require mutually supportive efforts between the public and private sectors. For example, the increasingly serious fiscal, economic and social situations of our cities have made public intervention essential if we are to

make any significant inroads into city problems. But just as crucial to successful urban economic development programs are the contributions of the business sector. No amount of fiscal transfusions from Federal, State and local governments will suffice without effectively leveraging multiple sums of private sector investment.

I believe the Commerce Department can serve as a bridge between investing institutions and government institutions. It can utilize those human, capital, and community resources that now lie fallow because of economic decline in certain regions, States and cities. It can promote more balanced economic growth throughout the Nation. And it can find ways to deal with business decline, seasonal and structural unemployment, and regional dislocations.

The Department already is working toward a coherent policy for alleviating the adverse impacts of such economic dislocations as those associated with excessive import competition and energy boom development.

In the next 10 years, for instance, between 200 and 400 counties not on the coast will be affected by significant energy development activities ranging from power plant construction to coal and uranium mining. Commerce's mechanism to provide assistance to these areas is the multi-state Regional Action Planning Commissions, whose membership consists of a Federal co-chairman and the governors of the participating states.

The Office of Coastal Zone Management, housed in our National Oceanic and Atmospheric Administration, is helping communities prepare for rapid growth that will accompany off-shore oil development and seeking to protect fragile environmental resources from poorly conceived development.

Through our Economic Development Administration, we will stimulate the economy through the accelerated construction of pending public works projects—when stimulation is needed—ensuring that public works expenditures are initiated at those times when their impacts will be greatest to counter cyclical downturns of the economy.

Obviously, we need more than a laundry list of targeted areas. We need to establish philosophical goals in order to achieve balanced priorities, such as the comprehensive set of oceans policies we are developing to enable us to realize the full economic potential of ocean resources while conserving them for future generations.

At the same time, Commerce can serve as catalyst in encouraging business to assess its views and evaluate the adequacy of its performance in meeting its social responsibilities with respect to consumers, employment, and the general formulation of public policies. Throughout history, there has been an artificial separation between people and departments of government interested in economic goals and those interested in human goals. I believe that we must build a private enterprise system that develops our greatest human potential, even as it develops programs tailored to deal with specific problems. In today's world that system requires a balance between technical and economic concerns on the one hand and social and human concerns on the other.

The business community is beginning to assert leadership in developing this consciousness, and the Commerce Department intends to facilitate and provide further leadership in this direction.

In doing so, it is my hope that the Department itself will become a model of the balance that can be achieved between technology and humanity.

Energy Goals



BY JOHN F. O'LEARY
Administrator, Federal Energy Administration

"Today America faces the most serious domestic challenge that it is likely to face in our lifetimes—the energy challenge. Our ability to meet this challenge will help determine whether we will be able to maintain our American way of life during the closing decades of the Twentieth Century. If we ignore the challenge today . . . we will face catastrophe tomorrow."

That is how President Carter has described the great economic and social imperative of our day.

The U.S. energy problem for all its many parts is actually fairly simple: demand continues to rise more quickly than production. In the past decade, U.S. energy consumption has risen more than 31 percent—roughly twice as fast as production. In recent years production of oil and natural gas, which accounts for 75 percent of U.S. energy, has declined.

Increasingly, the United States has turned to foreign oil to compensate for its domestic energy shortfall. Oil imports now comprise 20 percent of our total energy supply at an annual cost of about \$35 billion. This import dependence continues to subject the Nation to the possibility of supply interruption and price increases, whether deliberate or otherwise.



Coal is a plentiful source of energy in the U.S.

This is the lesson that we began to learn more than three years ago, with the Arab oil embargo of 1973-74.

Today there is new, even more compelling evidence that the United States must act to solve its energy problem. Recent studies show that without increased conservation, world demand for oil will begin to outpace world productive capacity in just five to seven years.

Part of the solution to this problem is to find and develop additional oil and natural gas on the outer continental shelves, in Alaska and through advanced oil recovery techniques in existing wells. The National Energy Plan provides very generous price incentives to bring on new supplies of oil and natural gas.

Yet, neither the United States nor the

world has enough oil or natural gas to support our current over-dependence on these fuels for long. Therefore, an essential part of the National Energy Plan must be to turn our economy away from its over-dependence on oil and gas and move us toward increased use of those energy sources which we have in greater abundance. At the same time, we must take actions to insure that all our energy resources—oil, gas, uranium and coal—are used wisely and efficiently.

Even as we plan our energy future to include changing our habits of energy waste, building more efficient equipment, reducing our dependence on oil and gas, and switching to coal, we must recognize that these steps alone will not reduce our oil imports to more manageable levels, nor will they bring our domestic energy demand and supply sufficiently into balance. To do that, we will also need to rely more heavily on nuclear power, and in the longer run, we will have to turn to nonconventional energy sources such as solar and geothermal energy.

The National Energy Plan proposed by President Carter last April provides three major strategies to shape our energy future:

- First, establishing an effective conservation program for all sectors of the economy to reduce the annual rate of growth of total energy consumption to less than 2 percent;
- Second, establishing incentives to promote and, in some cases, to require industries and utilities to use more coal—which constitutes 90 percent of our energy reserves—instead of oil and natural gas—which constitute only seven percent of our reserves; and,
- Third, establishing a vigorous research and development program to provide renewable and essentially inexhaustible resources to meet our energy needs in the next century.

To achieve results in each of these strategies, the Plan provides a balanced set of proposals that includes the use of regulations, technology, taxes and simple common sense.

No single economic approach dominates the Plan. It avoids the excessive increases that could occur by suddenly reverting to strict *laissez faire* doctrine or the inefficiency that could occur with excessive federal regulation. Above all, the Plan is designed to be as equitable as possible.

While some changes are mandated, the goal of the Plan is to achieve a gradual transition in our energy use, while preserving freedom of choice in our economy. This would be done through creative use of the tax system to provide incentives for



Solar thermal tests are conducted at Sandia Laboratories in New Mexico by the Energy Research and Development Administration.

conservation and use of more abundant fuels. However, where new taxes are proposed, there are provisions for rebates so that consumers do not lose purchasing power.

The rebates assure that conservation will not be achieved at the expense of jobs and economic growth. In fact, conservation can create jobs and economic growth, if we plan carefully. The capital we invest in making our economy more efficient will add jobs and growth in almost every sector of the economy.

In addition to conservation and development of coal and solar energy, the plan addresses problems which now plague nuclear energy development. It proposes reform of nuclear licensing procedures, standardization of plant designs, improved security procedures and waste disposal programs, and a delay in movement toward greater use of hazardous plutonium.

In all these measures, as in the many more to which I could refer, the National Energy Plan reflects ten basic principles. These are important to understand, because they are really a roadmap by which we can find the answers to our energy problems in a deliberate, but orderly manner.

- The first principle is that we can only have an effective energy plan if the people understand the problem, and the government provides the necessary leadership to solve it. This is why we have published the Energy Plan in plain English, and why we are now trying to explain its content to as many Americans as possible.

- The second principle is that we must assure continued economic growth and

jobs. This is why we have emphasized conservation and provided rebates to offset any new taxes.

- The third principle is that we must continue to protect the environment. There is no need to abandon our national commitment to a clean environment in order to solve our energy problems. With time and full use of our technological ability, energy, and environmental goals can be achieved together.

- The fourth principle is that we must reduce our vulnerability to embargoes. We will do this by reducing our demand for oil, increasing our domestic supplies and building a one-billion barrel oil storage system in the coming decade. By 1985, these measures should reduce our imports from a potential of 12 to 16 million barrels per day to about 7 million barrels per day.

- The fifth principle is that conservation must be the cornerstone of our entire energy effort. Conservation is the quickest, cheapest and most practical way to make energy available for important uses. The Energy Plan will make the United States a world leader in energy conservation.

- The sixth principle is that energy prices must reflect the true replacement cost of the energy we use. We cannot keep the price of energy artificially lower than the cost of production and expect supplies to increase or to be used wisely. At the same time we must assure that higher prices do not mean unfair profits for energy industries. The Energy Plan provides that assurance.

- The seventh and eighth principles—

referred to earlier—are that we must conserve our scarcest fuels and make the greatest use of our most abundant fuels, and that we must begin *now* to develop unconventional fuels for the next century.

- The ninth principle is that government policies must be predictable so every sector of our society can plan ahead with assurance. This is why the Plan lays out very clearly the tax and regulatory policies that will effect future energy costs.

- And the tenth principle is that all segments of society and all regions must be treated fairly. The desire to assure equity is reflected throughout the Plan:

- In the wellhead tax, which encourages conservation, but is returned to consumers;

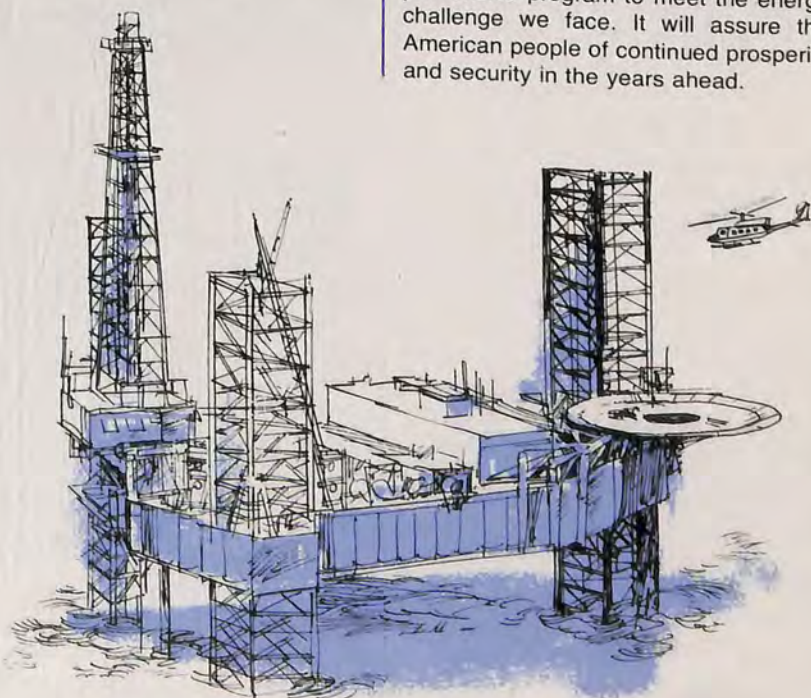
- In the dollar-for-dollar refund of the wellhead tax as it affects home heating oil;

- In ensuring that homes will have the oil and natural gas they need, while industry turns toward more abundant coal that can suit its needs;

- In the automobile tax and rebate system, which rewards those who save energy and penalizes those who waste it.

America has always been a "can do" country. Our business, Government and community leaders have always risen to the challenges which have confronted us in the past. There is good reason to believe that the U.S. energy problem can be solved in a deliberate and orderly manner if we adopt a "can do" attitude in every sector of our economy and in every region of the nation.

The National Energy Plan proposed by the President and now being reviewed in the Congress will emerge as a comprehensive program to meet the energy challenge we face. It will assure the American people of continued prosperity and security in the years ahead.



NEW GOALS



BY JOSEPH A. CALIFANO, JR.
Secretary of Health, Education, and Welfare

In the 1960s, this nation came to grips with some of its oldest and most severe social problems: Poverty, racial injustice and discrimination.

The problems were not solved, but significant gains were made. And perhaps most importantly, many Americans enlisted in the difficult struggle to find solutions.

We continue, as a nation, to be propelled forward by those commitments we made in the 1960s. But any illusions we entertained that commitment and concern were of themselves enough to guarantee social justice have been replaced, I think, by a more pragmatic approach to developing solutions.

In short, if the decade of the 1960s was one of renewing our commitment for social justice, I believe most of us agree that the last years of the 1970s must be devoted to translating that commitment into solid achievements. At HEW, our goal, if difficult to realize, is nonetheless simple to state:

We are determined to prove that we can make our programs at once more effective, more efficient, and more humane.

I feel fortunate to have worked in the 1960s for a President whose fundamental faith in the decency of Americans expanded our vision of what government might do to help those of our fellow citizens who cannot help themselves.

I feel equally fortunate to have reentered government service under a President who also cares deeply about America's poor and vulnerable citizens—and who recognizes that taxpayers have a right to require that their money is being spent carefully and efficiently.

As the Federal Department with the greatest direct impact on the American people—it currently spends \$1 of every \$3 the Federal government spends, and its more than 350 programs directly affect virtually every American—HEW must become a symbol of the manageability of government.

We already have begun addressing the need to strengthen management lines and guarantee tighter accountability by undertaking the most sweeping reorganization in HEW's 24-year history.

Without going into excessive detail, the result of that reorganization was to replace a fragmented, irrational organizational structure with a more rational grouping of programs that we believe can and will reduce spending, by making it easier to identify and eliminate duplication, and outright fraud abuse. We estimate that savings to the taxpayer will total some \$2 billion annually by 1981.

On the legislative front, HEW's initiatives also place great emphasis on im-



Computers are a vital tool in research programs of HEW.

proving programs, tightening management controls and—wherever possible—on heading off problems before they reach catastrophic proportions. To cite just a few examples:

Hospital Cost Containment—President Carter has asked the Congress to approve a short-term program to put a 9 percent ceiling on annual increases in hospital revenues from their in-patient services. The program also would put a nationwide cap on capital expenditures by hospitals, with the ceiling to be applied to the States on a per-population basis.

The purpose of the legislation is to bring hospital costs—which have been climbing some 2½ times faster than the Consumer Price Index—into reasonable line with the rest of the economy. Failure to halt the explosive growth of hospital costs, which have risen more than 1,000 percent since 1950, will greatly diminish our nation's ability to develop a financially feasible program of national health insurance.

Child Health Measures—Congress has before it a proposed Administration bill designed to expand and improve upon the Early and Periodic Screening, Diagnostic and Treatment (EPSDT) program, the foremost Federal effort to prevent sickness among poor children.

The proposed new program, called the Child Health Assessment Program (CHAP), would extend diagnostic and



education; and for \$3 million to increase grants under the Basic Educational Opportunity Grants program.

These and other changes we have requested in the Fiscal Year 1978 budget submitted by former President Ford represent a shift in emphasis, I believe, from problem solving to problem prevention. I believe government functions most efficiently when its resources are directed toward preventing human problems—sickness, ignorance, discrimination—whenever possible.

Two major goals of the Carter Administration with which HEW will be very deeply involved are creation of a system of national health insurance, and reform of the nation's welfare system.

While we do not anticipate proposing national health insurance legislation until 1978 at the earliest, HEW's planners are already involved in the lengthy and com-

plex studies and analyses that must necessarily precede such an undertaking.

It obviously is far too early to predict the form a national health insurance proposal will take. But great care will be given to assuring that our proposal will assist in rationalizing a national health care system that today is fragmented and inefficient, and which exerts extraordinary inflationary pressures on the rest of our economy.

President Carter already has unveiled the series of goals that our forthcoming welfare reform legislation will seek to address. In brief, this Administration is committed to providing access to employment for those currently on welfare who should work and are able to work; providing adequate cash support for those on welfare who cannot work; streamlining program administration to assure greater cost-effectiveness and to cut down on

treatment services to 700,000 poor children under age 6 not currently covered. The program, which offers financial incentives to encourage State participation, also would require immunization of all participants against childhood diseases.

The immunization provision of CHAP dovetails with HEW's national campaign to spur other levels of government and the private sector to improve on our shockingly low national rate of immunization. That campaign's goal is to raise national immunization levels for youngsters above the 90 percent mark. Immunizing children is obviously not only humane, but also cost-effective.

Education—We have asked the Congress for an additional \$20 million for Emergency School Assistance aimed at minimizing community problems resulting from school desegregation; for \$4 million to support a new program designed to attract and train minorities in the professions; for an additional \$20 million to strengthen Federal support for bilingual



New teaching techniques are aimed at improving the learning process.

Technician at the National Cancer Institute studies cancer cells.



fraud and abuse; and eliminating those existing provisions of the welfare program that tend to encourage family dissolution and discourage employment.

Emphasis will be placed on creating a credible and workable program—one in which both those who receive benefits and those who pay the tax bill can have confidence.

As I stated at the outset, I believe that the goals we have set for the years ahead can be met. The compassion of the American people for the plight of our nation's less fortunate citizens has never been questioned. Now is the time for government to prove that this compassion can be reflected in competent management of efficient and effective programs.

At HEW, that is and will remain our primary goal.

Labor Goals



BY RAY MARSHALL
Secretary of Labor

The aerospace industry has a special interest in our most important priority: putting Americans to work.

To me, providing productive work for the jobless is the central element in President Carter's economic recovery program. It is certainly our most important in the Labor Department right now. In carrying out our part of the Administration's program, we plan to build on past experiences. We will make improvements where necessary, and we hope to come up with some fresh approaches to a number of the most persistent problems facing our nation's workers and their employers.

In April, even though the unemployment rate fell to its lowest level in 29 months, there were still 6.7 million American men and women who were officially listed as out of work.

These were the officially unemployed members of the labor force. There were millions more—we really don't know how many—who have dropped out of the work force altogether because of discouragement or for other reasons, or who have never entered in the first place because of lack of jobs. Many of these people want to work, and they would if jobs were available.

Clearly, unemployment exacts too heavy a toll for us to be complacent. It demands immediate, priority attention.

One way we plan to attack this problem is by creating hundreds of thousands of new federally funded public service and public works jobs.

The public service jobs will let the unemployed use their talents to serve their fellow citizens in hospitals, in mental institutions, in improving our national parks, in recreation programs, in rehabilitating those parts of our cities where crime is high and hope is scarce, and in energy-saving activities. We will target our public service employment programs to areas of national need—such as improving our national parks, and in insulating homes and public buildings, as well as other energy-saving activities.

The unemployment rate among teenagers in April was 17.8 percent. The rate for blacks and other minorities was 12.3 percent, and for minority youth, 36.2 percent. Military veterans aged 20-24 had a jobless rate of 14.4 percent.

Carefully tailored programs are needed that not only supply employers with adequately trained workers as the economy improves, but that help these groups develop relevant, marketable skills in training programs closely linked with the private sector.

Youth unemployment is particularly severe and adversely affects the attitudes and work force attachment of men and

women early in their lives. During overall high unemployment, the young must compete with more experienced workers for available jobs. Too many teenagers lack any job training or possess education and training ill-fitted to today's employers' needs.

As a first step toward alleviating this problem, we are seeking substantial increases in youth-oriented training and employment programs. We plan to expand apprenticeship training opportunities for the young, particularly disadvantaged minority group members and women. More than half of existing apprenticeships are in the construction trades. The Department is working with labor and management representatives to establish formal apprenticeship programs in industries and occupations where they have not yet been tried.

Unemployment among veterans, particularly those who were disabled in line of duty, and the younger veterans of the Vietnam conflict, is of great concern to us.

To combat this problem, we are establishing outreach units staffed by disabled veterans in our state employment service offices. There is at least one unit in virtually every state, and one in each of the largest metropolitan areas.

These disabled veterans will seek out other disabled veterans, many of whom have become discouraged and have given up looking for work, to inform them of their rights and to encourage them to return to the mainstream of the labor market. Nearly 2,000 disabled veterans will be employed in this project; as of mid-May, about 1,300 were already on the job, with the remainder expected to be hired before the end of June.



Skilled aerospace workers assemble a transport aircraft.

Construction worker puts finishing touches on screen guard.





Maintenance mechanic repairs a harvesting machine.

Our proposals to improve job opportunities for military veterans involve both private and public employment and training measures. Under a new "HIRE" (Help Through Industrial Retraining and Employment) program, employers will receive incentives for hiring Vietnam-era veterans in the form of funds to help offset the costs of any training needed to make veterans more employable. We also hope to fill about 35 percent of all new public service jobs with veterans.



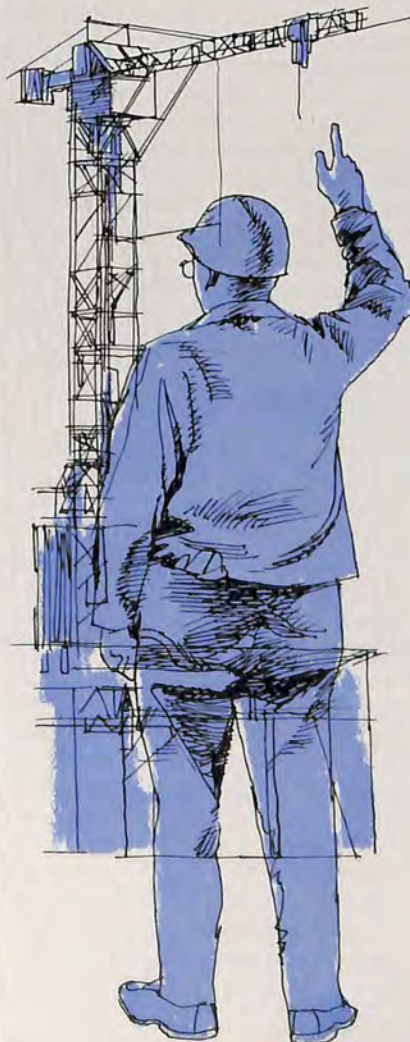
Registered nurse checks patient's pulse.

The second priority of my Department is combating discrimination against workers for any reason unrelated to their merits and productivity. Just as unemployment exacts a heavy toll, so does discrimination. Discrimination for reasons unrelated to productivity should be eradicated as rapidly as possible. It should not be permitted to continue to rob many American workers of employment and advancement opportunities.

Equal employment opportunity is easier to achieve in low-unemployment periods, but it must be accomplished, regardless.

Equal employment opportunity imposes a recruitment obligation on employers that does not always conform to the availability of skills in their immediate labor markets. It is essential that federal enforcement of laws, designed to increase job opportunities for qualified minority group members, women, veterans and the handicapped be coordinated with employment and training programs which can supply such workers.

Our third priority is improving the productivity of workers in the system. There



are two reasons why this is important:

- To increase the real income of American workers, and
- To move toward full employment without intolerable levels of inflation.

It is important for us to improve individual and systematic productivity. For, as we increase productivity, we diminish inflationary pressures on the system.

Our fourth priority is to carry out the various responsibilities entrusted to us under the law: to protect the wages, working conditions, health, safety, and trust funds of American workers.

Every American worker must have the opportunity to earn a living wage under decent, safe, and healthful conditions and to live in the assurance that the pension he or she has counted on for retirement years will not disappear.

Our fifth priority is to help create training opportunities to provide the skilled workers needed to meet national needs with respect to energy, health, environmental protection, and production of other goods and services needed to improve the quality of life for all Americans.

Sixth, we need to improve the operation of the labor market through better labor market information and mechanisms to improve the system of matching workers with jobs. We believe that it is better for the worker and less inflationary if we can move people into jobs, instead of having them on unemployment insurance or on welfare.

Seventh, we need to strengthen collective bargaining in both the public and the private sectors. Better union-management cooperation in key industries is a major factor in improving productivity and holding down inflation.

Finally, we intend to make a concerted effort to simplify complex government regulatory programs and to relieve unnecessary administrative and paperwork burdens on employers. The Occupational Safety and Health Act (OSHA) and Employee Retirement Income Security Act will be primary targets.

To restore public confidence in OSHA, we hope to eliminate unnecessary regulations and to simplify confusing requirements.

In striving to meet all of these goals that we have set for ourselves, we recognize that we cannot succeed on our own. Progress and change occur only with the cooperation and full participation of all Americans, including labor, management and the public.

I, therefore, ask for the public's help and cooperation as we move forward with our plans to provide a better life for the entire American work force on which our entire economy is so dependent.

NASA GOALS



BY ROBERT A. FROSCH

Administrator, National Aeronautics and Space Administration

It is a great honor to be asked to submit this article for *Aerospace* magazine and I look forward to meeting government and industry leaders in my new capacity. Like my distinguished predecessors, I am an unabashed space and aeronautics "buff"; so many of the Goals for America involve those fields and so many of our aspirations point to sky and space. We have a record of accomplishment at NASA and it will be upheld and even bettered in the future. In 1980, we return to the galaxy on a continuous and eventually permanent basis. The operational flights of the Space Transportation System round out one eventful decade and herald the era of prolonged life and work in the space environment.

Our vehicle, the Space Shuttle, is undergoing flight testing today and it will carry into orbit the vital payload of Spacelab. Initially, the Shuttle and its occupants begin an integrated series of probes—the atmosphere, magnetosphere and plasmas apart from Earth—with missions set for every six months. First, we study solar flares. Then, the Spacelab extends to the area of life-science, with the goal of insuring human well-being during prolonged periods in space. We can apply space technology to medical and biological problems and thereby heighten scientific understanding of the origin and distribution of life in the universe.

Most space agency projects bear the quality of innovation and the title of unique. Aerospace people are thoroughly familiar with the Shuttle's capabilities, including its returnable and reusable components and the return from orbit to an almost conventional landing.

From the start, the Shuttle program has a strong European connection. The Spacelab is being developed by ESA—the European Space Agency—and the eleven nations are spending some \$500 million to deliver the first unit to NASA; newer and improved labs will follow while Canada contributes the essential Remote Manipulator System.

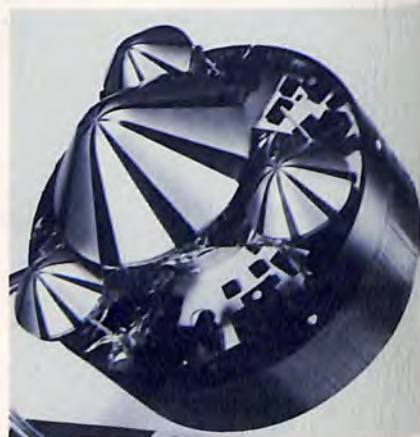
By the middle of the coming decade, we anticipate that flights into orbit and back are going to be almost routine. We will never lack for passengers, from scientific sectors and otherwise.

Meantime, NASA continues its deep space exploration, mostly with unmanned craft. We will find more answers to the external questions of life, natural matter and energy on Mars and beyond, investigations deep into the solar realm.

We will keep on drawing from the bounty of space to benefit the human lot on Earth. Technology transfer today is a growing concern, from producers to potential users. This is the law of the land,

spelled out in the legislation that formed NASA almost 20 years ago. Part of the National Aeronautics and Space Act of 1958 reads, "each contract . . . shall contain effective provisions under which such party shall furnish . . . a written report containing full and complete technical information on any invention, discovery, improvement, or innovation which may be made . . ." We are authorized to require all R&D contractors to document and report anything new, from concept to computation of programs.

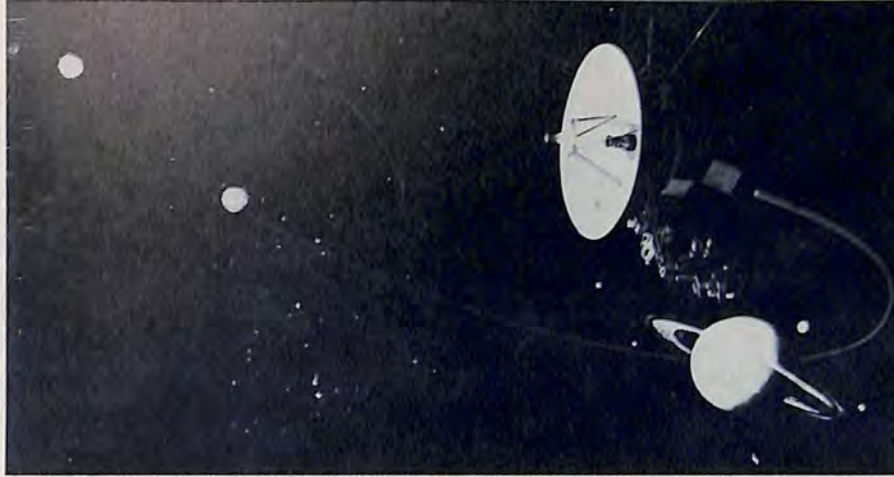
By law, our network of industrial applications centers continues to search literature and to evaluate and apply the results. The geographic range expands with every year and technology coordinators, matching NASA expertise with client interests, now are established at a half dozen NASA field centers. Worldwide, there is access to more than 8 million documents as well as audio visual and graphic aids. Clinics and medical institutions benefit. Public sector agencies gain from the storehouse of knowledge and concentration is on public safety, urban construction and safety, and the national transportation system.



Pioneer Venus missions will make a detailed study of the characteristics of the Venus atmosphere.

Artist's concept shows the Space Telescope, which will enable scientists to gaze seven times deeper into space than now possible.





Voyager spacecraft is shown in artist's conception as it passes Saturn.

Communications by satellite, possibly the widest exploitation of space, still takes giant strides by month and year. In 1976, most of the 16 unmanned spacecraft sent up by NASA were related to communications and electronics.

In some programs, communications and astronomy complement one another. We will make investigations outside the solar system with the large Space Telescope, already in the budget.

One half of our agency's title, one half of the responsibility we are charged with, is aeronautical research and development. The goal for aeronautics is to assure United States preeminence in aviation and our planning takes in improved design, materials and propulsion, lessening assaults on the environment, and safety.

Even though American industry is not in the business of making commercial supersonic aircraft, NASA research is well underway on supersonic engines, inlets and flight controls. We are even looking beyond to hypersonic jet technology and the possibility of building off-shore airports to accommodate the giant aircraft with an eye to noise abatement. Other programs, closely coordinated with the Department of Defense, include work on Short Takeoff and Landing (STOL) aircraft, modifications of existing STOL planes, and joint research with the U.S. Navy on the lift-fan vertical takeoff and landing vehicles. In 1981, we begin tests on a new generation of civil helicopters. Fuel consumption and ways to reduce wasteful expenditures are a critical part of NASA R&D.

On the drawing boards and on the launch pads over the next five years are a whole range of Landsat, Seasat, Nimbus and Tiros spacecraft. They provide near-term advantages for all people. Using space-based observation devices, they can supply data on the environment and related economic considerations. On Earth, we will gain the unique ability to:

- Predict global wheat production, survey rangeland and metropolitan areas, and monitor and inventory surface mining by 1981;
- Begin the monitoring of ocean currents and patterns, air/sea boundary conditions and surface technology;
- Forecast global production on all major crops in 1983;
- Achieve through use of systems reliable weather forecasting beyond three days. Target date: 1984 with storm prediction by 1986.

These are clearly defined goals and objectives, major roles in the programs that mesh and compliment one another. They motivate every NASA program officer, engineer and technician and the agency front office. The related priorities include:

- Effective use of the Space Shuttle for

all phases of space flight;

- Scientific studies for a fuller understanding of the Earth, the Sun, the solar system and the universe;
- Use of space in the perspective of man's interaction with the Earth and its resources and environment;
- New directions for the scientist, the engineer and the technician;
- Areas where research will be necessary to exploit the opportunities of space, and
- Assurance that U.S. leadership in aeronautics, eroded in recent years, will be maintained.

At NASA, there must always be the constant thought and motive that our work is two-directional. It is true that we explore space, therefore upward, but we also incline to benefit Earth and all its people, therefore inward.

Two statements bear out our motives. One is by the late brilliant rocket engineer and space scientist Werhner Von Braun. Of our goal, he said, "the Earth does not pose a limit for man. Our limit is the sky."

The inward view comes from Margaret Mead, the anthropologist whose insight is world renowned. Her evaluation is this: "We are at a point in history where a proper attention to space, and especially near space, may be absolutely crucial in bringing the world together."

Today, we possess in our brains and hands, especially in our spirit, the means to win independence from a crowded and frenetic Earth and at the same time to uplift the Earthly condition.



Transportation Goals



BY BROCK ADAMS
Secretary of Transportation

Transportation is a vital ingredient in American life. It is one-fifth of our gross national product, employing more than 10 million people. We drive 110 million passenger cars, operate 25 million trucks and buses, and boast an airline fleet of 2300 aircraft. Our combined freight and passenger transportation expenditures are approximately \$300 billion a year, and according to the Bureau of Labor Statistics American families now spend more of their income for transportation than for food.

Transportation has shaped the growth and development of the United States, provided us a freedom of personal mobility unprecedented in history and unparalleled in the world, and greatly expanded our domestic and international markets.

Through the years government has assisted the transportation evolution in America, to enhance and protect the public interest, but leaving to the private sector primary responsibility for meeting the nation's transportation needs.

America's transportation goals today are the same as those expressed in the 1966 Act which created the Department of Transportation. We still seek fast, safe, efficient, convenient transportation, easily accessible and reasonably priced. We want a diverse transportation system that meets the needs of all Americans consistent with other national objectives, including the efficient utilization and conservation of the nation's resources.

But while our objectives have not changed, certain of our priorities have. The growing social and environmental consciousness of recent years, together with the necessity to conserve energy now and in the future, require new policies and plans to ensure that essential transportation services are not lost or compromised. In the past government has taken responsibility for the safety of travelers, to protect the public from monopoly powers and the industry from unfair com-



Radar tracking of aircraft helps FAA traffic controllers keep the airplanes safe.

petition, and to develop or continue transportation services essential to the public or the general welfare. For the future, government's economic regulatory authorities can be reduced or relaxed. The industries they have protected are now mature and competitive. Airline regulatory reform proposals now before the Congress already have the Administration's blessings.

But while Federal regulatory powers can be abated, the environmental, energy and social requirements in transportation planning and decision-making require greater governmental emphasis and support.

The pre-depression dream of two cars in every garage is today a reality for 35 percent of the nation's households, but that glittering ideal has been tarnished by urban congestion, air pollution and energy scarcity.

"People-mover" station is an important element of urban mass transportation.



The airlines, which 40 years ago were considered "almost safe" for everyone but a novelty for most, today carry 200-plus million passengers a year, in near-perfect safety. But aircraft noise make airports unwelcome neighbors, and low profits have made airlines unpopular with the financial community.

Our highway system has laced the nation together, speeding interstate commerce and providing motorists access to jobs and leisure, but at a steep cost in accidents, fatalities and property damage.

Its multi-passenger advantages have given mass transit new social value, but the unfavorable ratio of revenues to operating costs has made public subsidies necessary for most transit systems.

In short, we are compelled today not only to satisfy our transportation needs, serving the consumer and providing for

mobile is a primary cause of our traffic-congested cities.

Under the terms of the Energy Policy and Conservation Act, I have set the fuel economy standards for passenger automobiles manufactured in the model years 1981 through 1984. These progressively stiffer mileage standards, ranging from the 20 miles per gallon ordained for 1980 to the 27.5 mpg average specified by law for 1985, are designed to help America's motorists achieve the annual reductions in gasoline consumption President Carter has proposed.

To meet these standards U.S. automakers must do what foreign manufacturers have long been doing, building cars that are smaller and lighter. Efforts to minimize emissions must also be continued. But we also need safer cars. As the numbers of smaller cars increase, the risk of death or serious injury in a colli-

and increased transit ridership. For unless we use our cars wisely, eventually we may not be able to use them at all.

Our transportation goals also require an early and equitable solution to the nagging problem of aircraft noise. President Carter's proposal for a two percent environmental surcharge on air passenger tickets and waybills (matched by a reduction of two percentage points in the present ticket and waybill taxes) affords the airlines the option of retrofitting existing aircraft, or buying replacement aircraft that meet Federal noise standards. The plan benefits society, since it will reduce noise pollution. It serves our energy conservation objectives by encouraging, or enabling, airlines to buy newer, more fuel-efficient planes. And it supports the nation's aircraft manufacturers and the economy by stimulating employment, production and exports.



future growth, but at the same time to solve related social problems as well. This means we must orchestrate transportation actions to encourage the most efficient use of each mode and the most rational balance of all the modes. We must implement policies that will cause our transportation resources to be more productive and less wasteful of fuel, lives and property. And we must keep transportation industries and activities in the private sector, to the fullest extent possible.

The future of the automobile poses one of our most difficult challenges. The motor vehicle industry is a major cog in the nation's economy; the motor car a staple of personal transportation. We do not want to give up the mobility the auto has given us, or forego the convenience and flexibility it affords.

Yet some relief from traffic congestion is necessary for our cities to survive, and some significant reduction in fuel consumption must be achieved if President Carter's energy program is to succeed. Our cars and trucks and recreation vehicles account for about one-fourth of our petroleum energy consumption, and commuter preference for the private auto-

tion with a larger vehicle is also increased and must be offset by improved occupant safety. We can no longer justify 45,000 highway deaths a year and social costs estimated at \$38 billion (1975) on the grounds of the motor vehicle's utility or the motorist's "right" to drive, regardless of his condition or at whatever speed he dares. The drunk driver is "unsafe at any speed," and the 16 percent reduction in highway fatalities since the 55 mile per hour speed limit was nationalized three years ago proves rather conclusively that higher speeds increase the severity of injuries and the risk of mortality.

Our objective, therefore, must be a reasonably safe car that is fuel-efficient, as non-polluting as technology will permit, and suitable to people's needs if not their tastes. These standards must be pursued in concert, because a motor vehicle is a unit and the left hand of government cannot be demanding one thing of the industry while the right hand is requiring something else.

We must also be concerned with the way we use our cars. The government must exercise leadership in programs that will encourage carpooling, compliance with the 55 mile per hour speed limit,



Coast Guard crew carries out a helicopter rescue mission.

According to a recent study done by the Stanford Research Institute for the Federal Aviation Administration, the number of jet aircraft in worldwide use is expected to increase by 55 percent by 1990, with the new wide-body types dominating world fleets. President Carter's financial assistance plan is the kind of inducement needed by the nation's airlines to initiate replacement orders which, in turn, will accelerate the industry's development of new and better aircraft, while at the same time easing the problems of excessive aircraft noise.

The Administration's special mechanism for retrofit, re-engining or replacement forms a supplement to regulatory reform. Together these proposals will improve the financial position of the nation's airlines, and help sustain the supremacy of America's aerospace industry.

Our long-term goals will also be assisted by the revitalization of the railroads. This has begun with the restructuring of the Northeastern lines and the creation of ConRail, the Northeast Corridor improvement project now underway, and the financial assistance available to the railroads through the "Quad R" Act for catch-up work on long-deferred maintenance.

While passenger rail service is not self-supporting on a national basis, certain city-pair routes are potentially profitable, and may merit government subsidies for other public interest reasons. Along the busy Northeast Corridor, for example, nearly 10 million people a year already travel by rail along the 450-mile route between Washington and Boston, compared to less than six million by air. The



Amtrak trains operate in heavily travelled Northeast Corridor.

Vast network of interstate highways links the U.S.



Tower operators at Dulles International Airport scan ground traffic.

\$1.75 billion improvement program, which will increase travel comfort and reduce trip times, is expected to attract 26 million passengers to rail transportation along the Corridor by 1990—20 percent of the total traffic. Greater use of train travel will not only yield substantial fuel savings, but will make costly highway and airport developments unnecessary.

On the freight side, the essential services the railroads perform, and the possibility that in the near future it may be necessary to move large quantities of coal and grain simultaneously, emphasize the importance of maintaining our railroads and bringing them to peak efficiency. Similarly, while the need for new highway construction will diminish as the essential segments of the Interstate system are completed, the importance of our motor truck and inter-city bus commerce re-

quires close attention to the safety of our existing highways and bridges.

From our earliest days, America's waterways have been essential components of our transportation system, and the fuel economy of water transportation gives it new importance today. Continued maintenance and improvement of our inland waterways, however, is costing nearly \$1 billion a year—a public expense that the users of the waterways are being asked to share.

In the area of public transportation, the task we face over the next several years is threefold: to develop mass transit systems the public will use; to entice commuters from their cars, through a variety of transit incentives and motoring disincentives; and to help America's cities with their local decision-making and assist their transit operations. Urban decongestion is directly dependent on public transit, but cities cannot undertake costly construction projects that exceed their ability to finance or support. We must work at the Federal level to budget funds more effectively. We also seek to simplify the mechanics for delivering Federal assistance and to increase local flexibility in setting priorities and using resources where they are most needed.

The nation's transportation goals today are particularly challenging because they demand a growth in transportation capacities and a reduction in fuel consumption; better mobility in a cleaner, quieter environment; more travel facilities with less congestion; and better service at affordable prices. We must make transportation safer, more responsive to the needs of the elderly and handicapped, and a better all-around bargain for consumers, communities and the country.

Transportation in America's third century, as in the past, will continue to be a proud product of private enterprise, aided by the government, dedicated to greater efficiency, a higher quality of life and better mobility for more people.

Treasury Goals



BY W. MICHAEL BLUMENTHAL
Secretary of the Treasury

Our ability to improve the health of our people, to revitalize our older cities, to reform our welfare system and meet other great social needs while providing for an adequate defense depends fundamentally on the achievement of sustained, non-inflationary economic growth.

Because Americans constantly seek to improve their lives and their society, the fulfillment of our aspirations will always be limited by our resources. We shall not escape the necessity of choosing among desirable personal and social objectives.

But more rapid economic growth, declining unemployment and fuller utilization of the productive capacity of American industry will add billions of dollars of resources that can make a decisive difference in the extent of our social progress.

These considerations underlie the strong commitment of the Carter Administration and the Treasury Department to:

- Growth of about 6 percent, after allowing for inflation, in the Gross National Product during 1977 and an average annual growth rate of more than 5 percent until we stabilize at a full-employment growth rate;
- A steady reduction of the intolerably high unemployment the United States has experienced in recent years, bringing the unemployment rate below 7 percent by the end of 1977 and to about 5 percent by the end of the decade;
- A dampening of the underlying rate of inflation by at least two percentage points by the end of 1979 and further reductions thereafter;
- A balanced Federal budget by 1981; and
- Comprehensive tax reform that will provide greater simplicity and equity in the tax system and encourage the capital formation needed for faster productivity growth.

Besides these measures at home, the Administration is working for a strong and stable international economic order—

recognizing that in this interdependent world, we and other nations can best achieve our domestic objectives through cooperation and the maintenance of an open world economic system.

It bears emphasis that the objectives of faster growth and reduction of inflation must be achieved together or not at all. Measures that seek faster growth at the expense of price stability rapidly lead to a new recession and the kind of stop-go economics that deters investment, lessens productivity growth and slows or even halts the growth of real incomes.

We have made a good start toward our goals but much remains to be done.

As the economy snapped back from the severe winter, growth in the first quarter of 1977 jumped to 6.4 percent from a fourth quarter level of only 2.6 percent. The President's economic stimulus program, as enacted by Congress, provides more than \$20 billion in added demand through October 1978. With this boost and the growing strength of the private economy, prospects are good that both our 1977 and our longer-term growth goals will be met. But if the expansion should falter, as it did last year, we will not hesitate to recommend further steps to stimulate the economy.

Unemployment has registered a similar improvement, falling from 8 percent three months earlier to 7 percent at the end of April. With the early achievement of our year-end unemployment goal, we are setting our sights on further reductions that would bring the rate to around 6.7 percent by the end of the year.

Much of the economic stimulus package will make a direct contribution to lower unemployment through its public works jobs, through countercyclical aid to local governments in high unemployment areas, through job training, employment aids and other measures. As the expansion progresses, we will need to place increasing stress on programs to aid the



hard-to-employ—those who lack work skills and experience and suffer other disadvantages.

Inflation poses a perplexing challenge, in part because it has multiple causes and can be affected by expectations and fears as well as real economic developments. So far in 1977, the overall inflation rate has worsened, due chiefly to increases in food prices. The underlying inflation rate, which abstracts from food and energy prices, continues at an unacceptably high rate of 6 to 6½ percent. While we may not be able in the short run to limit the price effects of bad weather and OPEC oil price increases, our prime target must be the underlying inflation rate.

For the attack on inflation, the President has assembled an array of measures that will be effective. But we must recognize that they cannot provide a quick cure. They must be pursued persistently for years to achieve price stability.

As part of our anti-inflation program, we will take new steps to assure that the government itself is not a contributor to higher costs through needless regulations and requirements for costly paperwork. Government procurement practices will be altered to lessen reliance on cost-plus contracts that weaken normal incentives to efficiency. We will foster increased competition in the American economy, by anti-trust actions and by eliminating outmoded rate-setting regulations, as in the airline industry, that serve mainly to lessen efficiency and stifle technological change. Initial measures to control the rise of hospital costs, which have been increasing at twice the rate of the cost of living generally, have been proposed, and we are strengthening the Council on Wage and Price Stability to enhance its ability to foresee problem areas and bottlenecks and to recommend timely preventative action.

The commitment of the leaders of the seven major industrial nations at the London Summit Meeting to avoid protectionism and to liberalize world trade will also contribute to the fight against inflation in the United States and elsewhere, as countries are able to expand their output of the goods they can produce most efficiently while importing more goods in which others have a competitive advantage.

And we are seeking the voluntary cooperation of labor and management in avoiding price and wage decisions that initiate futile wage-price spirals. A firm basis for this cooperative effort among business, labor, and the government exists in the widespread recognition that no one wins in the scramble to get ahead by jacking up prices or wages.



Customs pilots head for aircraft for night patrol along U.S.-Mexico border.

What we certainly shall not do in our anti-inflation program is coerce the private sector or impose wage and price controls. The ineffectiveness of such a policy has been amply demonstrated in the past.

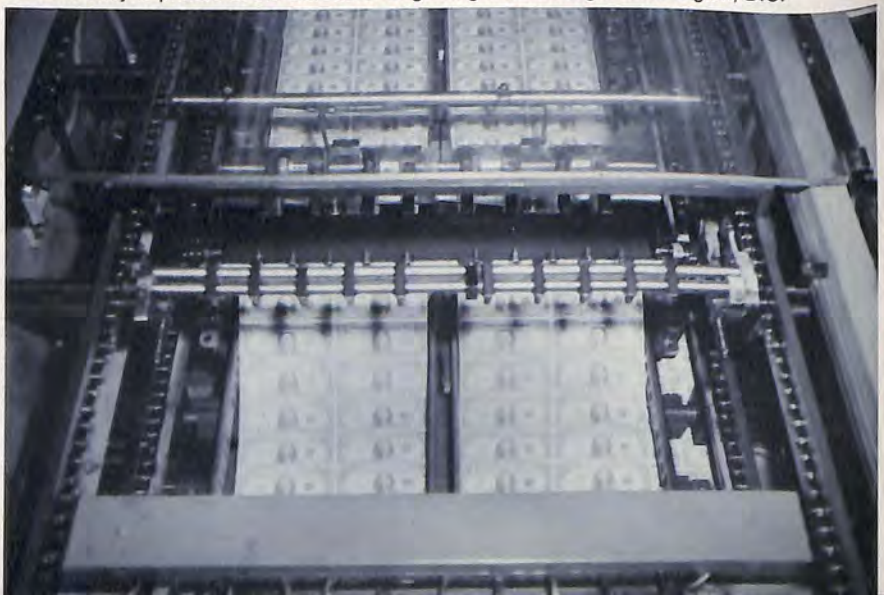
But for the longer term, neither our growth nor our inflation goals will be realized without significant increases in the rate of investment in the productive capacity of the American economy. We need increased business investment to fuel the continuation of our economic expansion. We need investment to avoid the capacity bottlenecks that we will otherwise face in a number of industries well before our total capacity is being used at an optimal rate and to help speed the pace of productivity growth. Even after adjustment for cyclical factors, the growth of output per man-hour in the private non-farm economy has recently lagged well behind previous rates. While the causes

for this circumstance are complex and uncertain, one important factor is that the rate of growth of capital per worker has fallen off in recent years.

Lately there are signs of a growing willingness by business to invest. This, in turn, derives from increasing confidence that steady economic growth will provide markets for the output of new factories and machines, that inflation is being handled in a responsible way, and that this Administration will expand the ability of the free market to operate. In addition, the comprehensive tax reform that will be proposed this year will provide new incentives to savings and investment. Elimination of double taxation of corporate income is being considered, along with other changes in business taxation.

Increased investment in physical plant and equipment of course requires an adequate supply of financial capital. The Administration's commitment to balance

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the Federal budget in 1981 and the reduction of annual budget deficits in the meantime will enlarge the resources available to the private sector, assuring that there is no "crowding out" of desired investment.

Achieving budget balance will not be easy. But with the strong economic growth we are seeking, with restraint and care in the allocation of Federal resources to tax reductions and new programs, and with continuing efforts to promote efficiency and economy in Federal activities through zero-based budgeting, our goal can be achieved. It is already clear that President Carter will persevere and make



Treasury agent inspects an alcoholic beverage manufacturing company.

the hard choices that are necessary to fulfill his commitment.

All of our efforts for sustained, non-inflationary economic growth in the United States are more likely to prosper in a sound and cooperative international economic environment. The communique of the London Summit recorded agreements on policy that must now be translated into concrete accomplishments in international finance, trade, and development assistance. To deal with the effects of the massive oil deficit, we must increase the resources of the IMF to provide time for adjustments by countries trying to reduce unsustainable deficits. In the Tokyo round of multilateral trade negotiations, we must take new steps to lower tariffs and diminish non-tariff barriers. We must increase the flow of grants and soft loans to the poorest countries and expand the export opportunities and capital flows for the more advanced developing countries.

The Carter Administration has adopted balanced, reasonable and attainable economic goals and coherent, consistent policies for their achievement. And with their achievement, we shall provide a firm basis for all else that we wish to do.



Defense Secretary Outlines National Security Goals

Secretary of Defense Harold Brown outlined some basic goals of the Department of Defense in his May 25, 1977 speech to the National Press Club in Washington. Following are key excerpts from that speech which are especially important to AEROSPACE Magazine's review of "Goals for America."

"... Years ago, when we enjoyed a clear strategic nuclear superiority, our unmistakable lead in nuclear weaponry acted as a strong deterrent even to non-nuclear aggressive moves by a potential enemy against the United States or its allies. Now, in the era of strategic equivalence, the same inhibition applies to a lesser degree—and in some cases perhaps not at all. We must carefully evaluate our ability and the ability of our allies to fight with conventional arms. We have reviewed our capabilities deployed in Europe in the NATO Alliance. . . .

"... For the short-term, we expect to augment NATO's anti-armor capability, increase the war reserve munitions of the Alliance and improve certain readiness and reinforcement situations. In these three short-term areas, our schedule for results is about a year.

"The long-term program, of which the President spoke in London, will look as far as ten years down the road at such areas as readiness and location of forces (particularly against short warning attack); quicker and more effective reinforcement; air defense; communications, command and control, and other NATO needs. . . .

"... Turning elsewhere on the globe, I expect sometime this summer to take a personal look at the conventional forces—including U.S. forces—deployed in Korea from which, as you know, President Carter has indicated our intention to withdraw U.S. ground troops over a four or five-year period.

"I assure you that this carefully planned action definitely will not diminish our commitment to South Korea's security. We retain a large stake in the security of South Korea as a result of our historic involvement, our longstanding political and commercial interests there, and the importance of peace on the peninsula to the security of Japan and the balance of power in East Asia. . . .

"... In Europe, we are seeking conventional force reduction—in a separate negotiation from that on strategic arms limitations—through negotiation with the Soviet Union. In Brussels, the NATO Defense Ministers took note of the Mutual and Balanced Force Reduction negotiations in the Communique. They reaffirmed their support for the principle that NATO forces be maintained and not reduced except, and I am quoting: 'in the context of a Mutual and Balanced Force Reduction agreement with the East which must in no way diminish the collective security of the Alliance.'

"We would, of course, welcome such an MBFR agreement, but it does not appear to be imminent.

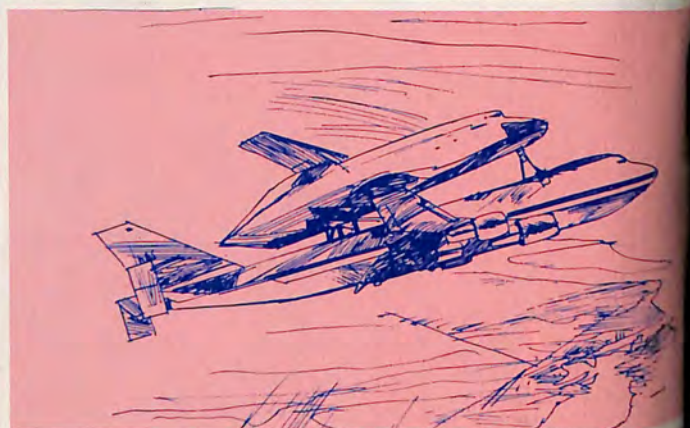
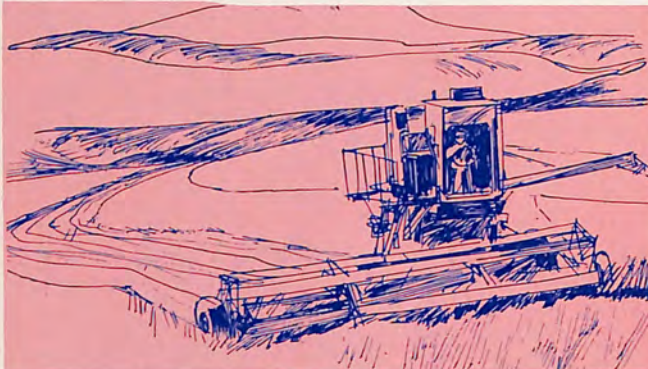
"We have been and remain hopeful about the prospects for a SALT agreement. There was some progress on how to proceed (which is the first step) in the SALT talks in Geneva last week. Secretary Vance and Foreign Minister Gromyko agreed to a framework for the negotiations pointing to three things: a treaty that will last until 1985; a protocol to the treaty that will last for the next three years; and a statement of general principles guiding the SALT III negotiations that would begin immediately upon the signing of the treaty and the protocol.

"Clearly, much difficult and complicated work remains to be done. But, in the wake of some gloomy interpretations after the Moscow meeting in March, I believe there is a fair chance we can achieve modest agreement on SALT II by October—when SALT I expires."



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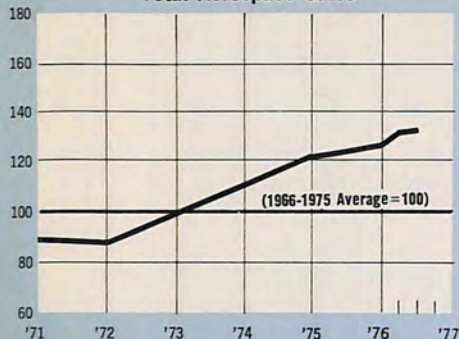
**SPACE SCIENCE—
Investment
in Tomorrow**

AEROSPACE ECONOMIC INDICATORS

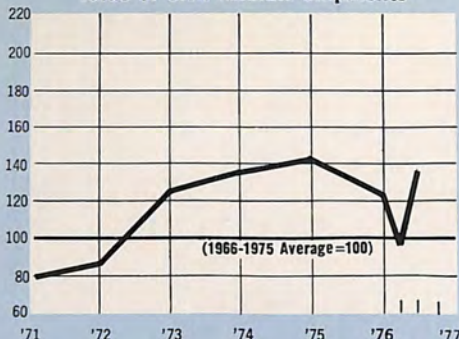
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OUTLOOK

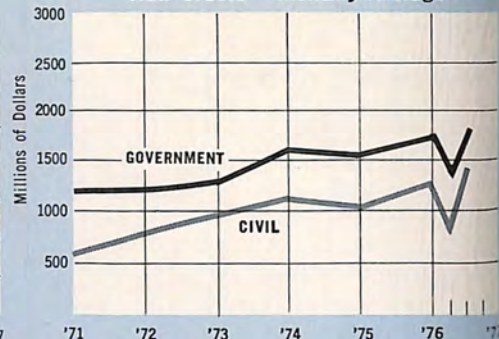
Total Aerospace Sales



Value of Civil Aircraft Shipments



New Orders — Monthly Average



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

ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD 2nd QTR. 1977
AEROSPACE SALES: TOTAL	Billion \$	Annually	26.6	30.8	31.7	31.9
	Billion \$	Quarterly	6.4	8.4	7.6	8.5
AEROSPACE SALES: TOTAL (In Constant Dollars, 1972=100)	Billion \$	Annually	27.3	23.1	22.9	22.7
	Billion \$	Quarterly	6.9	6.3	5.5	6.0
DEPARTMENT OF DEFENSE						
Aerospace obligations: TOTAL	Million \$	Quarterly	3,792	4,072	4,814	4,432
Aircraft	Million \$	Quarterly	2,361	2,841	3,286	3,147
Missiles & Space	Million \$	Quarterly	1,431	1,231	1,528	1,285
Aerospace outlays: TOTAL	Million \$	Quarterly	3,411	3,461	3,473	3,650
Aircraft	Million \$	Quarterly	2,031	2,156	2,011	2,367
Missiles & Space	Million \$	Quarterly	1,380	1,305	1,462	1,283
Aerospace Military Prime Contract Awards: TOTAL	Million \$	Quarterly	3,327	4,069	4,306	3,888
Aircraft	Million \$	Quarterly	2,109	2,694	2,380	2,821
Missiles & Space	Million \$	Quarterly	1,218	1,375	1,926	1,067
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million \$	Quarterly	780	646	816	835
Expenditures	Million \$	Quarterly	789	619	724	695
BACKLOG (70 Aerospace Mfrs.): TOTAL						
U.S. Government	Billion \$	Quarterly	28.6	34.3	38.7	39.9
Nongovernment	Billion \$	Quarterly	15.9	21.8	23.3	23.4
	Billion \$	Quarterly	12.7	12.5	15.4	16.5
EXPORTS						
Total (Including military)	Million \$	Quarterly	1,038	2,117	1,672	2,022
New Commercial Transports	Million \$	Quarterly	345	779	368	592
PROFITS						
Aerospace — Based on Sales	Percent	Quarterly	2.7	3.5	4.0	4.3
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	5.9	5.0	5.8
EMPLOYMENT: TOTAL						
Aircraft	Thousands	End of Quarter	1,166	895	885	901
Missiles & Space	Thousands	End of Quarter	650	483	476	487
	Thousands	End of Quarter	114	84	83	81
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS						
	Dollars	End of Quarter	4.38	6.36	6.74	6.89

* 1966-1975 average is computed by dividing total year data by 4 to yield quarterly averages.

† Preceding period refers to quarter preceding latest period shown.

Source: Aerospace Industries Association

SPACE SCIENCE

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



January 31, 1978, will mark the 20th anniversary of America's first successful space launch. Progress in the relatively brief span of two decades has been extraordinary, in terms both of exploratory accomplishment and of public benefit.

The practical benefits that have accrued from space research and development are well known to the American public. Communications and weather satellites have been in operational use for years. Earth-survey satellites now in orbit, or soon to be, promise enormous direct benefit in more efficient management of the planet's resources. NASA's aeronautical research contributes to American leadership in commercial aviation. A relatively new area of direct benefit is NASA's program of energy research, wherein the technology gained in aerospace programs is being applied to energy conservation and development of alternative sources of energy.

This issue of *Aerospace* focuses on another area of space benefit—space science, that portion of NASA's effort devoted to exploration of the solar system, the space beyond, and most particularly to learning more about our own planet.

Of all NASA's functions, space science is perhaps least understood by the general public. Its achievements are fascinating, but the benefit is obscure because for the most part space science is not addressed to current pressing problems, such as energy and resource conservation, but rather to a sweeping quest for knowledge that can later be applied to man's advantage. The wealth of scientific data being acquired today becomes the wellspring of tomorrow's technology. Therein, of course, lies the principal benefit in terms of improving the condition of mankind. It is important that we understand this most beneficial aspect of space science—so significant to man's future—however mysterious immediate program objectives may seem.

Aerospace also addresses a matter of vital importance to the aerospace industry's ability to function as partner to the government space research, in supplying high quality defense equipment, and in other areas of technological advance. The subject is profit. Profits in American industry are generally low today, and this is particularly true of the aerospace industry. Without an adequate level of profit, the aerospace industry cannot provide the basic research, the people and the equipment necessary to its partnership role as the government's principal source of high technology products.



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CONTENTS

- 2 SPACE SCIENCE—
INVESTMENT IN TOMORROW
By JAMES J. HAGGERTY
- 10 PROFIT IS NOT A DIRTY WORD
- 12 WEAPON COST DILEMMA—
RECOGNIZING REALISM
By OLIVER C. BOILEAU
President, Boeing Aerospace Company
- 14 THE AIRLINE INDUSTRY
LOOKS AHEAD
By DR. GEORGE W. JAMES
Senior Vice President—Economics and Finance
The Air Transport Association

COVER:

The artist's drawing depicts the Voyager spacecraft during its encounter with the giant ringed planet Saturn.

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;

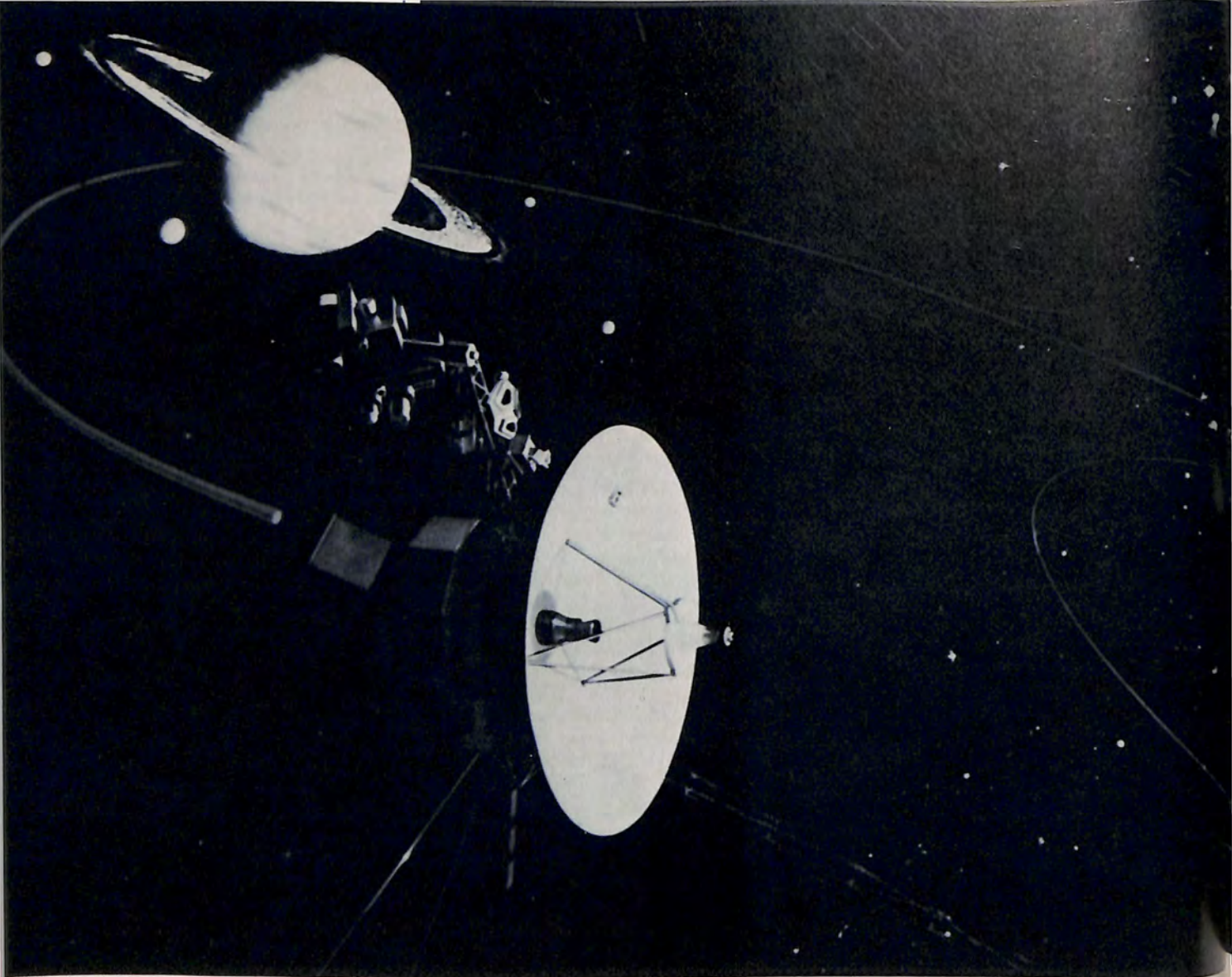
Foster understanding of civil aviation as a prime factor in domestic and international travel and trade;

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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space science

"This is a present from a small, distant world, a token of our science, our images, our music, our thoughts and our feelings."

So begins a recorded message by President Carter, addressed to a possibly existent extraterrestrial civilization that might intercept a Voyager spacecraft millions of years hence.

Each of the two Voyagers launched last summer carries a phonograph record containing spoken messages in 60 languages, electronic pictures, music and other Earth sounds. Because space is so empty, chances are extremely remote that any inhabitant of the cosmos will ever hear the recordings. But the presence of the records on board the Voyager underlines a point: the fact

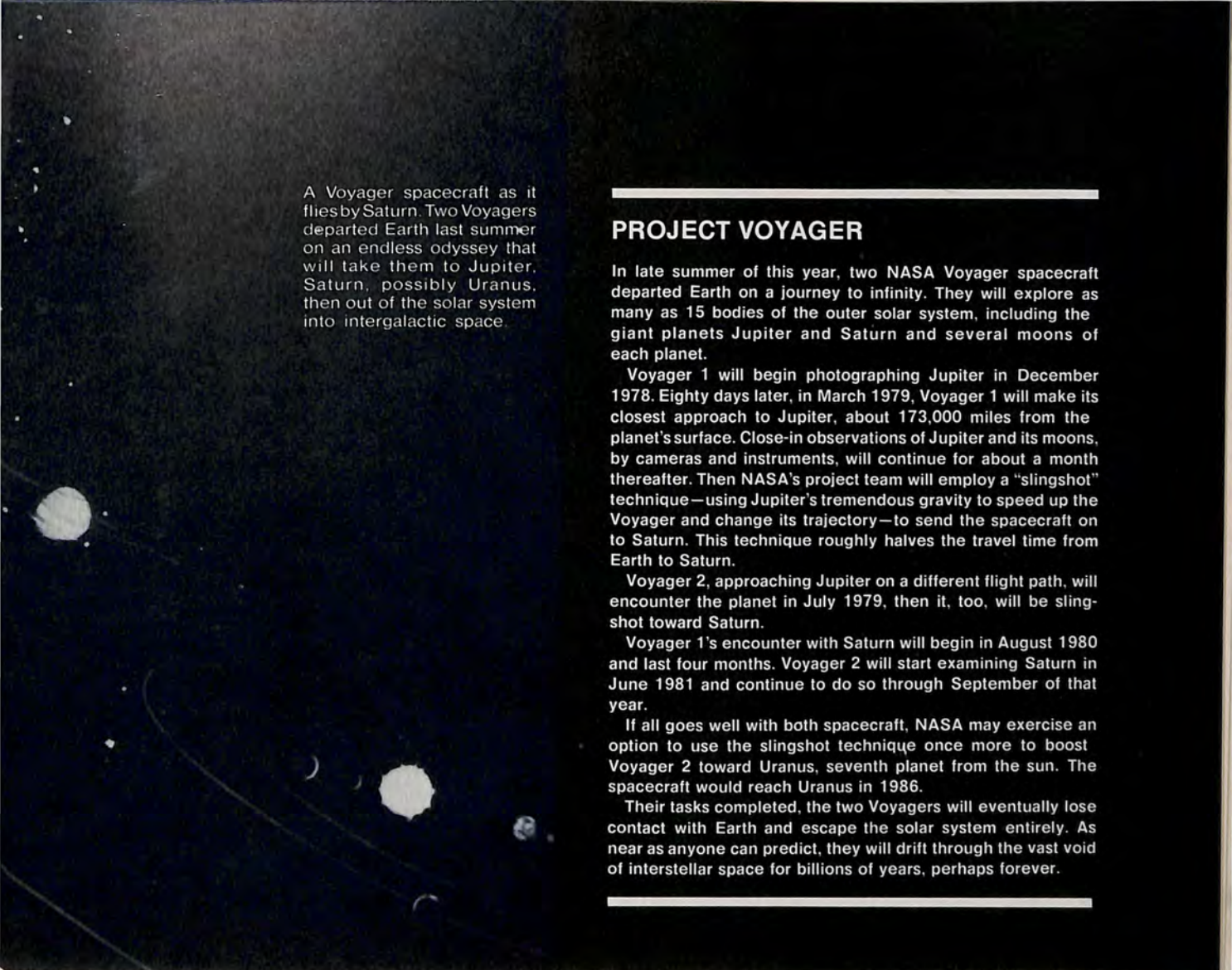
BY JAMES J. HAGGERTY

Associate Editor, Aerospace Magazine

that we can even contemplate extraterrestrial communication emphasizes the extraordinary scientific reach man has attained in only 20 years of space flight. The ability to send automated vehicles far beyond the solar system heralds a future era when man's capacity for probing the mysteries of intergalactic space will be limited only by his willingness to do so.

The Voyager project, of course, was not undertaken to seek contact with alien worlds. The two spacecraft have important work to do closer to home. They will make comprehensive investigations of giant Jupiter and ringed Saturn, including some of the many moons of the two superplanets. These investigations are expected to shed new light on the origins and history of the solar system, information of incalculable scientific value.

Voyager is part of the National Aeronautics and Space



A Voyager spacecraft as it flies by Saturn. Two Voyagers departed Earth last summer on an endless odyssey that will take them to Jupiter, Saturn, possibly Uranus, then out of the solar system into intergalactic space.

PROJECT VOYAGER

In late summer of this year, two NASA Voyager spacecraft departed Earth on a journey to infinity. They will explore as many as 15 bodies of the outer solar system, including the giant planets Jupiter and Saturn and several moons of each planet.

Voyager 1 will begin photographing Jupiter in December 1978. Eighty days later, in March 1979, Voyager 1 will make its closest approach to Jupiter, about 173,000 miles from the planet's surface. Close-in observations of Jupiter and its moons, by cameras and instruments, will continue for about a month thereafter. Then NASA's project team will employ a "slingshot" technique—using Jupiter's tremendous gravity to speed up the Voyager and change its trajectory—to send the spacecraft on to Saturn. This technique roughly halves the travel time from Earth to Saturn.

Voyager 2, approaching Jupiter on a different flight path, will encounter the planet in July 1979, then it, too, will be slingshot toward Saturn.

Voyager 1's encounter with Saturn will begin in August 1980 and last four months. Voyager 2 will start examining Saturn in June 1981 and continue to do so through September of that year.

If all goes well with both spacecraft, NASA may exercise an option to use the slingshot technique once more to boost Voyager 2 toward Uranus, seventh planet from the sun. The spacecraft would reach Uranus in 1986.

Their tasks completed, the two Voyagers will eventually lose contact with Earth and escape the solar system entirely. As near as anyone can predict, they will drift through the vast void of interstellar space for billions of years, perhaps forever.

Investment in Tomorrow

Administration's broad space science program, a sweeping study of space phenomena by means of deep space probes, planetary landers, Earth-orbiting satellites, instrumented sounding rockets, aircraft and balloons, and Earth-based telescopes. It is a program of great importance to mankind's future, yet its objectives are little understood by the general public. Space science excites the imagination but leaves a question in the minds of many: why do we spend large sums on projects which seem to have little practical value? The answer is that space science offers immense practical value, although it is not readily apparent.

The Why of Space Science

Virtually all of NASA's programs share a common aim: benefit to Earth's people, either directly or indirectly. In some cases the benefits are highly visible: communi-

cations or weather satellites, for example, or, more recently, Earth resources survey satellites which have extraordinary potential for concrete benefit over a broad spectrum of public needs. Or energy research, wherein NASA is seeking ways to reduce dependence on fossil fuels and to conserve existing energy resources. Or aeronautical research, which helps the U.S. economic posture by contributing to American leadership in commercial aviation, and benefits the public in general through improvements in flight safety, fuel conservation, noise reduction and pollution control.

Space science is similarly beneficial, but the benefits lack visibility. For one thing, the goals and results of space science, however important, are not readily understandable by the average layman. For another, space science rarely produces immediate *practical* benefit; rather it serves as the informational base from which

practical applications are developed. This relationship of science to technology was addressed in Congressional testimony by Dr. Noel W. Hinners, NASA's Associate Administrator for Space Science:

"Technical advancement is a recognized key to progress, but one must ask what drives technology, or more basically, what makes it possible? To a large degree, basic science provides the foundation for technology. The 'drivers' are the so-called space requirements.

"The scientist, in a quest to discover and understand, continually pushes technology to enable him to see smaller objects, to see further into the universe, to detect smaller amounts of chemicals. The technology thus developed inevitably finds its way into areas of use not conceived of in the initial application. For example, a mass spectrometer developed to analyze very small particles of lunar soil has recently been used to analyze heavy metals in blood samples—better than ever before.

"Similarly, science provides the basis for applications. There is no way to solve aerosol or ozone problems, to understand climate changes, or to comprehend the meaning of magnetic or gravity maps without a firm basis of physics and chemistry and an appreciation of the vagaries of nature, much of which derives from the space science program."

Hinners cites an example of how scientific knowledge can pave the way for beneficial applications of enormous dimension:

"We can now conceive of utilizing the moon's tremendous titanium deposits, unknown 15 years ago, or of mining an almost pure iron-nickel asteroid whose orbit crosses that of Earth. About 20 Earth-orbit-crossing asteroids have been discovered in a systematic search over the past couple of years, as compared to only four previously found at random. We now expect to find close to one thousand."

The basic goal of science—any kind of science—is the acquisition of knowledge. It is knowledge acquired by earlier generations that makes possible our current high standards of living. The knowledge being acquired today, and to be acquired tomorrow, can have profound effect on future generations in ways that are not currently definable.

Space science, which deals with the entire cosmos, offers enormous potential in knowledge acquisition. But, the pragmatist may ask, what good is the knowledge? How does it help Earth's people to learn whether there is life on Mars? Why are we interested in Jupiter's Great Red Spot, or its atmosphere? What earthly good can come from investigating Saturn's rings?

The earthly good is knowledge of Earth. From exploration of the sun, the moon, the planets and the galaxies beyond our solar system, space scientists are compiling comparative data that will enable us to understand better the physical processes that govern the planet we inhabit. Noted Cornell astronomer Carl Sagan explained it in this manner:

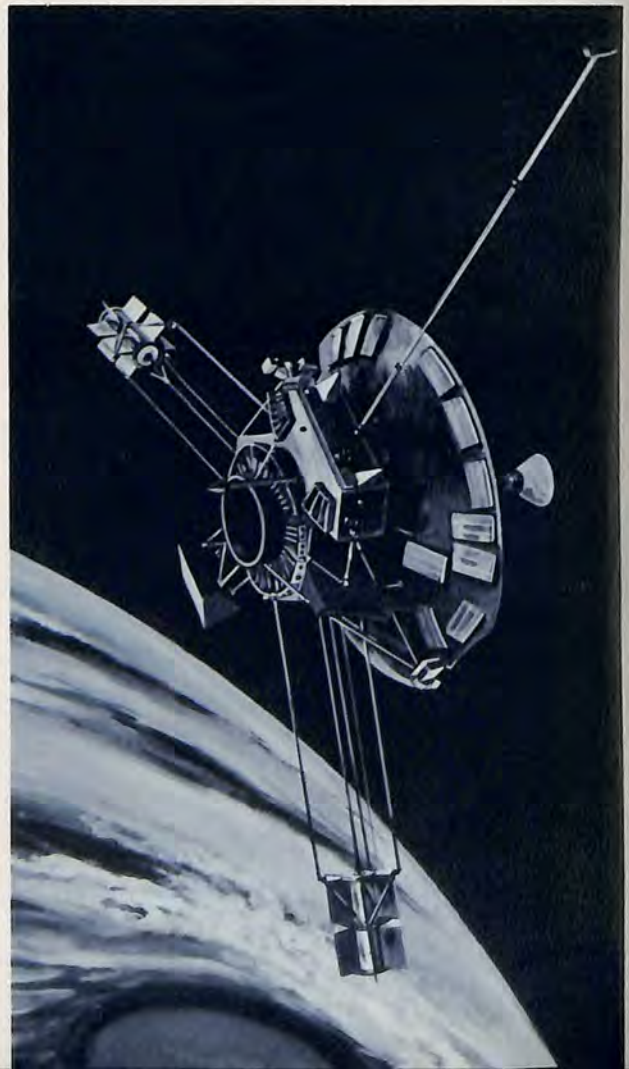
"We are profoundly ignorant of what the other planets are about. And that ignorance carries over to our own planet. It's very difficult to understand your own planet until you have looked at a few others so you have something to compare against it." Speaking of the Viking exploration of Mars, Sagan added: "There is a practical implication for Earthbound sciences like geology, meteorology, biology, that have until now been stuck on one

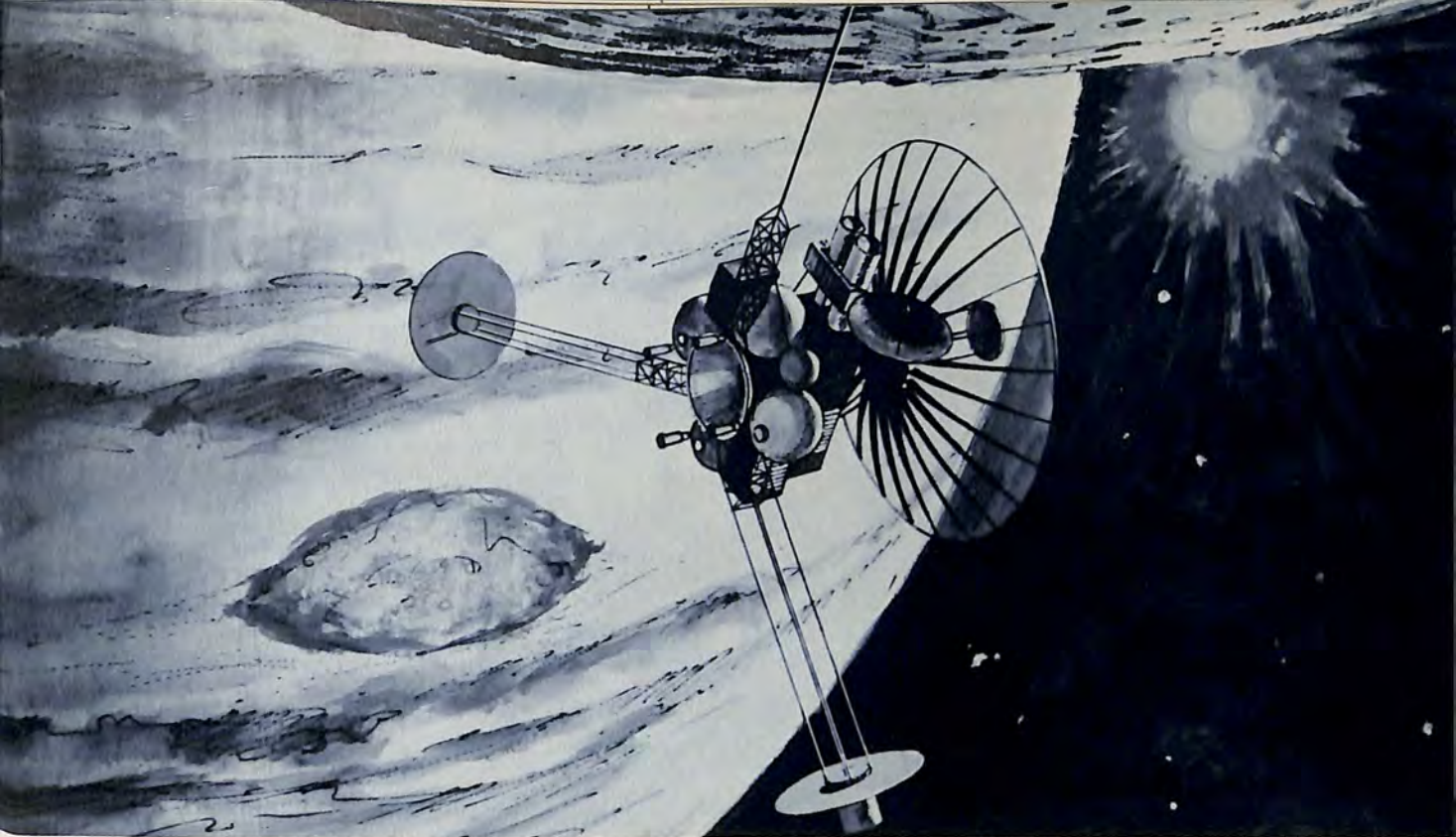
planet. They have been limited in their perspectives."

Thus, the ultimate goal of space science is knowledge of Earth's own complex workings. Knowledge of the forces that control Earth offers the possibility of managing them for mankind's benefit. Part of the space science program focuses on studies of Earth from space; another part contributes to Earth knowledge by fitting our planet into the big picture that is the origin, the history and the structure of the universe. Space scientists are assembling a vast mosaic of trillions of tiles, each tile a bit of information. The quest is seemingly endless, but in time portions of the mosaic will come clear, perhaps to provide the basis for practical applications of enormous scope—weather control, disaster control, biological breakthroughs, the possibilities are infinite and for the most part unimaginable because we don't know enough to speculate. Clearly, space science is much more than an exercise in intellectual curiosity; it is a matter of practical self-interest.

In that context it is appropriate to review NASA's space science program in a perspective that embraces not just *what* NASA is doing but *why*. The program is so broad that it cannot be totally detailed in anything less than a catalog-size volume. But a few examples of major

Pioneer at Jupiter. Pioneers 10 and 11 investigated Jupiter in 1973-74, marking the beginning of NASA's close-up examination of the outer planets. Pioneer 11 is now en route to Saturn.





Artist's concept shows the Jupiter Orbiter taking a close look at one of Jupiter's large moons. Scheduled for launch in 1981, the Jupiter Orbiter/Probe is a two-element spacecraft, one segment of which will drop into Jupiter's atmosphere while the other will become a man-made Jovian moon.

projects serve to outline the type of information NASA seeks and how it fits into the grand mosaic.

Voyager

In exploring Jupiter and Saturn, the two Voyager spacecraft will be breaking a lot of new ground. The Jovian planets, as the pair are collectively known, have been studied by ground-based and orbiting telescopes and on fly-bys of two Pioneer spacecraft, one of which is still en route to Saturn. But the Voyager will be photographing and acquiring instrumental data on parts of the Jovian system never before investigated, as well as amplifying existing information. Voyager represents a giant step in assembling the cosmic jigsaw puzzle.

In earlier exploration, NASA's focus was on the terrestrial planets, the four nearest the sun—Mercury, Venus, Earth and Mars. Now NASA is beginning a comprehensive examination of the outer planets, so remote from the sun they amount to an entirely different realm. Jupiter is almost half a billion miles from the sun, Saturn almost twice as distant, and Uranus, which may get a Voyager visit, almost two billion miles away. The all but incomprehensible distances are underlined by this fact: Voyager's radio signals, traveling at the speed of light, will take more than 40 minutes to reach Earth from Jupiter—and Jupiter is the closest of the outer planets.

The Jovian planets are enormous in every respect—dimensions, mass and gravitational influence. Jupiter, for example, has 10 times Earth's diameter, 318 times the mass, and it contains more matter than all the other planets combined. Jupiter, in fact, is considered a "second solar system" because of its enormity, its radiation output and the fact that it plays host to 13, maybe 14

moons, four of them almost as large as terrestrial planets. Saturn, with 10 known moons, is second in size only to Jupiter among the planets of the solar system.

Including photography, the Voyagers carry instruments to conduct 11 major investigations of the two planets, each of these areas embracing countless individual bits of scientific information. Generally, the spacecraft will be studying the atmosphere of Jupiter and Saturn, their magnetic fields, the intense radiation emanating from the planets, the space between them and the solar wind that streams outward from the sun for billions of miles.

Of what use is such data? The investigations and their aims are so complex they cannot be treated in detail, but a few examples show the type of information NASA seeks for comparison with Earth processes and for indications as to the genesis of that tiny corner of the universe we call the solar system.

Jupiter and Saturn are vastly different from the terrestrial planets. They are mostly, perhaps totally, composed of gas and liquid. Because they have such tremendous gravities, indications are that little or none of their materials could have escaped in the 4.6 billion years since they were formed. In other words, some of the material from which the solar system formed is still there, and even though evolution may have changed it, first-hand study of this material offers clues of tremendous value as to the origin of the solar system.

Comparative planetology, or relating phenomena on one planet to conditions on another, requires construction of planetary models. Theoretical models exist for Jupiter and Saturn, but the Voyagers will contribute in great measure to more precise modeling of the Jovian

planets' structures by amplifying and clarifying current information. The Voyagers' instruments will analyze the multi-layered composition of the atmosphere of Jupiter and Saturn and seek to answer a key question: are they entirely gas and liquid or do they have rocky cores? This is a matter of fundamental importance to the comparison process.

The spectacular surfaces of Jupiter and Saturn are cloud structures with massive turbulence systems, believed to be driven by forces similar to those that create Earth storms like cyclones and hurricanes, but on a grander scale. Thus, information about these Jovian storms has bearing on Earth climatology. Of particular interest is the storm center known as the Great Red Spot, a turbulence system thousands of miles across that has been raging more or less continuously since it was discovered 300 years ago.

Perhaps the most fascinating of all the Voyager investigations, because it is of interest to both layman and scientist, is the planned examination of Saturn's rings. Theory holds that the rings are remnants of a gaseous disc that surrounded Saturn at the time the Jovian planets were formed. Some of the gas condensed into particles that could "accrete," or attach themselves together. From the accretion process, the particles grew to form the many satellites of Jupiter and Saturn. But apparently tidal forces or collisions near Saturn prevented formation of moons and the material coalesced into the rings that have long excited man's curi-

osity. Detailed study of the rings may bring understanding of how gravitational actions, collisions or other forces distributed the primordial matter. Thus, the rings offer invaluable clues as to how the bodies of the solar system—or at least part of it—were formed.

For similar reasons, the Jovian satellites are of prime interest, and the Voyagers will look at about a dozen of them. Of special importance is Callisto, Jupiter's second largest moon. Scientists think that Callisto is probably half water and that its rocky core is very small; because it is small, it rapidly dissipates radioactive heat that might have melted it or otherwise changed it. Therefore, Callisto may have experienced the least change of all the larger satellites since its formation billions of years ago, so it is a source of information about the early solar system.

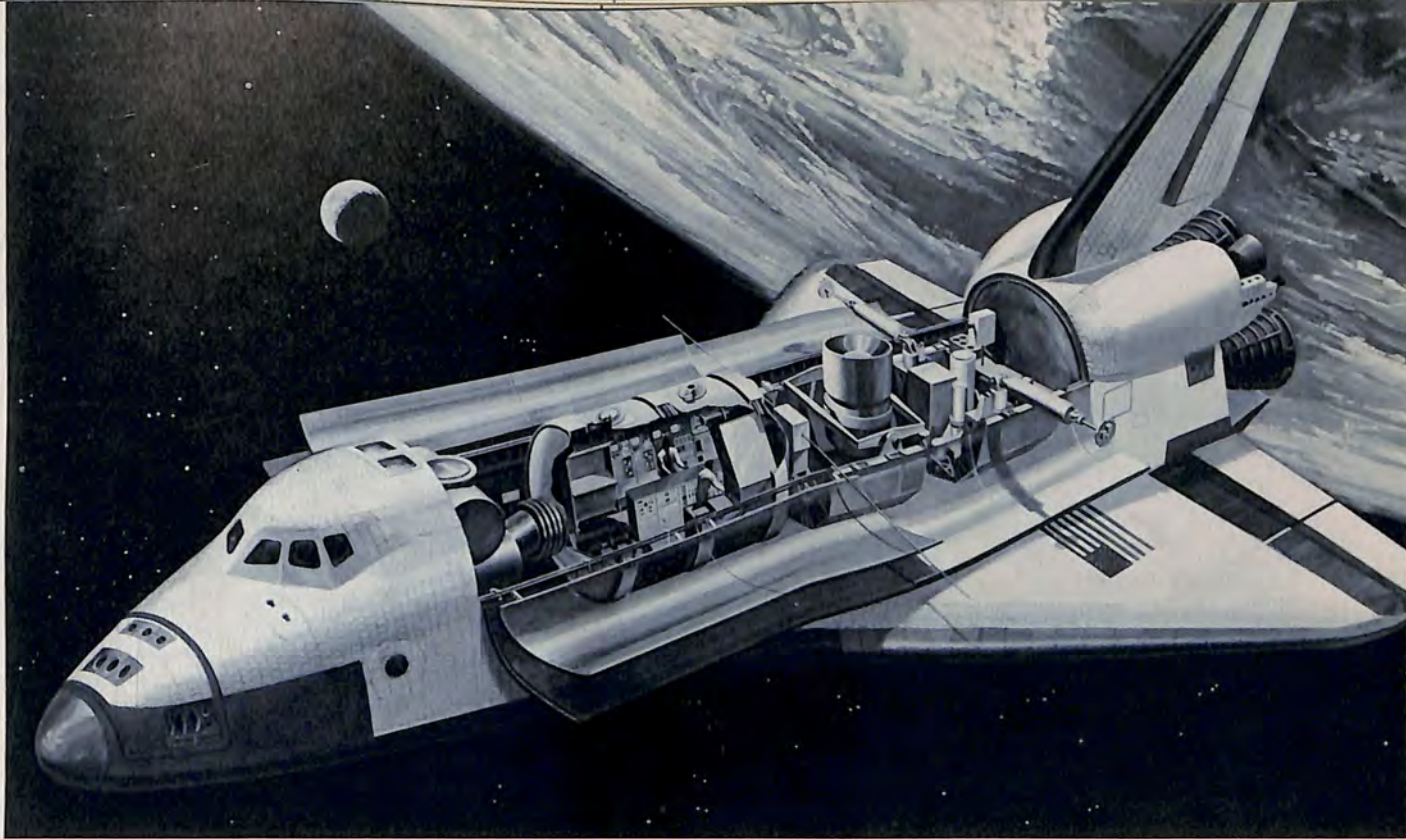
Most interesting of all the moons is Saturn's Titan, largest satellite in the solar system. Titan is almost as large as Mars, has an atmosphere perhaps as dense as Earth's and a solid surface on which complex molecules can accumulate. Although crushing gravity, intense radiation and temperatures as high as 54,000 degrees Fahrenheit virtually preclude existence of life in most of the Jovian system, there is speculation that Titan could harbor some primitive form of life. The matter of other life in the solar system is still a question of prime importance to comparative study and almost equally important in terms of assembling the grand mosaic is indication of the *non-existence* of life.

Finally, there is Uranus, which may come under the scrutiny of Voyager 2's cameras and instruments. The seventh planet from the sun, Uranus is so distant it takes 84 years to circle the sun. Once each circuit, the sun shines directly on the north pole; 42 years later it lights the south pole. Voyager will have an opportunity to photograph the sunlit hemisphere and the planet's five known moons. The spacecraft will also perform atmospheric and magnetic field investigations and provide amplifying information on a recent discovery: the fact that Uranus, like Saturn, has rings. Not much is known about Uranus; no spacecraft has ever inspected it closely. For that reason, the contemplated Voyager look is scientifically exciting.



In the Pioneer Venus project, NASA will begin an intensive study of the planet Venus in 1978 with two separately-launched spacecraft. The one shown is the multiprobe bus, which will carry four probes that will descend through Venus' cloud cover and sample the atmosphere. The other spacecraft will report data while orbiting the planet for a year.





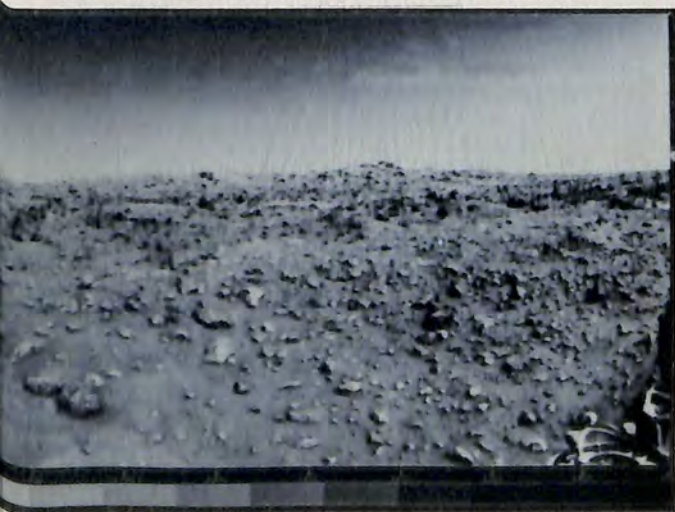
Spacelab is a human-habitable orbiting laboratory that fits into the cargo bay of the Shuttle Orbiter. Capable of accommodating four scientists for as long as 30 days, it will become operational in 1981.

Jupiter Orbiter/Probe

Important as they are, the Voyagers will be able to observe Jupiter for relatively brief periods as they fly by, and they will analyze the planet's atmosphere from a distance, rather than right in it. To expand the basic knowledge provided by the Voyagers, NASA will send another spacecraft to Jupiter for a long-duration examination of the planet and its moons.

The first planetary explorer to be launched by NASA's Space Shuttle, the Jupiter Orbiter/Probe will depart Earth in December 1981. About a thousand days later, near Jupiter, the main spacecraft will release the probe,

The Viking Lander on the surface of Mars. One of the most successful of all space science projects, Viking is still returning information about Martian weather and other phenomena.



which will descend into the planet's atmosphere. For half an hour, as it drops through the various layers of gas and liquid, the probe will provide vital first-hand data on atmospheric composition and structure, sending its information to the main spacecraft for relay to Earth. As it reaches the lower levels, the probe will be subjected to gravity pressures as much as 20 times Earth's atmospheric pressure, which will crush it and end its transmissions.

At this point, the main spacecraft's rocket engines will be fired, adjusting course and velocity so that the vehicle will swing into orbit around the planet. The Orbiter will become a man-made satellite of Jupiter and its orbit will take it repeatedly to areas of the planetary system never viewed by fly-by spacecraft—the Pioneers and Voyagers. The Jupiter Orbiter's cameras and instruments will conduct investigations similar to those planned for the Voyagers: studies of Jupiter's atmosphere, magnetosphere, hurricanes and other phenomena. The difference is that the Jupiter Orbiter will report continuously over a long period and from many different vantage points, thus vastly expanding Voyager's findings and filling in myriad informational gaps in the model of Jupiter.

A matter of special scientific interest will be the Orbiter's close and repetitive examination of the Galilean satellites—the four big ones, named Io, Europa, Ganymede and Callisto. Operating as a "member of the family," the Orbiter will repeatedly swing by its fellow satellites, photographing them and recording instrumental data for transmission to Earth. The Galilean satellites, ranging in equivalent size from the planet Mercury to our moon, display some of the most interesting phenomena in the solar system. Partially ice-covered and prob-

ably rocky-cored, they constitute an entirely new class of planetary objects for comparison with Earth; they enable study in a completely new context of geological processes familiar on Earth.

Pioneer Venus

While focusing on the outer planets, NASA continues to study our close-neighbor planets—Mercury, Venus and Mars. Although they are no longer making headlines, the Viking spacecraft—two Orbiters and two Landers—are still examining conditions on Mars, such as massive dust storms, Martian meteorology and marsquakes, providing new data of importance to comparative planetology. Information on Mercury, made available by a multiple-encounter mission of Mariner 10 in 1974, is still being analyzed. NASA's recently-published *Atlas of Mercury*, a compilation of high quality photos obtained by Mariner 10, will inspire broader study of Mercury by planetary researchers.

The next major step is Pioneer Venus, which will make the most comprehensive exploration of Venus yet undertaken. Pioneer Venus is two separate spacecraft, scheduled for arrival at Venus at the end of 1978. One is a "multiprobe;" it includes a main spacecraft "bus" which will dip into the upper atmosphere of Venus to report



The High Energy Astronomy Observatory (HEAO) carries instruments to explore scientifically-important x-rays, gamma rays and cosmic rays. The first of three HEAOs is now in orbit.

data, and four instrumented probes that will descend through Venus' clouds down to the surface, reporting as they go. The other spacecraft is a Venus Orbiter, which will circle the planet for at least a year, making investigations similar to those of the Voyagers at Jupiter.

Generally, the two spacecraft of the Pioneer Venus program will develop new information about the composition, structure and dynamics of Venus' atmosphere, to allow more precise modeling of the planet. This research also has direct, near-term practical application. Venus, our nearest neighbor, is considered the most Earthlike planet; it offers a natural laboratory for comparative study of some of the factors that determine Earth's own complex environment, of which we have only rudimentary intelligence. It may, for example, contribute to improved knowledge of the many influences on Earth climate, or help us understand a problem of growing concern—the consequences of atmospheric pollution on a global scale.

Spacelab

For all the intense activity of the past 20 years, we still have a lot to learn about planet Earth, its atmosphere and magnetic field, solar radiation and the particles which impinge on Earth, and a variety of other information that will contribute to comparative planetology. Toward that end, NASA will continue to launch a series of unmanned Earth-orbiting satellites, and, after 1980, to deposit them in orbit by means of the Space Shuttle. In addition, the Shuttle makes it possible to send teams of scientists into space for first-hand observations aboard Spacelab.

Spacelab is a pressurized orbiting laboratory that fits into the Shuttle Orbiter's cargo bay. It can accommodate four non-astronaut scientists for periods up to 30 days, and its equipment can be changed to meet the differing needs of a variety of investigations. Thus, a scientific team can focus its attention on surveys of Earth conditions, on investigations of the sun, on human-directed observations of the planets, stars and galaxies, or on life science studies of man and other living things in the weightless environment of space. Being developed and financed by 10 member nations of the European Space Agency, Spacelab will be available to all the world's scientists, broadening the expertise base. Because the most sophisticated unmanned instruments still cannot match human direction and judgment, Spacelab will be an enormously important tool in assembling the cosmic jigsaw puzzle. NASA contemplates initial flights in 1981 and about four missions a year thereafter.

An example of the practical potential of Spacelab is planned experimentation in space processing and manufacturing. In-space manufacturing offers a variety of direct benefits in production of certain items that are best produced under vacuum or zero gravity conditions, hence cannot be accomplished on Earth: for example, pharmaceuticals totally free of impurities that might cause undesirable side effects; large, high-purity crystals for electronic equipment; or pure, contamination-free glass for optical, laser and electronic uses. The Space Shuttle opens the door to building large structures in space where these and other products can be manufactured; Spacelab experiments will pave the way for that important development.

Space Telescope

Comparison of Earth with the other planets of the solar system is a vitally important part of NASA's space science program, but only a part. The solar system, vast as it is, occupies only a tiny corner of the cosmos. So there is a broader quest: exploring the whole universe to add more tiles to the cosmic mosaic and thus to learn more about how Earth and its inhabitants came to being.

NASA's Dr. Noel Hinners offers a fascinating thought: "You, yourselves, or rather the atoms that make up your bodies, were at one time, in all probability, deep in the interior of a star such as the sun." He is talking about the "Big Bang" theory of the origin of the universe, which holds that it all began some 15 billion years ago with an immense explosion containing all the matter in the universe. The matter existed then as hydrogen and helium, and over the eons that followed it gradually evolved into the other elements of which Earth and everything on it are composed. Thus, to learn about our own origin, we must study the whole universe and the

matter it contains; we must extend the comparison process beyond the solar system, looking at our sun in relation to the other stars, our galaxy in relation to other galaxies.

No space science project is more exciting to the scientific community than NASA's forthcoming Space Telescope, whose unparalleled capabilities will allow a new search of the universe and even a look at stars' interiors. Man has been using telescopes to explore the heavens for centuries; observations, however, have been limited by the layer of atmosphere surrounding the Earth, which obscures and distorts the Earthbound view. In the last 20 years, it has been possible to send astronomical observatories into space for clearer views of the cosmos. They have been invaluable, but they too have been limited by available technology and by relatively short operational lives.

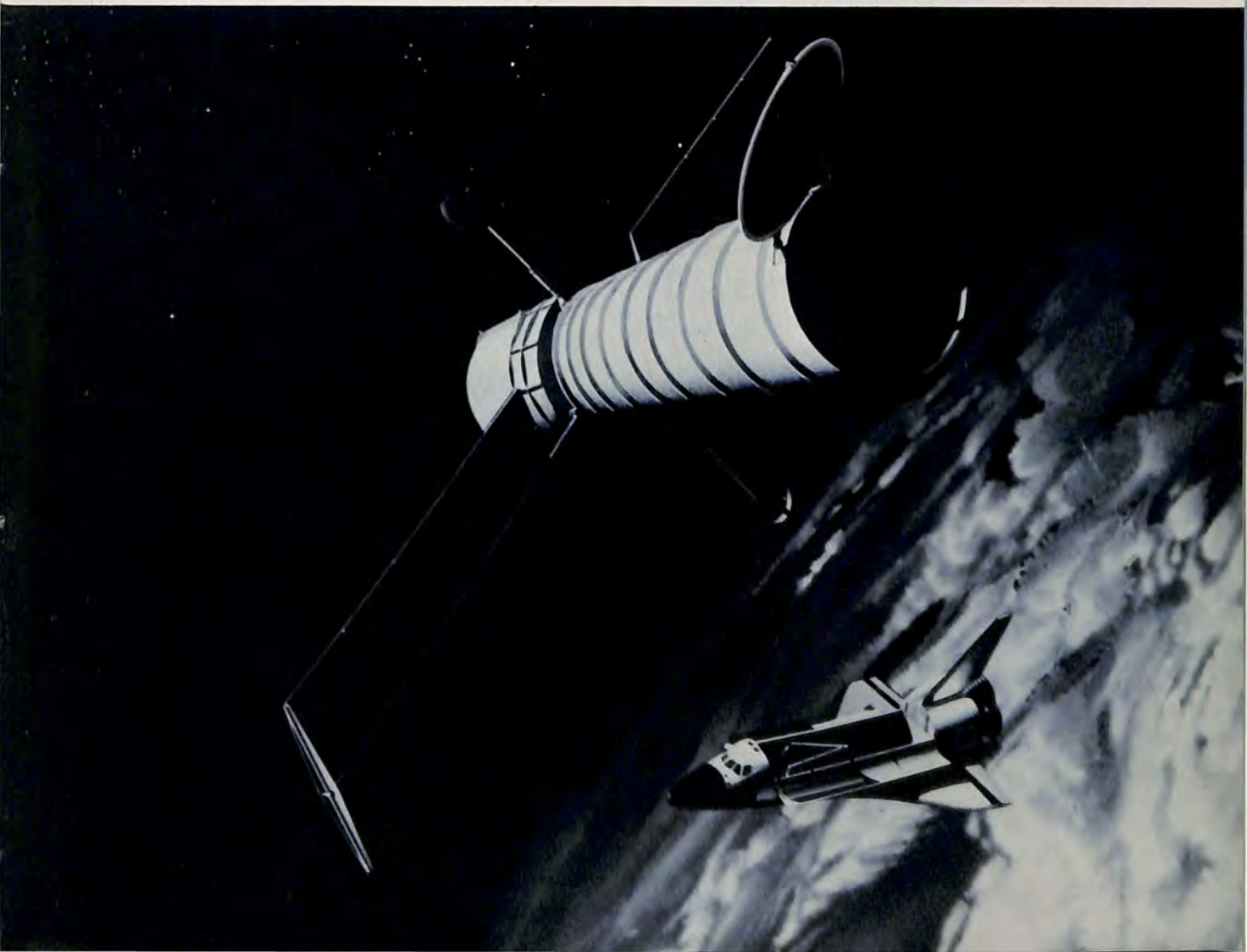
The eight-foot diameter Space Telescope, capable of accommodating up to five different astronomical instruments, will permit observations far deeper into space and with far greater resolution than has ever before been possible, either by large Earth-based telescopes or by any of the orbiting systems yet flown. It has the

added advantage of long lifetime. To be delivered to orbit by the Space Shuttle, it will be serviced thereafter by Shuttle Orbiter crews. The telescope will be maintained in orbit, or, if necessary, recovered by the Shuttle Orbiter for return to Earth, refurbishment and redelivery to orbit. In that manner, its operational lifetime will be extended to at least a decade, probably more. And, although it is unmanned in orbit, the system will be human-directed from Earth.

The Space Telescope's reach and resolution will provide information on the origin, structure, evolution and energy balance of the universe that can be obtained in no other way. Its orbital delivery in 1983 will inaugurate a new era of astronomy and contribute immeasurably to man's knowledge of the cosmos—and to fitting tiny Earth into the vast cosmic scheme.

This review covers only a few major projects out of scores, but it serves to underline the point that there is great practical value in the abstruse but methodical space science program. The program provides a foundation from which technological innovations of tremendous practical benefit may emerge. It is an investment in tomorrow.

The Space Telescope will permit observations far deeper into space than has ever before been possible. To be delivered to orbit by the Space Shuttle Orbiter in 1983, the telescope will be maintained in space by Orbiter crews to extend its useful life.



How much profit do you think American business firms make on a dollar of sales after the government takes its tax bite?

Recent opinion polls asked that question of a cross-section of the American public. The answers were startling. People felt that the average profit was 33 cents on the sales dollar.

Actually, it's less than five cents. In the aerospace industry it is three and a half cents.

This public misconception exemplifies a matter of growing concern to American business: the fact that a large segment of the American populace does not understand the business community's struggle for profits—the key to progress and jobs. Uninformed views have given rise to unsympathetic attitude toward business in general and big business in particular. Such an attitude can have a negative effect on business because, today more than ever before, government is sensitive to mass opinion. Even demonstrably wrong views, if they are widely held, may influence government policy relating to business. For that reason, myths and misconceptions about the economy handicap the quest for vigorous economic growth and the fight against inflation and unemployment.

High on the list of misconceptions is the role of profit in American society. Profit has lost its respectability in the minds of many, who regard it as a symbol of greed and a debasing human endeavor.

Posing the question "What Good Are Profits?", a U.S. Chamber of Commerce publication had this to say about the social function of profits:

"Profits are about as badly misunderstood and universally sought as happiness in marriage.

"In plain English, profits—the whole system of profit—is a scorekeeping device for a society. Profits tell the society what goods and services to produce more of, and the ones to produce less of.

"Whatever the motive of the profit seeker, the *social function* of profits is to tell the society which goods and services are adjudged by people in markets to have a social value worth the resources used to organize their production.

"If markets are competitive, then profits attract more producers, as honey draws flies. Soviet Russia had to re-invent profits as soon as it allowed any consumer choice."

Economically speaking, profit is the keystone of the

free enterprise system. The expectation of profit inspires investment in capital equipment to increase productivity. Increasing productivity means more jobs, better jobs and, generally, an improvement in our standard of living. Profit not only inspires investment, it makes the investment possible because expenditures for plant expansion are financed in large measure from corporate earnings.

Secretary of the Treasury W. Michael Blumenthal recently addressed the importance to the nation of increased investment by business:

"Our ability to improve the health of our people, to revitalize our older cities, to reform our welfare system, and meet other great social needs while providing for an adequate defense, depends fundamentally on the achievement of sustained, non-inflationary economic growth....

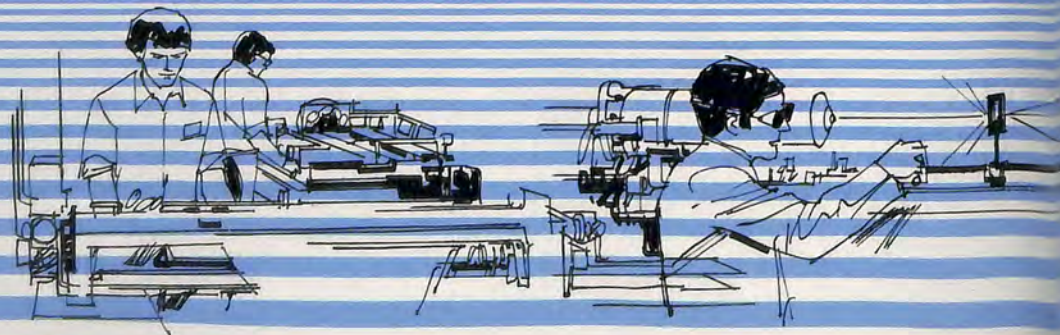
"But for the longer term, neither our growth nor our inflation goals will be realized without significant increases in the rate of investment in the productive capacity of the American economy. We need increased business investment to fuel the continuation of our economic expansion. We need investment to avoid the capacity bottlenecks that we will otherwise face...and to help speed the pace of productivity growth."

Profit—investment—productivity—economic growth and the nation's ability to finance social programs—all are inextricably intertwined. Thus, those who sneer at profit making are mistakenly attacking their own well being. In similar vein, there are many who demand more and more social benefits from the government with no regard for how the government gets the requisite money. A lot of it—in the form of taxes—comes from profits. *Today*, a publication of Martin Marietta Corp., cites the view of an American businessman:

"Those who criticize corporate profits conveniently overlook the fact that a substantial part of corporate profits goes to pay taxes, which help support the countless programs of federal and state governments.

"The rest of the profit dollar is what keeps our economy regenerating itself. Part of it is paid out as dividends to millions of Americans who have invested their savings in our private enterprise system in the expectation of getting a return on that investment. And a large part of the balance is spent directly to build the new plants and buy the new equipment needed to provide more jobs for American working men and women.

PROFIT IS NOT A DIRTY



"It is this function of profits—providing the funds for the continual modernization and expansion of the means of production—that is so vital to the future of our country and is so little appreciated."

Another anti-business view is that corporate profits are too high, although in fact they are generally too low. It is understandable that the average citizen, harried on all sides by rising costs of everything, may lay the blame on the business community. This view, however, ignores the fact that business is similarly harassed by inflation. Profits, in dollars or in percentage of sales, have risen somewhat in recent years, reflecting an upturn in the economy. But, expressed in constant dollars, profits are still far below the peak of 1966.

To amplify that point, after-tax profits of non-financial corporations rose from \$37.2 billion in 1965 to \$55.8 billion in 1975. This is an apparent large increase. However, allowance must be made for the fact that the latter figure is an artificial statistic stemming from a decade of high inflation. The figure must also be adjusted to take into consideration, for example, depreciation of plant and equipment, which should be put on a more accurate basis to reflect replacement cost rather than original cost. That would further shrink the apparent gain in profits. An authoritative estimate places the properly adjusted 1975 profit figure at \$32.8 billion. Thus, for the decade 1965-1975 corporate profits experienced a decline rather than a gain. Dividend payments to shareholders must be subtracted from the adjusted profit figure; the resulting retained earnings are too low for the rate of investment essential to economic growth.

Uninformed beliefs to the contrary, profits are still low. Labeling profits for the first quarter of this year "a disappointment," *Business Week* recently stated:

"Lagging profits are one obvious reason for the reluctance of business to make long-term investment commitments. They also help explain the faltering performance of the stock market. Unless corporate profits and corporate dividends to shareholders can increase, there will be no incentive for expansion and no money available for investment in industry.... Without an adequate level of profits—after taxes—the U.S. economy faces a period of low economic growth and high unemployment."

The Chamber of Commerce adds a footnote:

"(Low profits) hurt by slowing down new investment. Japan invests around 27 percent of its Gross National Product, the Netherlands and West Germany about 20

percent, and the U.S. is near the bottom of the list. These countries, with faster investment, are improving their ability to produce faster than we are. They are gaining on us in ability to sell goods and services to other nations."

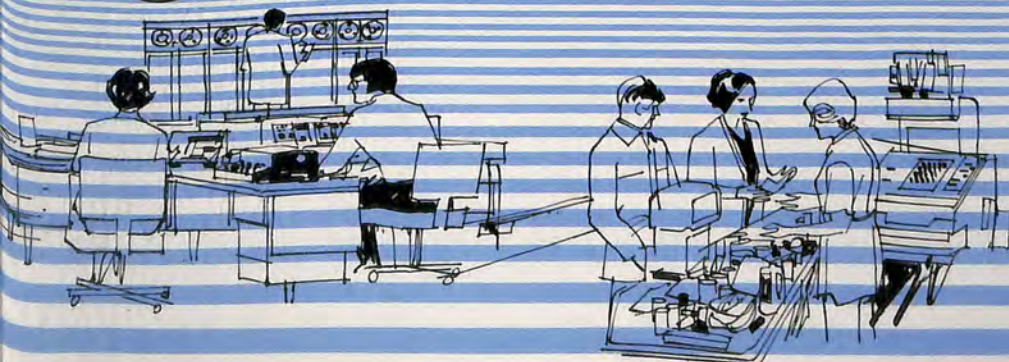
Without profit there is no progress. Businessmen and economists fully understand that tenet, but apparently a large part of the public does not. Enlightenment, therefore, becomes an essential step toward full realization of the U.S. economic potential. The public needs convincing that, far from being a dirty word, profit is the lubricant for the nation's economic machinery.

PROFIT PERSPECTIVE

Does business get the lion's share of the total U.S. income? Many people think so, but in fact corporate profits represent a small portion of the national income. Says the U.S. Chamber of Commerce: "The bulk of national income flows through corporations—but it goes in and then comes out." More than three-quarters of it "comes out" in the form of employee salaries, wages and bonuses. A summary of national income compiled by the Department of Commerce shows where corporate profit stands in comparison with other types of income. Below is the breakdown for 1976:

TYPE OF INCOME	PERCENTAGE
Employee compensation	76
Interest (bonds, savings, etc.)	6.1
Business and professional (unincorporated)	5.5
Corporate profits retained for reinvestment and other purposes	3.6
Dividends	2.6
Rents	1.8
Farmers	1.7

WORD



Weapon Cost Dilemma—

RECOGNIZING REALISM



BY OLIVER C. BOILEAU
President, Boeing Aerospace Company

In a recent speech to the Defense Systems Management College, Fort Belvoir, Virginia, aerospace industry leader Oliver C. Boileau offered some blunt, practical thoughts on improving the government-industry relationship with regard to weapons systems acquisition. The following is an excerpted version of the speech. A graduate engineer with a master's degree in industrial management, Oliver C. Boileau is president of Boeing Aerospace Company, a division of The Boeing Company.

I believe that the aerospace industry and the Department of Defense are doing a fine job—much better than the newspapers would lead one to believe. The industry and the DOD are doing as good a job—or better—than other branches of the government and many parts of industry.

I have talked to many people who are or have been involved with weapons acquisition and procurement. The question I raised was, "If you were given a chance to present the industry viewpoint, what would you say? What message would you want to leave with the people who are or will be running things?"

Predictably, there was concern that the military services—spurred by congressional criticism, I'm sure—are always working the last horror story. Regulatory bodies respond to mistakes of the past. In the regulations, they try to preclude something bad which happened from happening again. These bodies lay the regulations on everything—like a blanket—without apparent regard for whether they're applicable here, there or elsewhere. One wonders if the cure isn't worse sometimes than the illness. Certainly, it's more expensive....

By the very nature of this business we're in—that of designing, developing and building new, sophisticated systems—our products are going to carry a high price tag. The government should not make matters worse by asking us to "gold plate" our products. It makes one long for the simplicity of weapons and warfare of the old days. When warriors carried only clubs, it was easy. The manufacturer simply wrote a notation on the knobby

end of the club: "This end up." Today, we're building missiles that can fly around corners and chase a target down a rat hole. Naturally, the instructions on the box have gotten more complicated and so have the reliability and maintenance requirements.

General Sam Phillips, when he was head of Air Force Systems Command, challenged industry on the issue of hardware reliability. General Phillips said we must recognize that the equipment we develop and produce will be operated, maintained and supported in the real world of military operations. Our pilots, he said, have other things to worry about than the tender, loving care of fragile electronic equipment. Our maintenance personnel do not have the background of your graduate engineers, he said, and the results of repair-level analysis are sometimes ignored under the pressures of military commitments.

Well, I have a proposal for easing part of the problem which General Phillips mentioned, and I believe it could save the taxpayers some money, too. I believe the government should hire industry to perform more of its maintenance chores. Reduce life-cycle costs by contracting to industry for the design, production and life-cycle maintenance and repair of certain end items, and the weapon system elements, without compromising tactical capabilities. It can be done. The original manufacturer would not only provide greater efficiencies and cost savings, but he also would get a chance to see how his equipment could be improved. We see this approach as opening the way for such things as airline-type maintenance, which is based on economic tradeoffs. It would eliminate the need for multiple government repair areas. It would fit right in with the industrial base our government tries to preserve during peacetime....

Anyone can guess from the number of high-level people who are working on weapons acquisition that we have a real problem. Among other things, the inability of industry and government team to bring systems in within predicted cost and schedule has alienated Congress. As a result, Congress has become less willing to provide funds to produce the defense system this country needs....

My director of finance said if current trends continue, the Department of Defense soon would not be able to afford modern military systems. He spoke not as a finance director, either. He voiced the concern felt by Americans everywhere—a concern that the defense establishment one day might not be able to defend this



country against a strong, well-equipped enemy force. That kind of concern makes the hair stand up on the back of your neck.

How did we get into this shape? With the system we have now, it probably was inevitable. There simply are too many procurement people and too many contractor people oriented toward recovery of costs and disallowance of costs and the challenge of cost elements. There are too few contractor people who are concerned with determining which is the best product for the price....

The contractor who is best prepared to do the job is the one most likely to do the best job for the least cost. If that contractor has the manpower—trained people—facilities, and good, strong management and is adequately motivated with incentives—that contractor is going to produce the best results regardless of the type of contract. The government can buy something cheaper, perhaps, from a contractor who will make a more aggressive commitment on a fixed price basis, but that experience has been catastrophic to both parties (the government and the contractor) in the past.

So, where are we? Is there a way to conduct a competition so that it doesn't become a cut-throat cost competition? In the past few years we have seen that cost competitions don't work when applied to development programs. When we return to competing technically, we'll wind up with the best system and cost. We should stop kidding ourselves into thinking that the next development program is going to be a miracle—a miracle where the new, the unknown, the complex are all going to come together perfectly the first time.

The government should make it clear to its industrial partners that we're living in a different environment. There won't be any of this nonsense about how cheap everyone can do the whole job. There won't be any best-and-final offer where we sit by and watch two or more contractors slit one another's throat—and, inevitably, the program's. The government should state we're going to be in this, realistically, together; try to figure out what it really does cost to develop this new missile, or new airplane, or whatever....

Once we arrive at a realistic amount which the government can afford—and here is the punch line—there should be *technical* competition. The government should be prepared to select the contractor who submits the best technical proposal for meeting the tailored and realistic specifications—meets them, but doesn't exceed them if the increased capability results in greater cost.

If a company submits a more advanced technical proposal that will inherently cost more money, that company should be disqualified for not being responsive. The objective should be to get the best technical proposal available within the realistic, affordable price.

After the government has narrowed the choice down to the winning contractor, and before the winning contractor is announced, the contractor should be asked to price the package.... The price negotiation must be done on a realistic basis. The negotiated price of a development program should not be permitted to influence the selection of the winner, if the government is satisfied that it has selected the best technical proposal from the contractor who has demonstrated good, inherent cost performance capability.

The selected contractor is going to make some money, but he won't get rich. If the contract incentives are properly structured, follow-on procurements will be negotiated at reduced prices. The government has all the controls it needs to keep the contractor from making a profit over-kill. As a matter of fact, it is simply not possible for a contractor to earn and retain excessive profits under cost-negotiated government contracts....

Another side of the procurement problem is that involving the need for adequate funding. The DOD must be able to level with Congress. It must be able to say, "It will cost so much if we do it now, cost this much if we defer it," and so on. The DOD must decide that this is something the United States really needs and be prepared to fund it adequately. By "adequately" I mean the DOD must have the funds to accommodate changes that are going to come, and I do not mean just engineering changes. I mean changes in requirements as the services more precisely define what it is they really need. For example, I mean changes that may occur in the threat.

A common problem in the past has been a fear by industry of being honest about the price of a new system. We in industry have been afraid we wouldn't be able to sell a new system at the realistic price; the military services on the other hand, have been afraid they couldn't afford them. So together we have kidded ourselves into believing that somehow we could beat down the development costs. It never happened! These new, sophisticated systems that are so important to our future defense will always be costly—at least in the development phase. We should be realistic about that. More importantly, we should be honest with ourselves and the Congress.





THE AIRLINE INDUSTRY LOOKS AHEAD

BY DR. GEORGE W. JAMES

Senior Vice President—Economics and Finance
The Air Transport Association

The picture for 1977 is encouraging with regard to traffic and earnings of the nation's scheduled airlines. Encouraging, yet paradoxically a matter of concern. The concern stems from the fact that the airlines face a massive re-equipment program; anticipated outlays for new aircraft in the decade of the 1980s will demand a total investment roughly four times the amount being spent in the seventies. Viewed in that perspective, the bright picture dims; although the scheduled carriers are making a good recovery from recent recession years, the current earnings level is inadequate to the needs of the coming decade.

Revenue passenger miles were up six per cent in the first seven months of 1977 over the same period in 1976 when the scheduled airlines carried a record 223 million passengers. However, overall costs in areas ranging from labor to fuel were up 8.7 per cent during the first half of 1977. Revenue gains were nearly outpaced by increases in unit costs; but productivity gains helped the industry's financial performance. Profits of the nation's scheduled airlines in 1977 should, therefore, approximate the \$563 million earned in 1976.

By 1990, the airlines will have to replace more than 75 per cent of their present fleet of 2,260 aircraft. This means an investment of about six billion dollars annually through the 1980s to buy at least \$60 billion worth of new aircraft. By way of comparison, the airlines acquired \$10 billion worth of new aircraft in the 1960s, and they will spend an estimated \$16 billion in the 1970s.

These estimates of new aircraft needs and the magnitude of the investment necessary to finance them are conservative. They are based on such conservative assumptions as 18 years of service life for aircraft and average annual inflation increases of only six per cent in the cost of new aircraft.

The aircraft will be needed to meet growth in the demand for air transport services and to take advantage of the technology that can produce aircraft that are quieter and more fuel-efficient.

ATA is projecting average annual growth rates through the 1980's of about five percent in revenue passenger miles and from six per cent to seven per cent in ton miles of freight service.

An average annual growth rate of five per cent in revenue passenger miles, for example, will mean that they will nearly double by 1987 and triple by the mid-1990's. Passenger enplanements per departing aircraft will more than double in the last quarter of this century.

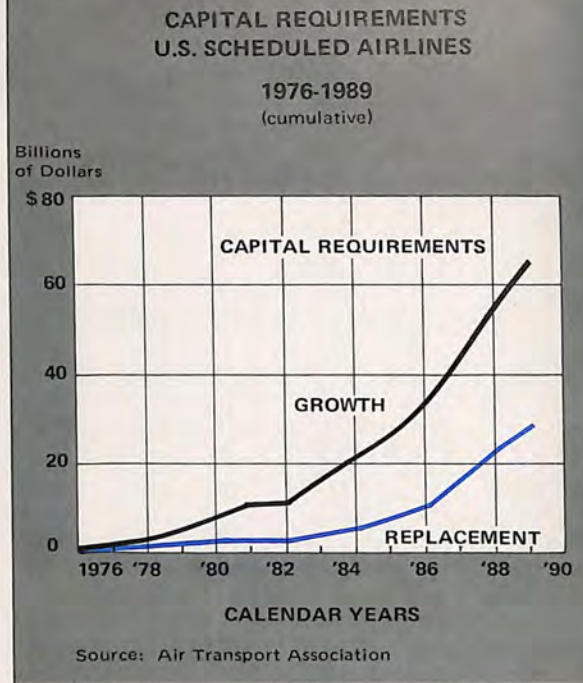
Consistent annual airline earnings substantially higher

than those of 1976 and 1977 will be needed to finance acquisition of enough new aircraft. Last year's airline industry profit margin of 2.6 per cent was about half what it should have been to achieve the necessary 12 per cent rate of return on investment established by the Civil Aeronautics Board. Such a 12 per cent rate of return on average will be needed annually throughout most of the rest of the century to obtain \$60 billion in new capital funds. Realizing a 12 per cent rate of return on investment in present years requires annual net earnings ranging from \$800 to \$900 million and, of course, will require even higher earnings as the investment base expands.

Meeting the industry's future investment needs will also require an improved and more efficient capital recovery program. The present tax structure relies upon useful life of equipment and does not recognize that the equipment's real value has been eroded by inflation. A change in depreciation accounting that recognizes the impact of inflation in providing for replacement of capital goods is needed.

Increases in the cost of buying and operating aircraft are already having an impact on the types of aircraft airlines buy. The quest is for more and more productive aircraft and this impact will become more pronounced. The airlines will become even more selective in technological investments.

Strong and wide-ranging research to achieve quieter and more fuel-efficient aircraft meeting airline needs for increased safety and productivity will become even more important than they are today. This is why the airlines believe the National Aeronautics and Space Ad-



ministration (NASA) should continue and expand its role in providing the technological base for these improvements.

Despite the growing importance of developing more fuel-efficient aircraft, airlines have not awaited technological breakthroughs to the neglect of self-help. Airline fuel conservation efforts began with the very onset of the fuel crunch in 1973 and, in the years since, few growth industries can match the fuel conservation success of the airlines with help from the engine and airframe manufacturers.

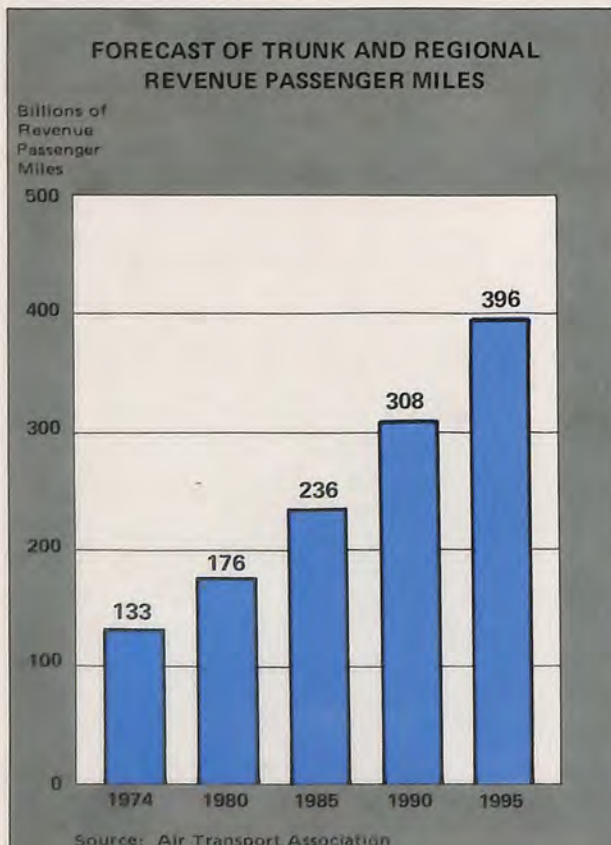
Consider the most recent evidence. In 1976, for example, the nation's airlines carried 21 million more passengers than in 1973 and they handled this additional demand while consuming 800 million gallons less fuel. These figures show that the airlines transported 10.4 per cent more passengers last year than in 1973, when the fuel crunch began, and that they did the job while consuming 7.5 per cent less fuel.

A number of innovative steps by the airlines contributed to the fuel conservation success. Some flights were eliminated. Greater use was made of flight simulators, in place of actual training flights. Computerized flight planning was used to get the aircraft from point to point with minimum fuel consumption. Slight reductions in speed, adding only a few minutes to flight times, were able to accomplish significant reductions in fuel consumption. And other fuel conservation measures have been found effective while aircraft were on the ground awaiting departure. These measures continue.

Legislation is now pending that would facilitate a more rapid replacement of older aircraft with quieter, more fuel-efficient aircraft. Although the legislation was proposed primarily because of the need to meet new federal noise standards, it would produce fuel savings that are equally important.

Here are some examples:

Replacement of the more than 400 B-707 and DC-8



aircraft still flying in airline fleets would do more than introduce a larger number of quieter aircraft. Such a replacement would also save 500 million gallons of fuel annually. And there is fuel-saving technology in the works that should be taken advantage of. By the mid-1980's, new airframe, wing and engine technology will enable airline aircraft to reduce fuel consumption per seat mile by 15 to 20 percent.

Airlines are deeply concerned about fuel prices because the pattern of their escalation in the recent past has had a profound impact upon the industry's operation costs and is likely to have an even more profound effect in the future. In mid-1973, fuel accounted for about 12 percent of the airlines' direct operating costs. Now it accounts for some 20 percent. Fuel that cost 11 cents a gallon in 1973 now costs more than 35 cents per gallon. And each penny increases in the price of a gallon of jet fuel has increased the industry's annual fuel bill by about \$100 million.

It is estimated that, by 1980, jet fuel prices will range between 50 and 55 cents a gallon. By the mid-1980's, according to some estimates, the price will be 75 cents. An upward movement in the price of jet fuel from 36 cents per gallon today to 75 cents a gallon in the mid-1980's would mean more than \$4 billion in additional costs for the same amount of fuel. Ways must be found to minimize this impact.

With fuel consuming a greater share of each airline revenue dollar, even greater strides must be made in fuel-efficiency—if sufficient earnings are to be retained to help airlines finance continued fleet modernization. As a promising long-term research and development approach to this problem, the airlines support the efforts of NASA's fuel conservation program for aircraft.

Aside from the challenges of finding an adequate supply of fuel at an affordable price and achieving improved airline financial performance, a number of other challenges must be overcome in meeting growth in demand for air transportation.

There is one other that involves not only the airlines, but also our airport authorities and our citizens living near airports. Airline traffic growth of the extent projected by most forecasts will strain the capacity of many existing airports and the airspace over and near these airports. It may outpace this capacity in some instances. This prospect arises at a time of increased opposition to building new airports and opposition even to building new runways at existing airports.

Existing airports must be maintained and improved to the maximum extent compatible with environment and cost effectiveness. Some new airports may be needed before the end of the century. Every possible option should be explored to get the most out of existing airports, however, before commitments are made to develop new ones.

Obviously, a number of formidable hurdles must be overcome to continue the airlines' record of high quality service at reasonable prices and to meet a growing demand for these services. Yet, there are grounds for an outlook of confidence.

Airlines have a record of overcoming challenges. With the help of constructive public policy, they can continue this record. It is in the national interest that they do so—to maintain the finest air transportation system the world has ever known.



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AEROSPACE INDUSTRIES ASSOCIATION

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The unparalleled capabilities of NASA's Space Telescope will extend man's scientific reach in probing the mysteries of distant galaxies. (See *Space Science—Investment in Tomorrow*, page 2).




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AEROSPACE
REVIEW
AND
FORECAST

1977

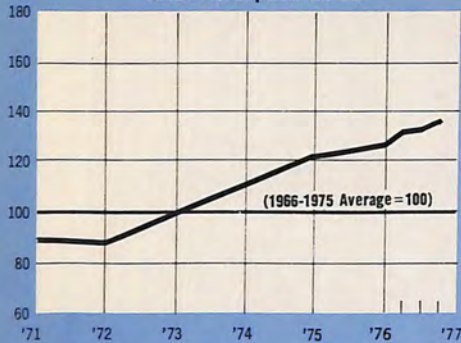


AEROSPACE ECONOMIC INDICATORS

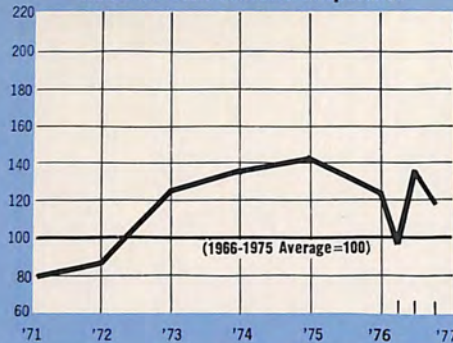
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OUTLOOK

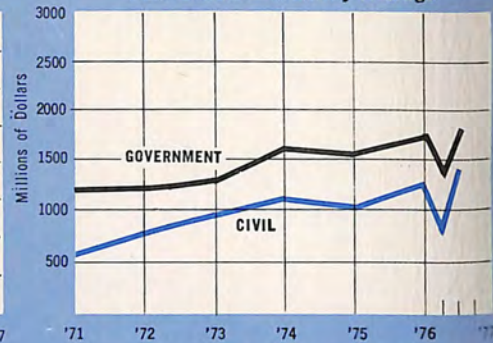
Total Aerospace Sales



Value of Civil Aircraft Shipments



New Orders — Monthly Average



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

ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD 3rd QTR. 1977
AEROSPACE SALES: TOTAL	Billion \$	Annually	26.6	30.4	31.8	32.6
	Billion \$	Quarterly	6.4	7.2	8.5	8.1
AEROSPACE SALES: TOTAL (In Constant Dollars, 1972=100)	Billion \$	Annually	27.3	22.6	22.6	22.6
	Billion \$	Quarterly	6.9	5.4	6.0	5.6
DEPARTMENT OF DEFENSE						
Aerospace obligations: TOTAL	Million \$	Quarterly	3,792	3,753	4,432	3,645
Aircraft	Million \$	Quarterly	2,361	2,312	3,147	2,281
Missiles & Space	Million \$	Quarterly	1,431	1,441	1,285	1,364
Aerospace outlays: TOTAL	Million \$	Quarterly	3,411	3,022	3,650	3,701
Aircraft	Million \$	Quarterly	2,031	1,972	2,367	2,202
Missiles & Space	Million \$	Quarterly	1,380	1,050	1,283	1,499
Aerospace Military Prime Contract Awards: TOTAL	Million \$	Quarterly	3,327	3,359	3,888	3,680
Aircraft	Million \$	Quarterly	2,109	2,129	2,821	2,418
Missiles & Space	Million \$	Quarterly	1,218	1,230	1,067	1,262
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million \$	Quarterly	780	750	835	541
Expenditures	Million \$	Quarterly	789	731	695	736
BACKLOG (70 Aerospace Mfrs.): TOTAL	Billion \$	Quarterly	28.6	37.0	39.5	39.5
U.S. Government	Billion \$	Quarterly	15.9	22.2	23.4	23.1
Nongovernment	Billion \$	Quarterly	12.7	14.8	16.1	16.4
EXPORTS						
Total (Including military)	Million \$	Quarterly	1,038	1,784	2,022	1,657
New Commercial Transports	Million \$	Quarterly	345	535	592	340
PROFITS						
Aerospace — Based on Sales	Percent	Quarterly	2.7	3.7	4.3	4.3
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	5.3	5.8	5.0
EMPLOYMENT: TOTAL	Thousands	End of Quarter	1,166	895	901	903
Aircraft	Thousands	End of Quarter	650	483	487	488
Missiles & Space	Thousands	End of Quarter	114	84	81	81
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	End of Quarter	4.38	6.51	6.89	7.05

* 1966-1975 average is computed by dividing total year data by 4 to yield quarterly averages.
† Preceding period refers to quarter preceding latest period shown.



1978: MILESTONE YEAR

In the coming year, you will be seeing a lot of the emblem shown above, the Department of Transportation's symbol for powered flight's diamond anniversary. The circular area represents the world, divided into two hemispheres; in the center, the Wright Flyer is superimposed on the outline of a modern jet. The emblem signifies the impact on the world of the extraordinary progress achieved in aviation's 75 years.

Flight's diamond anniversary is one of a number of notable aerospace milestones to be commemorated in 1978. Among others are the 70th anniversary of military aircraft development, the 20th anniversary of American space flight, and the 20th anniversary of the first commercial service by U.S.-built jetliners.

On December 17, 1903, Orville and Wilbur Wright made not just one flight but four, each of greater duration than the previous one. The accomplishments of that memorable day at Kitty Hawk set a theme for the story of flight—ever farther, ever faster, ever higher, ever improving efficiency of flight vehicles as the pace of aerospace progress steadily accelerated.

Seventy years ago, in February 1908, the Signal Corps of the U.S. Army contracted with the Wrights for the first military airplane, which was demonstrated in 1908 although not formally accepted until the following year.

A half century later, a new aerospace era began with the launch, under military auspices, of the first U.S. spacecraft on January 31, 1958. Underlining the American intent to emphasize peaceful applications of space, President Eisenhower signed—on July 29, 1958—the National Aeronautics and Space Act. Just two months later—on October 1—the National Aeronautics and Space Administration officially commenced operation.

In that same month—October 26, 1958—came still another aerospace milestone when the first American jet transport, the Boeing 707, went into regular airline service with Pan American World Airways.

These multiple anniversaries serve as reminders of the leading role the United States, its aerospace and airline industries, its military services and its space agency, have played in advancing aviation and space technology and utility. On this diamond anniversary of flight, Aerospace Industries Association extends a salute to the thousands of American aerospace pioneers who followed where the Wrights led; their efforts have enhanced world security, improved the global pattern of commerce, and provided a foundation for the forthcoming era of expanded space benefits.



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CONTENTS

2 AEROSPACE REVIEW AND FORECAST 1977

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

6 AEROSPACE HIGHLIGHTS: 1977

By JAMES J. HAGGERTY
Associate Editor, Aerospace Magazine

12 PRIVATE ENTERPRISE

Alive And Well...Or Losing Ground?

15 PROFIT IS NOT A DIRTY WORD II

16 AEROSPACE PERSPECTIVES

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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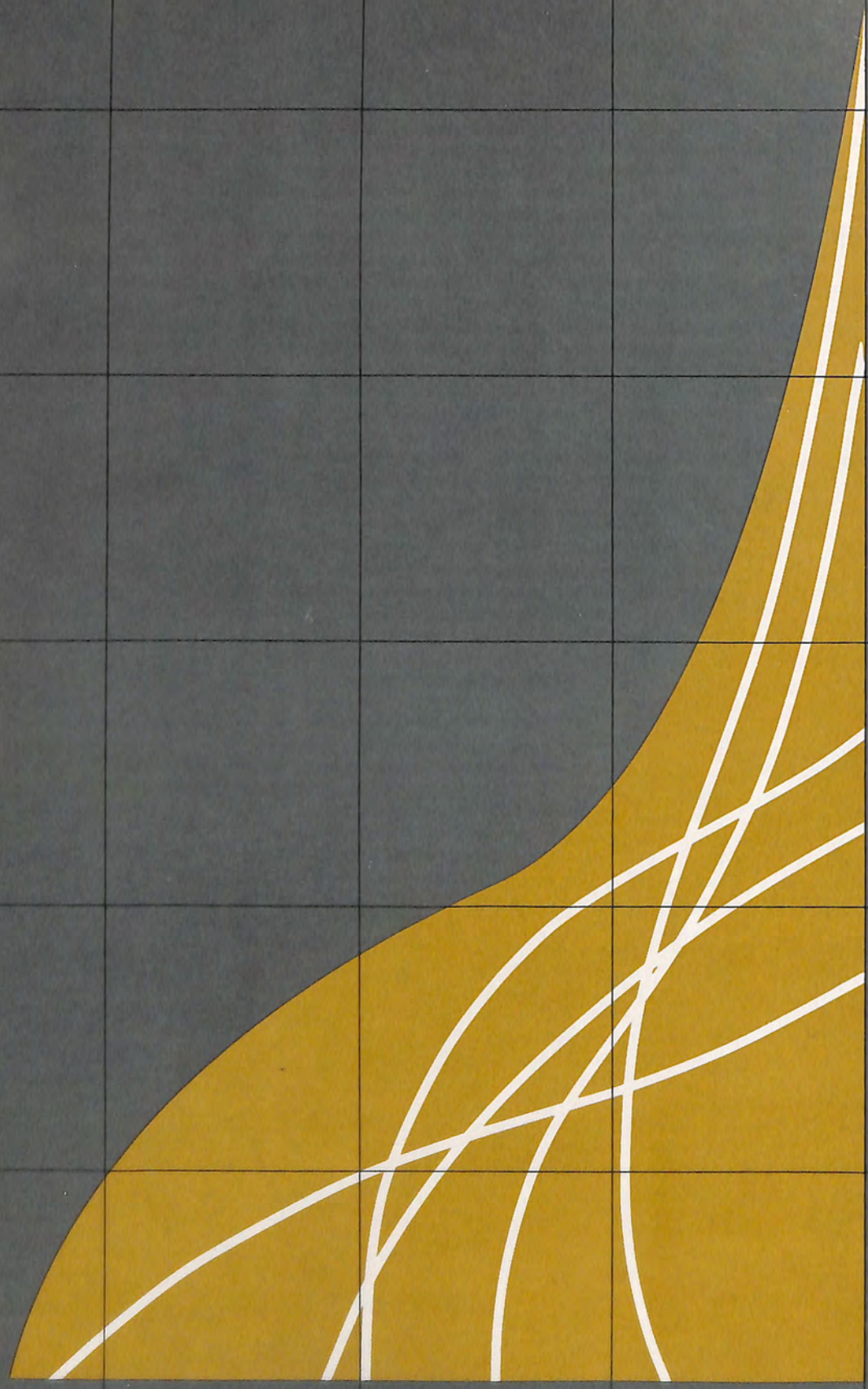
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Aerospace

Review

**and
Forecast**

1977





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

The year 1977 was a good year in terms of aerospace industry sales and earnings, which increased appreciably but not dramatically in comparison with the previous year.

Statistically, 1977 was a record year. It is perhaps superfluous, yet essential to proper perspective, to point out that the record is tainted by the fact that inflation accounted for most of the sales gain. Still, sales increased at a rate slightly greater than the inflation rate and in constant dollar sales volume, 1977 was the best year of the last four.

Profit as a percentage of sales climbed half a percentage point, but remained below the average for all U.S. manufacturing industries.

For 1978, the industry anticipates sales gains of similar proportions. Space activity is expected to continue at approximately last year's level, military sales should top 1977's, and increased deliveries of commercial transports are predicted. These factors indicate another record year, with inflation again accounting for most, but not all, of the dollar volume gain.

So, actual and predicted sales for 1977 and 1978 represent a new upturn in what has been a mildly fluctuating, more or less flat activity curve throughout the seventies. Using the constant dollar scale, 1978 promises to be the aerospace industry's best year since 1970.

Looking farther down the road, the crystal ball clouds, misted by a number of uncertainties, many of them involving government decisions that will determine the industry's posture for years to come.

For example, there is the question of whether the U.S. will be able to maintain its economically-important world leadership in commercial transport sales. There are many reasons for concern.

Foreign manufacturers are more competitive than ever. They enjoy an advantage over their American counterparts—they have the backing of their governments in their attempts to capture a larger share of the international market. Because of government provided subsidies, they are in many instances able to offer more attractive deals to the potential customer. There is also the matter of government-directed procurement, wherein a government tells its government-operated airline what airplanes it will buy, regardless of merit or airline desire.

The industry looks for help in such areas from the General Agreement on Tariff and Trade (GATT) negotiations now in progress. The aerospace industry, virtually alone among American industry, is pressing for elimination of all tariff and non-tariff barriers to free and fair trade. Whether or not our government negotiators support that position will have crucial bearing on the industry's ability to maintain its commercial transport leadership.

A new uncertainty has entered the export sales equation: an initiative by the Administration to control "strategically critical" technology, or keeping advanced technologies out of the hands of nations which might someday use them against us. The aerospace industry supports the principle, but it cannot help be concerned about the possibility

of new restrictions on transport sales and other products sold abroad. For example, would new controls prohibit the sale of a commercial transport overseas because the airplane's equipment contains technology considered strategically critical? Imposition of a new layer of technology controls on top of existing product controls could severely impact the industry's export sales.

In the area of military aerospace hardware, the industry's status will be strongly affected by a number of decisions before the Administration and the Congress—the SALT negotiations, for example, and final resolution of the nation's defense structure, particularly the manned element of the Triad defense system.

A related issue is the matter of foreign military sales. The Administration has stated its intent to curtail such sales, but the degree of curtailment and the policy regarding limitations is not clear. No one can quarrel with the moral principles involved, but the issue is complex. There is the demonstrated eagerness of other nations to fill sales gaps created by U.S. refusal to sell arms abroad, together with other complicating factors: diplomatic pressures exerted by buying nations, who want the best weapon systems available; the U.S. national balance of trade, which would be further eroded by reduction of foreign military sales; the domestic jobs involved during a period of high unemployment; and the advantages to the U.S. in terms of its own weapons procurement costs, which are lowered by the broader production required to meet foreign needs.

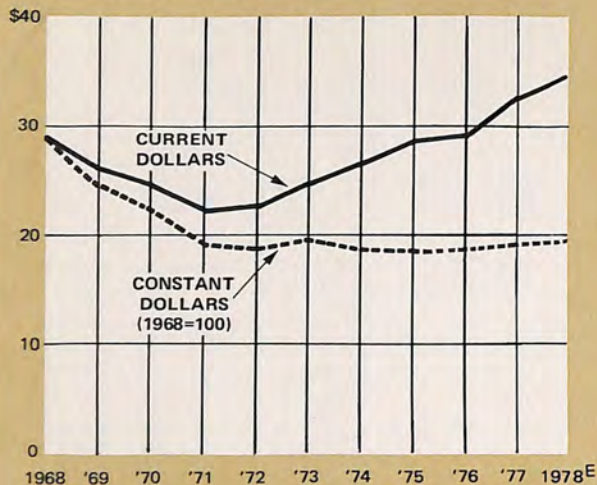
The outcome of several other issues before Congress and the Executive Branch will bear heavily on the aerospace industry's ability to maintain its technological superiority. A key element in that regard is solving the industry's capital formation dilemma, a problem shared by all American industry but one that is particularly acute for the high technology aerospace industry. Among the matters affecting the industry's capital formation capability are the level of government investment in research and development, government policies toward independent research and development, the nature of tax reform legislation, and recognition by the government of the need for depreciation policies appropriate to the risks involved in high technology operations.

Other matters which bear on industry efficiency and earnings are the problems inherent in doing business with the government, such as renegotiation, overregulation, expanding paper work and government competition with industry.

Decisions on many of these matters will—or at least *should*—be made this year. Such decisions will provide the key to the nation's aerospace future. They are decisions of importance to everyone, since they will significantly affect both the economic well-being and the national security of the country; negative decisions could lead to forfeiture of the pre-eminent position the U.S. has long held in high technology.

AEROSPACE INDUSTRY SALES

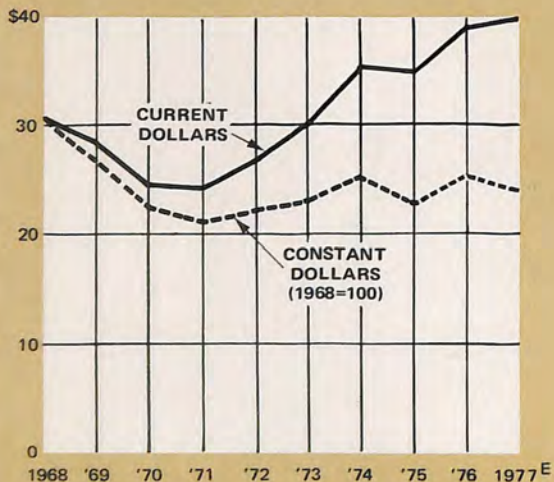
(Billions of Dollars)



E - Estimated

AEROSPACE INDUSTRY BACKLOG

(Billions of Dollars)



E - Estimated

SALES AND EARNINGS

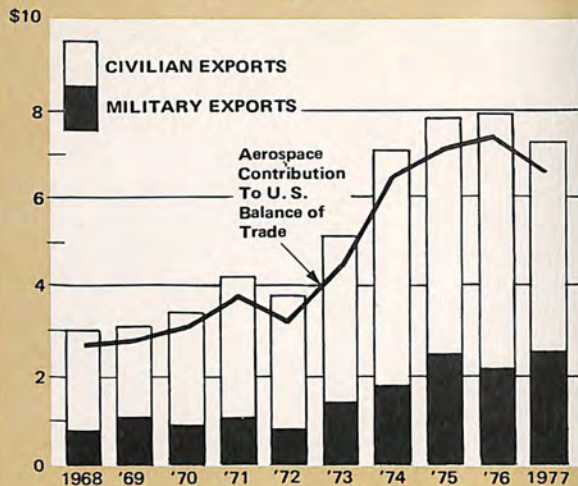
Aerospace industry sales in 1977 totaled \$32.4 billion, up \$2.4 billion over the previous year. Inflation accounted for much, but not all, of the gain. In terms of inflation-adjusted constant dollars, using 1968 as the base year, sales increased by some \$500 million. Constant dollars sales, however, were almost \$10 billion below the sales volume of 1968, the industry's peak year.

Profits as a percentage of sales amounted to four percent, up from 3.5 percent in 1976. Backlog at year-end was more than \$40 billion, up slightly over 1976. In constant dollar terms, backlog was below the 1976 year-end level.

Industry estimates for 1978 indicated another increase of approximately the same order as the 1977 gain. Higher levels of military activity and commercial transport sales were expected to boost total sales to \$34.9 billion, an increase of \$2.5 billion over 1977.

AEROSPACE EXPORTS

(Billions of Dollars)



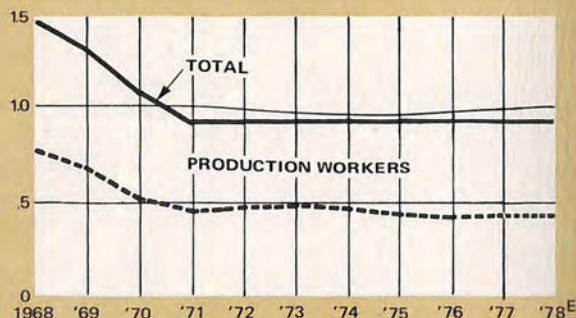
EXPORTS

Aerospace exports remained above the \$7 billion level for the fourth straight year, but they dropped some \$600 million below the previous year. The major decline was in commercial transport shipments abroad; the dollar value of transport deliveries fell about \$700 million, from \$2.5 billion in 1976 to \$1.8 billion in 1977.

Once again the aerospace industry made an important contribution to the international trade balance, recording an aerospace trade surplus of \$6.5 billion. However, the aerospace trade balance was about \$700 million below the all-time record set in 1976.

AEROSPACE EMPLOYMENT

(Millions of Employees)

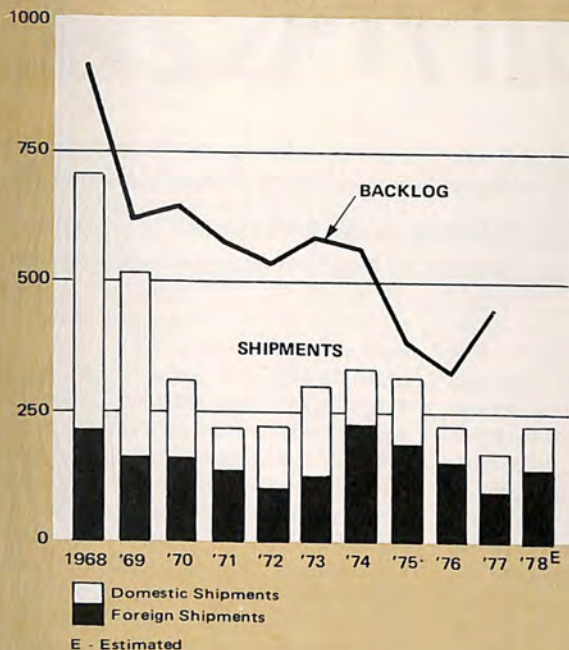


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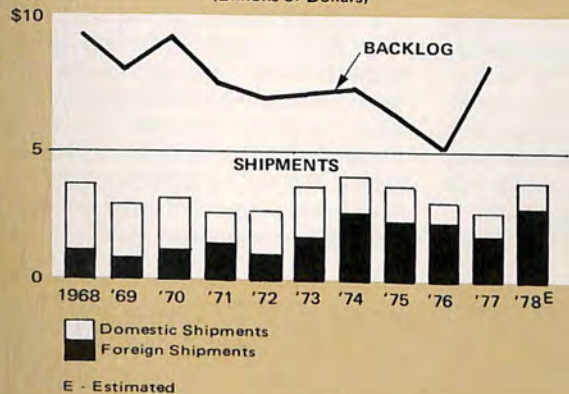
EMPLOYMENT

Aerospace industry employment dropped for the third straight year, but the decline was moderate—5,000 people, or a fraction of one percent—as cancellations, program revisions and some expansions more or less balanced out. Year-end employment was 893,000. Estimates for 1978 indicated another slight drop, to 890,000.

COMMERCIAL TRANSPORT SHIPMENTS AND YEAR-END BACKLOG UNITS



VALUE (Billions of Dollars)



COMMERCIAL TRANSPORT SALES

Sales of commercial transport aircraft continued to decline, as they had in the two preceding years; the decline was due in part to strikes at the plants of two of the three major transport manufacturers. In 1977, the industry delivered 185 transports with a total value of \$2.9 billion; this compares with 1976 deliveries of 238 planes valued at \$3.1 billion. About half of the 1977 deliveries went to foreign customers.

AIA estimates indicate that the declining trend has bottomed. Improving financial status of U.S. and foreign airlines brought a substantial upsurge of new orders in 1977 and backlog climbed to \$8.4 billion; that compares with \$5 billion at the end of the previous year. The industry forecast 1978 transport sales of \$3.8 billion, an increase of almost \$1 billion over 1977.

Federal Research and Development

President Carter's proposed Fiscal Year 1979 budget would arrest the trend of recent years toward declining government spending on research and development. The budget proposes R&D outlays by 29 federal agencies totaling \$28.4 billion, up \$2.2 billion from the current fiscal year; this represents a percentage increase of more than eight percent and amounts to real growth, above the inflation rate, if the year's inflation matches present levels.

The budget emphasizes basic research in such areas as defense, environment, energy and agriculture. Basic research, at \$3.5 billion, would increase nearly 13 percent.

In those areas primarily affecting the aerospace industry, defense R&D would increase by more than \$1 billion (almost nine percent) and NASA's space/aeronautics R&D gain would amount to \$300 million (more than nine percent). Here are the defense and NASA breakdowns:

DOD RESEARCH, DEVELOPMENT, TEST AND EVALUATION BUDGET PLAN

(Millions of dollars)

	FY 1977	FY 1978	FY 1979
Technology base	\$ 1,678	\$ 1,797	\$ 2,000
Advanced technology base	528	487	593
Strategic programs	2,328	2,536	2,178
Tactical programs	3,872	4,383	5,051
Intelligence and communications	795	828	1,095
Programwide management and support	1,387	1,382	1,551
TOTAL	\$10,588	\$11,413	\$12,468

Source: Department of Defense FY 1979 Budget Briefing

NASA RESEARCH AND DEVELOPMENT BUDGET PLAN

(Millions of Dollars)

	FY 1977	FY 1978	FY 1979
Space Shuttle	\$ 1,413.1	\$ 1,349.2	\$ 1,439.3
Space flight operations	199.2	267.8	311.9
Expendable launch vehicles	151.4	134.5	76.5
Physics and astronomy	166.3	224.2	285.5
Lunar and planetary exploration	191.9	147.2	187.1
Life science	22.1	33.3	40.6
Space applications	198.2	234.8	274.3
Technology utilization	8.1	9.1	9.1
Aeronautical research/technology	190.1	228.0	264.1
Space research/technology	82.0	97.7	108.3
Energy technology applications	6.0	7.5	3.0
Space tracking and data systems	255.0	278.3	305.4
TOTAL	\$ 2,883.4	\$ 3,011.6	\$ 3,305.1

Source: NASA FY 1979 Budget Briefing

Energy research and technology development, at \$2.7 billion, is budgeted at approximately the level of the current fiscal year, with increases in some areas offsetting declines in others. Major funding increases are contemplated for nuclear research and applications, basic energy science, coal and geothermal energy R&D.

AEROSPACE

1977

First flights of NASA's Space Shuttle Orbiter, launch of two Voyager spacecraft toward the outer reaches of the solar system, major changes in defense programming and a record year for the nation's airlines—these are among the highlights of the aerospace year 1977.

SPACE

Last August 12, a unique "piggyback" flight system took to the air at Dryden Flight Research Center in California's Mojave Desert. It consisted of NASA's Space Shuttle Orbiter, the *Enterprise*, perched atop a modified Boeing 747 carrier aircraft. At 24,000 feet, explosive bolts separated the two craft and the *Enterprise* flew to an unpowered landing on a dry lake bed. The glide flight took only five minutes 22 seconds, but it ranked as the year's most significant flight because it marked the beginning of a new era of space capability.

Built by Rockwell International, the Orbiter is the manned segment of the Space Transportation System, which also includes two solid rocket boosters and a huge external fuel tank. At launch, the Shuttle is powered by the two boosters and by the Orbiter's three main rocket engines, which draw their fuel from the big tank. After the boost

phase, the solid rockets are released to descend by parachute for recovery and re-use; the tank is jettisoned and not recovered. The Orbiter continues into space for missions up to 30 days, then returns to an airplane-like Earth landing. By eliminating the need for costly single-use launch vehicles, the Shuttle system offers routine and economical access to space for a variety of purposes: delivery of satellites to orbit, servicing payloads in space, retrieving them for rework on Earth, acting as a construction vehicle for erection of large structures in orbit, or serving as a transportation link to manned orbiting scientific or manufacturing facilities.

Following its initial glide checkout, the *Enterprise*, first of several Orbiters planned, made four additional free flights. All were successful and that concluded the landing test phase. In March of this year, the 747 will piggy-

back the Orbiter to Marshall Space Flight Center, Huntsville, Alabama, for extensive ground testing. Orbital proving flights of the complete Shuttle system will begin in 1979 and the Shuttle will start operational service in 1980.

In August and September, NASA continued its systematic program of planetary exploration with launches of two Voyager spacecraft on endless journeys through and beyond the solar system. They will fly by and examine the giant planet Jupiter in 1979, then travel to Saturn for encounters with the ringed planet in 1980-81. If all goes well, Voyager 2 will be targeted toward distant Uranus, reaching that seventh planet from the sun in 1986. After that, both Voyagers will escape the solar system entirely and drift in interstellar space indefinitely.

Another important space science project reached flight status in 1977



HIGHLIGHTS:

By JAMES J. HAGGERTY

with the launch of the first of three High Energy Astronomy Observatories. Boosted into space on August 12, the two-ton HEAO-1 was the heaviest unmanned spacecraft ever orbited by NASA. Its assignment, like that of the two companion craft to follow, is study of some of the most intriguing mysteries of the universe—pulsars, quasars, exploding galaxies and the scientifically-exciting "black holes," believed to be collapsed stars so gravitationally forceful that even light waves are unable to escape, with the result that all external evidence of the star has disappeared.

The other NASA payloads launched in 1977 were a pair of International Sun-Earth Explorers, launched by a single rocket on October 22. The ISEEs are part of a joint NASA-European Space Agency project aimed at better understanding of how the sun influences solar-terrestrial phenomena, such as weather and climate, energy production and depletion of ozone in the atmosphere.

Of 13 successful NASA launches during the year, nine were in the reimbursable category, wherein payload sponsors pay NASA launch costs. Four of these were communications

satellites, including NATO-3B, the second stationary-orbit spacecraft in the North Atlantic Treaty Organization's communications system; Palapa-2, a back-up satellite for the Indonesian space communications network; the Hughes-built Intelsat IVA-F-4, an addition to the global commercial communications system; and a Japanese satellite designed to relay telephone and color television transmissions.

Also launched were three weather satellites, one each for Japan, the European Space Agency and the U.S. National Oceanic and Atmospheric Administration. The remaining NASA launches included the Italian Sirio-1 scientific satellite and a U.S. Navy Transat navigation satellite.

Among the major space development programs in progress during 1977 were Spacelab, a human-habitable space laboratory, the first of which is to be launched in 1980 aboard the Shuttle Orbiter; Project Galileo, an orbiter probe spacecraft which will depart Earth in 1982 for an extensive survey of Jupiter; and the Space Telescope, which will permit observations far deeper into space than has ever before been possible. The latter

system will be Shuttle-launched in 1983.

For 1978, NASA has scheduled 25 launches, 15 of them reimbursables and the rest NASA's own payloads, equally divided between scientific and applications systems for direct Earth benefit. Among the more important are the third of the General Electric-built Landsat series of Earth resources monitoring satellites; Pioneer Venus, a two spacecraft team designed to provide the clearest photos yet of Earth's sister planet; Seasat-A, which will conduct global studies of ocean phenomena; and HEAO-B, second of the High Energy Astronomical Observatories.

Continuing in development during the year was the NavStar Global Positioning System, the principal space program of the Department of Defense. Being developed by General Dynamics and Rockwell International, NavStar is a global system of satellites and ground equipment designed to provide precise positioning and other information for more effective operation of aircraft, artillery, ships, and tanks. It is scheduled for operational service in the mid-1980s.

1. NASA's Shuttle Orbiter *Enterprise* completed the landing phase of its test program in 1977.

2. In August and September, NASA launched two Voyager spacecraft for investigation of Jupiter, Saturn and Uranus. Artist's concept depicts Voyager flying by Saturn.

3. Shown mated together, ready for dual launch, are two International Sun/Earth Explorers, part of a joint NASA/European Space Agency program. The satellites were successfully orbited in October.

4. In development and scheduled for 1978 launch was Seasat-A, an ocean-monitoring satellite.



A major change in defense programming for the 1980s occurred in July, 1977 when President Carter announced a far-reaching decision: the Air Force B-1 bomber, under development for several years by Rockwell International and associated contractors, would not be ordered into production.

Instead, the President said he would direct accelerated development and eventual operational deployment of air-launched, sea-launched and ground-launched cruise missiles. Additional alternatives to be explored included life-extending modifications to the existing fleet of Boeing B-52s, possible conversion of the General Dynamics FB-111 bomber as a strategic penetration system, and the potential of transport aircraft as stand-off missile launchers.

Cruise missiles in development during the year included the Boeing Air Launched Cruise Missile and the General Dynamics Tomahawk; both were in flight test status. The Boeing weapon is to be launched from B-52s; the Tomahawk is designed for launch from submarines, surface ships and aircraft; in early development was an additional version to be ground launched. At year-end, the Department of Defense initiated a series of tests to determine how effective cruise missiles are against modern air defense systems, including high performance aircraft and surface-to-air missiles.

In the ballistic missile category, the Navy's Lockheed-built Trident 1 sub-launched missile began its flight test program in January. The missile scored nine successful flights in as many attempts during the year, impacting targets some 4,000 miles down the Atlantic Missile Range from the launch point at Cape Canaveral, Florida.

The Air Force's Boeing Minuteman III ICBM continued in production. In operational status at year-end were 550 Minuteman IIIs and 450 Minuteman IIs. In development was Minuteman's planned successor, the MX mobile intercontinental missile, a multiple-warhead strategic weapon system designed for greater accuracy and survivability.

In advanced flight test status was the Army's Patriot air defense system, being developed by Raytheon Company with Martin Marietta Aerospace as principal subcontractor for the missile portion of the system. In tests at White Sands Missile Range, New Mex-

ico, the Army was investigating the Patriot system's ability to operate against electronic countermeasures. In November, the first mobile tactical equipment produced for the Patriot was successfully tested. DOD plans called for initial production funding in Fiscal Year 1979 and operational service in the 1980s.

Among DOD aircraft developments, the Air Force's General Dynamics F-16 fighter reached a flight test milestone in November with first firings of air-to-air missiles at China Lake, California. Slated for first operational service in 1980, the F-16 will eventually become the bulwark of NATO air superiority forces as well as a primary Air Force fighter. At year-end, the F-16 was in production at General Dynamics and initial European co-production was slated for 1979.

Also in development was the Navy F-18 Hornet fleet air defense and air superiority fighter, which was scheduled for production under FY 1979 funding. Prime contractor is McDonnell Douglas Corporation and Northrop Corporation is the major subcontractor.

Continuing in production and advanced development status during 1977 were DOD's two high performance air superiority fighters, the Navy/Grumman F-14 Tomcat and the Air Force/McDonnell Douglas F-15 Eagle.

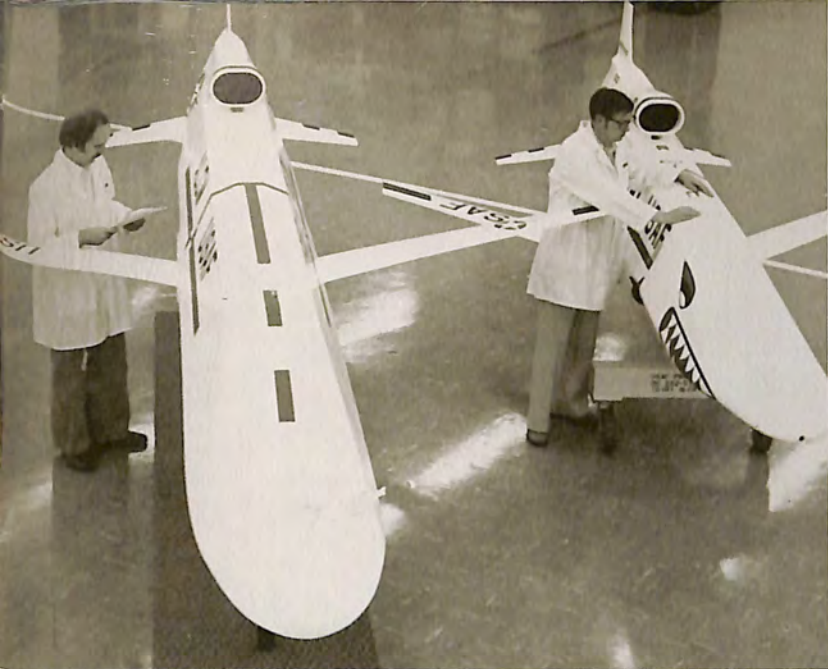
Among other DOD aircraft programs in development or production during the year were:

- The Air Force EF-111A, a tactical airplane designed to counter enemy air defense systems by electronic jamming. The plane is a modification of the General Dynamics F-111A; Grumman Aerospace Corporation is prime contractor for the program.
- The USAF's Advanced Tanker/Cargo Aircraft (ATCA), a derivative of the McDonnell Douglas DC-10 commercial transport, which will provide added capability for both long-range in-flight refueling and transportation of oversize cargo.
- The Air Force/Boeing E-3A Airborne Warning and Control System (AWACS), designed to overcome the limitations of ground-based radar by air deployment of long-range jamming-resistant radars. First production models were delivered in 1977.
- The Navy's Light Airborne Multi-Purpose System (LAMPS), a ship-based manned helicopter to be employed as a localization and attack



vehicle under the tactical control of the parent ship. IBM Corporation is prime contractor for the system; in September, Sikorsky Aircraft Division of United Technologies was selected for development of the helicopter.

- The Army/Sikorsky UH-60A Black Hawk helicopter, designed to airlift an infantry squad for tactical assaults and related combat support missions.
- The Army/Hughes YAH-64 Advanced Attack Helicopter, slated to be the backbone of the Army's anti-armor/anti-personnel helicopter force of the future. Also in development, by Rockwell International, was the Hellfire heliborne missile, the anti-armor weapon system for the YAH-64.
- The Air Force's Advanced Medium STOL Transport (AMST). Basic flight testing of two competing prototypes—Boeing's YC-14 and the McDonnell Douglas YC-15—was completed in 1977.
- The Navy/Rockwell XFV-12A V/STOL aircraft, which was delivered in November to NASA's Langley Research Center for ground checkout preparatory to first hover tests in 1978.



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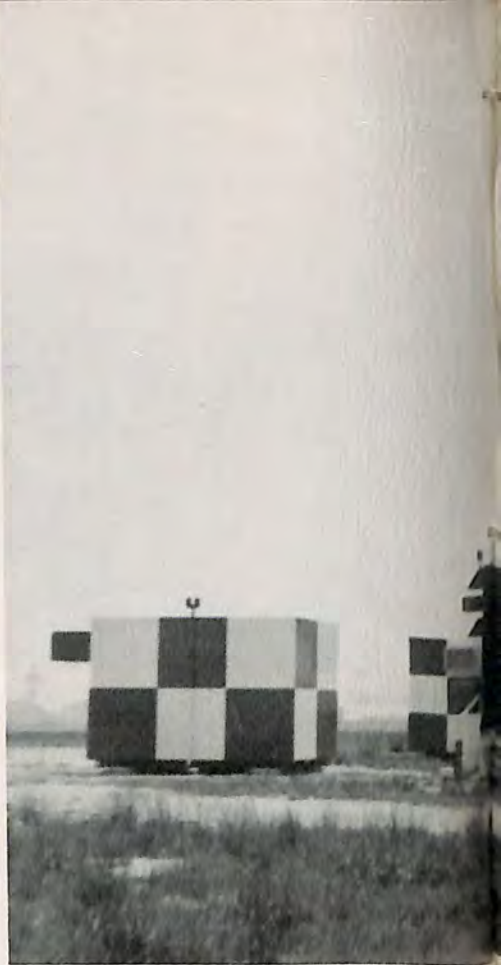
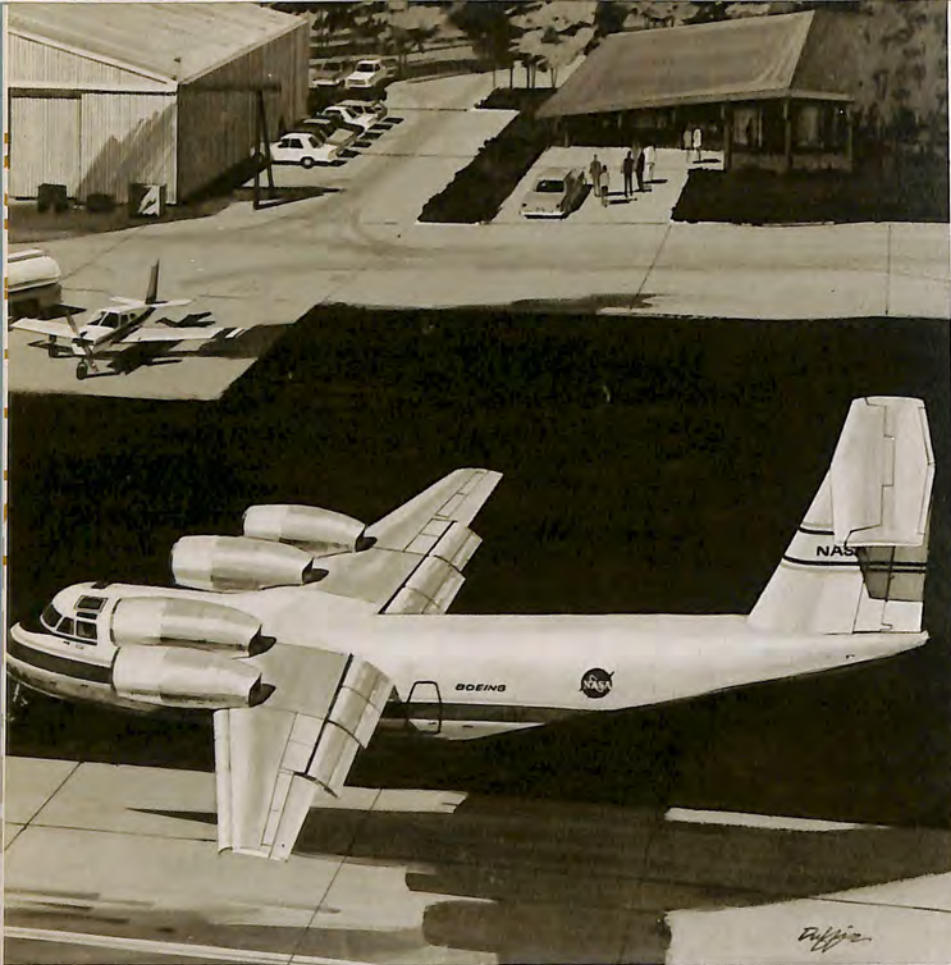
1-2. Cruise missiles in 1977 development included the Navy Tomahawk, shown at left in its first underwater launch, and the USAF Air Launched Cruise Missile.

3. The Navy's Trident 1 submarine-launched ballistic missile scored nine successes in as many test flights during 1977.

4-5. Two military fighters—the USAF F-16 (top) and the Navy Hornet were in advanced development during the year. The Hornet is shown in two versions: top, the F-18 fighter and below, the A-18 attack aircraft.

6. In September, the Navy selected a Sikorsky design as the helicopter component of the Light Airborne Multi-Purpose System, a ship-based antisubmarine system.

7. Shown at August roll-out ceremonies is the Navy's XFV-12A V/STOL aircraft, slated for initial hovering tests early in 1978.



CIVIL AVIATION

For the nation's scheduled airlines, 1977 was a year of record-breaking performance as the industry's traffic and earnings reached all-time highs.

Passenger traffic rose about eight percent above the previous record year of 1976. U.S. airlines boarded some 240 million passengers in 1977 and accounted for more than 80 percent of all public intercity passenger miles. The Air Transport Association predicted that air travel would grow another five to six percent in 1978.

ATA estimated 1977 earnings between \$700-\$800 million on total revenues of \$19 billion, which amounts to a profit ratio of about 3.5 percent on sales. However, earnings were well below the level necessary to meet capital investment needs for near-future years. ATA stated a need for a level of five percent on sales in coming years to finance an estimated \$60 billion in expenditures for new equipment in the decade of the 1980s. The association predicted 1978 revenues of \$20 billion.

In 1977, the airlines experimented

with a variety of domestic and international discount fares which provided new impetus to mass air transportation. A 1977 study showed that 63 percent of all adult Americans have now flown on commercial airlines.

At year-end, the U.S. scheduled airline fleet numbered 2,300 aircraft. Together with supporting facilities and ground equipment, this represented an investment of about \$21 billion. Industry employment, after a dip in recent years, expanded to more than 300,000. Average total compensation per employee was about \$25,000, one of the highest averages of all U.S. industries.

NASA's civil aviation research program during the year focused on ways to reduce aircraft fuel consumption. Energy efficiency improvements were being sought through research on engines, aerodynamic shapes, computerized flight control systems and lighter aircraft structures. In a related program, NASA continued its "clean and quiet" research effort designed to improve the environmental charac-

teristics of current and future aircraft. A flight project scheduled for initial test in 1978 is the Boeing-developed Quiet Short-haul Research Aircraft (QSRA), a modified STOL transport featuring exceptionally low noise levels. Also in development during the year were the Quiet, Clean Short-haul Experimental Engine and the Quiet, Clean General Aviation Turboprop.

In 1977, NASA was conducting—jointly with the Army—two vertical lift research projects, both in flight status. The Sikorsky S-72 Rotor Systems Research Aircraft (RSRA) is a heavily instrumented flying laboratory designed to test a variety of new rotor systems and to investigate characteristics of the compound helicopter. The Bell Helicopter Textron XV-15, flown for the first time in 1977, is a tilting-rotor research aircraft to explore in-flight conversion, in which the rotors provide helicopter-like vertical lift for take-off, then tilt forward to operate like propellers in conventional flight.

During the year, commercial transport manufacturers were planning de-



1. Among NASA's aeronautical research projects active in 1977 was the Quiet Short-haul Research Aircraft, scheduled to begin flight test in 1978.

2. In photo, the tall structure is a currently-used Instrument Landing System (ILS) antenna; the boxes at left are antennas for the Federal Aviation Administration's new Microwave Landing System, designed to replace ILS and provide greater reliability and precision. FAA's version of the Microwave Landing System, known as the Time Reference Scanning Beam system, won the recommendation of an International Civil Aviation Organization panel for worldwide standardization. Final ICAO selection of a standard system is expected in April.

velopment of derivative versions of existing jetliners for near-future introduction and also conducting design studies of more advanced transports. In the commercial helicopter field, Sikorsky's S-76 12-passenger twin-turbine helicopter was undergoing Federal Aviation Administration certification tests and the company reported orders of 123 S-76's from 37 customers; first deliveries were planned for mid-1978. Bell Helicopter Textron reported options for 120 of its new Bell 222 6-10 passenger twin-turbine helicopter. Five prototypes were flying in 1977 and flight test hours topped the 1,000 mark. Initial deliveries were scheduled for September 1979.

The Federal Aviation Administration reported that U.S. aviation reached new peaks of air traffic activity during Fiscal Year 1977. FAA's air route traffic control centers handled 25.9 million aircraft flying under instrument flight rules, topping the previous year's count by 8.4 percent. Aircraft takeoffs and landings as reported by FAA airport traffic control

towers totalled 66.7 million, an increase of 6.7 percent over 1976. Instrument operations alone totalled 31.7 million, up from 28.1 million.

FAA's program to introduce a high level of automation at 20 centers in the contiguous United States and 63 of the nation's busiest terminal areas was completed and the agency initiated a program to enhance the capability of the new automated system.

One of the more significant projects was the Minimum Safe Altitude Warning System (MSAWS), which enhances the automation capability of the Automated Radar Terminal System (ARTS-III). MSAWS receives surveillance and altitude data from properly equipped aircraft being tracked by air traffic control. This information is compared with highest points-of-ground-elevation data contained in a terrain map stored in the terminal computer memory. When an aircraft is flying too low, MSAWS provides the controller with both an aural and a visual alert; the controller in turn issues a radio warning to the pilot that he has descended

below a minimum safe altitude. MSAWS became operational at all 63 ARTS-III terminals during fiscal 1977.

In continuing development during the year was the Microwave Landing System (MLS), designed to replace the present Instrument Landing System (ILS) and provide improvements in reliability and precision. FAA's version of the Microwave Landing System is known as TRSB, for Time Reference Scanning Beam system; it is being developed by a team headed by The Bendix Corporation and Texas Instruments. Along with competing systems developed by other countries, TRSB was submitted to the International Civil Aviation Organization as a candidate for international standardization. After an assessment, ICAO's All Weather Operations Panel recommended to the Air Navigation Commission that TRSB be adopted as standard. The recommendation was forwarded to the worldwide ICAO/All Weather Operations Division, which is expected to make a selection at an April 1978 meeting.

PRIVATE ENTERPRISE

alive and well... or losing ground?

Americans generally have faith in their economic system, which is based on the idea of private property: that is, individual businesses competing with each other to sell their goods and services. On the other extreme, is a government monopoly of business, which we know as socialism. However, private enterprise means different things to different people. In a series of spontaneous interviews, Sundstrand Corporation's *Spectrum Magazine* asked a number of its employees to talk about their notion of private enterprise, its importance, and its health today. *Aerospace Magazine* is pleased to reprint their interesting and noteworthy views.



Albert King, *Reliability Analyst*,
Aviation, Rockford

I guess the amount of acceptable government intervention would depend on who you are. If I were chairman of the board of a large business, I'm sure I'd feel over-regulated and pressured. From the point of view of a customer, I'd say the government is superficially doing a fine job of regulating, but isn't enforcing its controls very well. For example, environmental clean-up is a good idea, but I think the government is too liberal there, in letting companies continue to get away with high pollution.

Yet, in Russia, for instance, where the government controls everything, the people have given up their freedom of choice. With freedom comes responsibility. Under private enterprise we have freedom of choice, and it's our responsibility to keep it. If I had a product or service to sell that was necessary, and fairly priced, I'd succeed. If I couldn't stay in business, I should be allowed to die a natural death. But in reality, the government keeps stepping in to "save" certain businesses. Sometimes, I agree, government intervention is a necessary evil, but I don't like to see much of it. It creeps toward socialism, which is bad economically, and is a reason for our high inflation rate.

With all our faults, this is the best place I know of to live. I'll probably start talking about the glories of motherhood and apple pie in another minute, but I truly believe the ultimate power is still in the American individual, as a consumer and as a voter.

Frankly, we need a good government; being Black in America, I'm not sure I should have talked to you in this way without the government having helped get me where I am today.

We have to remember that as consumers we have the power to decide which products will survive and which will fail. I think we don't always realize this, any more than we realize that our votes *do* count. I believe the people still have lots of power; you can still communicate your views to your legislators.

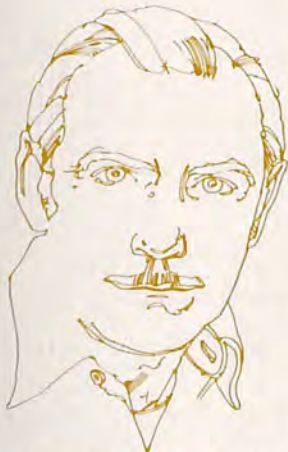


Gene Smith, Applications Engineer, Sundstrand Compressors

Free enterprise is an economy regulated by open competition, without unnecessary regulation. Sure, some laws, such as anti-collusion laws, are necessary to keep business honest. The laws I'm against are those that take away from our freedom of competition. Many governmental organizations are necessary, but they abuse the authority we have given them.

Basically, private enterprise is alive and well, but it has sick areas. It sometimes abuses its privileges. For example, I don't know whether to believe or disbelieve in oil or coffee shortages.

In essence, the government is involved too deeply in regulatory functions; and too, it needs to keep its own house clean. The government and its powers tend to make our society more socialistic and would degrade those in the middle income brackets, sap incentives, take away goals.



Harold Hounder, Chief Inspector, Sundstrand Syracuse

I am very concerned about business because our economy is going down the tubes. There are just too many government bureaus, all operating at a very low rate of efficiency with no apparent accountability at a tremendous cost to the taxpayers.

Private enterprise is a person's chance to do things on his own for his benefit, providing a product or a service he thinks someone will buy....

Our government should pump money

into creating jobs in construction, industry, environment, railroad repairs; but no more government jobs—we have too many of those already!

Our government seems at times to have its priorities reversed. We have billions of dollars for foreign aid and have some of our own senior citizens in want of food and the other bare necessities of life.

I believe in certain aspects of the government, such as safety regulations. OSHA is no problem here because New York State itself has always had strict safety laws. But every state isn't New York State and every company isn't Sundstrand.

No one should be able to pollute the air or water. I feel the private sector can solve pollution problems without too much government intervention.

We must leave the private enterprise system alone to have it work right.



Nancy Johnson, Supervisor, Office Services, Sundstrand Hydro-Transmission, Ames

I don't think private business is in any real danger of dying out, because it's the basis of our whole way of life. As long as we've been exposed to the freedoms of this system, I don't think we'll be willing to give them up.

The American culture is very fast moving and aggressive. Americans have their dreams of getting ahead, of self-improvement. I think it would be a terrible burden to live in a completely regulated society and know I can't do what I want to. With all the movements in the country, by minorities and women, people are saying, "I want my freedom, I want to achieve the goals I've set for myself." Government and business need to work together to provide opportunities for those people who have been denied education and economic opportunities, but they can—and should—do so without complete governmental control of business.

Today's biggest problem in the U.S., I think, is the lack of communication between different segments of society. There is no lack of messages and words, of course, with all the media we have. But I don't think real communication is going on. For example, so often one group, such as

environmentalists, get all the exposure.

I believe our government, based on free choice of candidates, is very much like our business system, which also is based on choices. Granted, elected officials try to offer all kinds of "benefits" to please those people who are voting for them, but the population needs to know that if the government penalizes businesses, this takes away from the capital that businesses need to create new jobs.



Rosemary Weis, Nurse, Sundstrand Denver

Although private enterprise is alive and well at the present time, we have to guard it carefully against encroaching government controls. I think we've let the government keep growing because it's easier to get someone else to make guidelines than it is for us to take care of our own concerns.

We like to complain that big business is the root of many problems, but we have to remember that big business wasn't always big; all industries started out small, and they grew because people bought their products. The public doesn't worry about a business until it becomes large and then they suspect its motives. I think when Henry Ford resigned from the Ford Foundation he said in a speech that people must not forget how many educational projects businesses have supported and how many of the philanthropic foundations in this country today are due to business.

I suppose if the government kept growing it wouldn't affect my job that much: I'd still be a nurse, though I might have more paperwork.

We need to straighten out the unemployment situation so that people can regain dignity and self respect. People need a job to go to, and I know some kind of job is available somewhere for most people. Sometimes you can't have exactly the kind of work you want. I think many jobs are available in industry, though the government could step in to create a few to fill the gaps and provide the programs to train the unskilled. Although I don't like the thought of paying taxes for more government jobs, it's better than paying taxes for welfare....



Garfield Gains, Testman,
Sundstrand Hydraulics

I think it's better for the working people that stockholders run businesses. They can keep things under better control than the government can.

I think the government does need to help the unemployed by adding more government jobs—but not necessarily at the expense of private business. To me, the worst problem in our country today is the high crime rate, and I think our unemployment situation has something to do with that. Jobless people have too much free time.

In some ways the government does too little for its people. It seems that we keep paying lots of taxes, but I don't know where all my money goes. I just feel I don't make enough money to keep up with my taxes....



Sandi Milburn, Secretary,
Sundstrand Energy Systems

To me, private enterprise means that a company is free to run its business as it wishes without interference from the federal government. Right now, I think the government is controlling too much.

Although I don't *directly* see the effect of widespread government controls, they do, in fact, affect me very much, especially

in view of my husband's general contracting business. The amount of government controls on large corporations will naturally influence the selling price of their products. If the large corporation is unable to market its products and make a reasonable profit, they naturally will have to cut back on their employment...

Our biggest problem today is the unemployment picture, and the ill-administered welfare system. Although I dislike the idea of work programs, people must maintain the incentive to work. One of the best things to do would be to make the welfare program *not* so attractive.

I never spent much time thinking about our business system until I saw films brought back from Russia by someone in our department. I most distinctly remember a picture of a long line of people who'd been standing in front of a department store for six hours because something was on sale—they didn't even know what was on sale, or whether they needed it! Then I realized how different conditions were there, and how much I liked home better.



Duane Schneider, Electrician,
Sundstrand ATG-Operations, Rockford

Private enterprise means good things to me: the ability to advance in society; expansion of facilities and work; better wages; freedom to do the kind of work you want.

The kinds of things that bother me, though, are corporations that are insensitive to the needs of their people. Corporate managers must be progressive, and recognize that their employees are their greatest resource. Another thing that bothers me is the inequality of some of the government laws. Your legal rights all too often depend on how important you are.

But much depends on us as individuals, and we don't seem to respond to problems. A corporation that you feel is bad can fail if you refuse to buy its products. I'm personally very committed to buying American products, because I see how imports make our economy suffer. Private enterprise is our way of being able to climb out of where we are, and it's up to us to do the climbing, to become what we want to be. We don't need a bigger government, we just need to make better use of what we have.

I think free enterprise is thriving because the government and business can work very well together for the benefit of everyone. For example, how would our aviation operation do without government contracts? And what is the government but a voice of the people? One big objection I do have is that we have too many appointed officials who are not responsible to the voters, only to higher-level bureaucrats....



Leland North, Machine Operator,
Sundstrand Tubular Products

I raise cattle at home, so I'm very much a private enterprise man. To me, it basically means a group of people standing on their own two feet without need of federal assistance.

In this part of the country, at least, private enterprise *is* alive and well. I know the morale in the plant here is good; we know that if we don't do our part, the company can't keep us, so we're working for our own security. It's different from working for the government, where everything is based on some classification. Here, they judge the quality and quantity of your output. We can see our progress, and we get rewarded for it. We want Tubular Products to make a profit because our jobs depend on how much money the company has to spend on plants and equipment. Tubular Products doubled the size of its plant last year, and that has created a lot of new jobs.

We always hear about the huge profits companies make, but the press doesn't usually tell you when a company is losing money. It takes lots of money to accomplish what the people of this country want.

The government's doing an okay job, I think, except with its monster, the welfare system. We've lost control of it. I've lived in the same community 50 years and know three generations of people from the same families on welfare. The children never learn how to work. I believe that everyone who is able to work and who is offered a decent job should take it or be cut off welfare.

We don't realize how much control the government has: it creeps up on us. It seems that we can't do without government help, and then we can't live with it, either!

Harold Sydney Geneen, who started his business career as a 16-year-old runner on the floor of the New York Stock Exchange and later was responsible for building one of the world's great multinational corporations, says that if he were starting over again, he would go into business for himself.

Just retired as chief executive officer of International Telephone & Telegraph Corp., but still chairman of the board, Geneen celebrates his 68th birthday today. Neither the passage of years nor the shedding of burdens has dimmed his vigor—or his habit of speaking bluntly to the point.

U.S. business, Geneen asserted when we visited his relatively spartan new office at ITT's Park Avenue headquarters in New York, is being short-changed by the American public, the government and the media, which generally don't understand the importance of profits in making the free enterprise system work.

"The only courage a businessman has got is his profits," Geneen said. "When he has profits, he goes and builds plants, does things, creates jobs. And when he doesn't have profits he pulls in the roof and gets scared. It's just that simple.

"What the hell is wrong with profits? And what the hell is wrong with unconscionable profits? Any business that has profits, generally speaking goes and builds more divisions and has more R&D, comes up with more products, and does things with it. That creates jobs and creates a standard of living.

"Suppose they have excess profits?" he continued. "Suppose some guy got a big dividend and bought a yacht? What the hell is wrong with that? The guy is going to put someone to work to build the yacht, spend some money while he's got it, and when he's dead, you take it away, anyway.

"Take the oil industry, for example," Geneen added, warming to his point. "Everybody is stifled on this whole energy program because they're scared stiff somebody's going to make a profit. That's really the problem. The oil industry is going to make a windfall profit. And my comment is, suppose the hell they did? They're going to spend it on exploration...and if they give it in dividends, it's no great problem. And the stock market would go up, and a lot of things would happen to keep this momentum going that built the kind of country we have.

Profit Is Not A Dirty Word II

ITT Chairman Geneen Equates Profits, Jobs

By Philip Greer and Myron Kandel

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Mr. Geneen

"Companies ought to be able to make a profit, make a big profit," he said. "I don't think there's anything wrong with a big profit—unless the guy puts it away in a mattress."

Profits are the key, he emphasized. If the businessman gets no profits, or dwindling profits, "his initiative begins to curdle" and the country's growth comes to a halt.

But the government and the public have got to the point, Geneen asserted, "where they're scared stiff to advocate that we should continue an unfettered free enterprise system.

"This comes out of the style and vogue that's been coming on us in the last 15 or 20 years that, somehow nobody is supposed to have more than anyone else," he contended. "This is

a sort of egalitarian approach, and the politicians are scared stiff of it. And actually what built the country was just the opposite. Everybody had an equal opportunity, but you needed a wealthy class that earned it—I'm not talking to the guy who inherited it—because that was the incentive for the other guy."

Geneen himself was not born to the purple, nor ever seemed to aspire to it. He was brought to this country from England as an infant, lived with his mother after his parents split up and went to a boarding school. He worked his way through college at night, became an accountant and wound up having more influence on the development of business around the world in the third quarter of the 20th century than any other corporate executive of his generation. He also became one of the most controversial, as ITT became involved in accusations that it improperly tried to influence governments here and abroad.

But Geneen, unflappable through it all, concentrated on building ITT and its profits. He earned close to \$900,000 annually the last two years and the stock and options he holds make him a millionaire several times over.

In his 19 years at the helm, he built ITT into a company with sales of more than \$12 billion a year and businesses in every corner of the globe. Although he shuns ostentation, Geneen is proud of his achievements and the niche he carved for himself in the corporate pantheon.

And yet, he told us, if he were advising a young college graduate today on how to seek his fortune, he would suggest—to those "who are motivated that way"—that they "get out on their own and have a small company in the end."

He feels that way, he explained, because "my impression is that nobody has any real idea of what the people running large companies do or what they're accomplishing."

Entertainers and athletes are paid huge sums, and nobody questions that, he noted. "But if they pay some guy running a corporation half a million dollars, and he's got 40,000 people working for him, somehow that's wrong."

But, Geneen said, "The economy is supported by big companies, not by small companies. And '99 percent' of the people running them, he added, are "solid American citizens who believe in everything you believe in."



Notable views of notable people on aerospace matters...

aerospace perspectives

Harold Brown, Secretary of Defense, in the DoD Fiscal Year 1979 Annual Report:

"Over the past decade there has been concern that the defense budget has had an especially harmful effect on the U.S. economy.... Recently some have challenged these beliefs, yet these beliefs still remain widely accepted despite what the evidence clearly shows. Over the past 10 years, social and economic spending in this country has grown about five times faster than defense spending. If the effects of inflation are taken into account, defense spending has declined by 23 percent over this period while social and economic spending has increased by over 100 percent. Though this period compares defense from the peak levels during the conflict in Southeast Asia, it still appears that many people do not realize how sharp the decline in public resources allocated to defense has been since that time."

General George S. Brown, USAF, Chairman, Joint Chiefs of Staff, in the U.S. Military Posture Statement to the Congress:

"In looking back over my previous reports to you, I am struck by the fact that in nearly every area of military strength there has been a relative decline over the years in relation to the Soviet Union, our principal potential adversary. This is not to suggest that there have been no improvements in our forces and capabilities.... Modest increases in combat forces and in readiness, the development of several major weapon systems and other improvements all contribute to increased U.S. military power. However, in light of the extensive growth in the military capabilities of the Soviet Union, it is questionable whether what has been done is enough to assure the security and well-being of our country in the coming years.

"In a time when the potential costs of inadequate strength and preparedness can be so high, and in a world where miscalculation can have such serious consequences for millions of people, the United States must possess a very substantial military strength—and that strength, and our willingness to use it, must be clearly perceived by our potential adversaries. It must also be perceived by our allies and friends and by others whose well-being may be affected by military conflict. Perception of strength can be as important as strength itself. Our commitment to the security of the country must leave a clear message to others: we can and will defend our interests effectively; we cannot be coerced."

T.J. Murrin, President, Westinghouse Public Systems Co., in an address to the Lima (Ohio) Chamber of Commerce:

"What is the basis of Soviet military strategy?... The types of refinements with which we deal in formulating our military strategy are never, to the best of our knowledge, considered by the Soviets. For example, Soviet operational planning does not consider limited nuclear war, flexible response, or damage limitations. They think and plan only in terms of total destruction. I cannot predict—nor can our leaders or experts

predict—what the current Russian regime, or the one that may follow it, plans to do with their military arsenal. But it well might be a fatal error to assume that the thinking of the Soviets on this matter parallels our own."

W.F. Rockwell, Jr., Chairman of the Board, Rockwell International, at the Explorers Club Annual Dinner:

"Industrial exploration is the art of making new discoveries about nature, inventing useful applications for these discoveries and applying those inventions to goods and services.... Industry's exploration of nature spans a size scale from the enormous galaxies that make up our universe to the unseen subatomic particle galaxies that make up the world.

"Just as any explorer sets out in search of new ideas, new discoveries and new knowledge, so too do the explorers in the industry set out with those same three goals in their search to improve products and services. In today's world, improved products mean products that can do a better job—products that function at a greater speed, utilize less energy, or can be provided at a lower cost."

Pierre J. Marion, President, European Aerospace Corp., in an address at the Town Hall of California, Los Angeles:

"In spite of the very positive response to the Concorde, the supersonic aircraft cannot be considered as the airplane of the 1980s.... I think that the supersonic transport is here to stay, but it will remain for a number of years an expensive way to go and will constitute only a small portion of the overall air transportation activity.... That being said, I strongly believe that a second generation supersonic aircraft will be developed. Due to the technical and financial considerations involved, I believe that such a supersonic airplane will be developed jointly by the United States and Western Europe, and it will not be in commercial operation before 1995."

Karl G. Harr, Jr., President, Aerospace Industries Association, in testimony before the House Committee on Science and Technology:

"No one in industry is pushing for a U.S. supersonic transport. However, it is important to be in a position technologically to proceed if the occasion demands. There are two reasons for this. First, flying as a means of transportation is justified almost entirely by the time savings involved. Where it can be made safe and economical, it is the most attractive timesaver available in the transportation area. Second, in terms of productivity in a climate of rising costs, the supersonic transport has a definite edge. It can fly more passengers simply because it can make more trips in a given period of time. Being more productive, it offers the best chance of keeping long range air travel within the reach of the public at large. The bottom line is that some time down the road—and perhaps not too far down the road—the nation that produces an efficient SST is going to dominate the world's airways."



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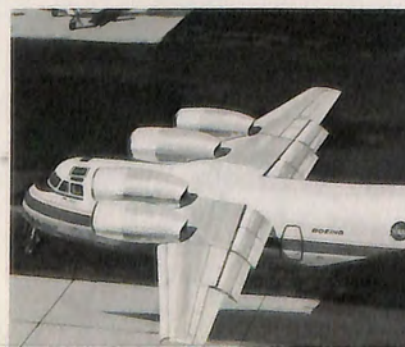
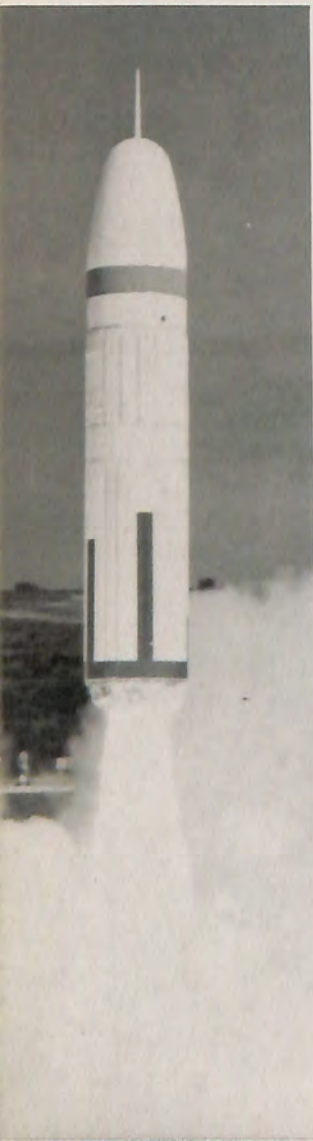
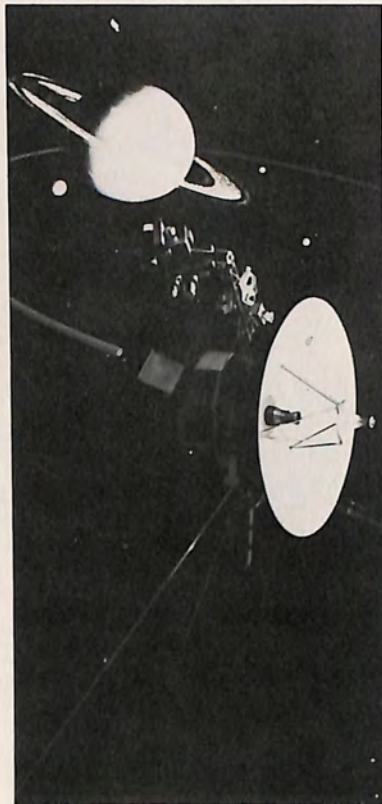
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A review of aerospace industry accomplishments in the past year is carried in *Aerospace Highlights: 1977*, p. 6



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Notable views of notable people on aerospace matters...

aerospace perspectives

President Jimmy Carter, *in an address to the 1978 graduating class of the U.S. Naval Academy:*

"With essential nuclear equivalence, relative conventional force strength has now become more important. The fact is that the military capability of the United States and our Allies is adequate to meet any foreseeable threat..."

"We will continue to maintain equivalent nuclear strength because we believe that, in the absence of worldwide nuclear disarmament, such equivalency is the least threatening, most stable situation for the world."

"We will maintain a prudent and sustained level of military spending, keyed to a stronger NATO, more mobile forces and an undiminished presence in the Pacific. We and our Allies must and will be able to meet any foreseeable challenge to our security from strategic nuclear forces or from conventional forces. America has the capability to honor this commitment without excessive sacrifice by the people of our country, and that commitment to military strength will be honored."

Senator Adlai E. Stevenson, *Chairman of the Science, Technology and Space Subcommittee of the Senate Committee on Commerce, Science and Transportation, in an introduction to a symposium on The Future of Space Science and Space Applications:*

"Historians of Earth in the next millenium are likely to remember the United States principally for its initial leadership in space exploration. Leaving the confines of our planet to travel, explore and do useful work in space is a dividing line in human experience that will stand throughout recorded time. We can be proud of these accomplishments. But we should be thinking far more creatively than we are of ways to build on these beginnings..."

"The harsh truth is that our present efforts to plan the nation's future in space lack the foresight and dedication that characterized the decisions made 20 years ago... Today the planning process for the U.S. space program is little more than the product of annual battles between Congress and the Office of Management and Budget over specific line items in the federal budget. This process is almost immune to establishing longer run purposes and directions."

Dr. Ruth M. Davis, *Deputy Under Secretary of Defense for Research and Advanced Technology, in a statement to the Research and Development Subcommittee of the House Armed Services Committee:*

"If we are in any way to exercise control over the manner in which we cope with our military future, then we must possess the managerial mentality to stimulate, pace and utilize our scientific and engineering resources... Our desire for technological superiority is but one way of asserting the importance of being best in the military competition that engages us as a nation. It is the same measure of success in competition that is used in business or in the marketplace. Being technologically superior gives us an edge in any military conflict and may allow actual conflict to be avoided through the tacit acknowledgement, without a fight, of the 'winner.'"

"Technological superiority...also gives us technological surprise as a powerful weapon. Technological surprise is what we want to make happen to others. If it happens to us, then we must react with a resultant loss in our ability to plan and pace our own scientific military future, and we will have to forego our right to select our own options for orderly military research and development pursuits. Avoiding technological surprise is important in business; it is a national necessity in military matters."

George M. Low, *President, Rensselaer Polytechnic Institute, at a joint meeting of Franklin Institute and the American Institute of Aeronautics and Astronautics:*

"Our nation became a great nation because of our inventive genius—because we recognized and nurtured technological innovation... But today...technological innovation in the United States is faltering, faltering not because there is a shortage of new ideas, but faltering because new laws and regulations and current economic policies provide disincentives, rather than incentives, for new technological developments..."

"Our standard of living depends on our investment in technology and our balance of trade is strongly related to high-technology manufactured products. But technology is also one of our most perishable commodities. It must continually be replenished, or it will be obsolete. And our rate of replenishment is now too low...What is needed now is an immediate reversal in the decline of research and development support—a gradual increase in the proportion of our Gross National Product devoted to R&D for new programs related to the needs of the future."

N.R. Parmet, *Vice President-Engineering and Quality Assurance, Trans World Airlines, at the Society of Automotive Engineers International Air Transport Meeting:*

"It appears that the next generation of aircraft will be dedicated to fuel economy, noise and exhaust emission improvements while making relatively modest gains, if any, in the area of seat mile cost reductions. From a practical and economic standpoint, a point will soon be reached beyond which additional improvement in aircraft noise will be economically unfeasible, and further improvements in the airport noise environment will require increased emphasis on the regulation of land use in addition to regulation of aircraft. In effect, everybody is going to be paying the price to obtain airplanes which are low in fuel consumption per seat mile flown."

"In order to achieve such goals, increasing complexity is going to be required. The use of derivative high bypass ratio engines, new airfoil shapes, the use of composite materials can all combine to improve the efficiency of the product. In doing so, however, the investment per passenger seat will continue to rise and the cost of all this technology going into reducing noise and reducing air contamination will offset the increase in efficiency brought about by the new technologies."



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CONTENTS

- 2 SOLAR ENERGY:
POWER FOR TOMORROW
By JAMES J. HAGGERTY
Associate Editor, Aerospace Magazine
- 7 CORPORATE TAXES:
LARGE FIRMS PAY HIGHER RATES
- 8 HOW GOVERNMENT COMPETES
WITH FREE ENTERPRISE
- 10 AVIATION'S FIRST 75 YEARS
By ROBERT J. SERLING
- 14 AERONAUTICAL RESEARCH—
CLEANER, QUIETER AIRPLANES

Back Inside Cover: ECONOMIC INDICATORS

COVER—Artist's conception shows how a Satellite Power System could be constructed in orbit, part of a study by The Boeing Co. on the use of miles-long orbiting platforms to harness the sun's energy and transmit it to Earth for public use. The key to orbital erection of large facilities is the fact that the weightlessness of space permits use of thin, prepackaged weblike structural parts which would be crushed if used on Earth. The structure would be covered with thousands of acres of solar cells, which convert sunlight directly to electricity.

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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AEROSPACE ISSUES

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

The late 1970's are relatively placid days for the aerospace industry. Statistically, most of the measures of achievement are good. Sales are reasonable, backlog is generally strong, the growth of technology is steady and our companies are reporting sound earnings. There is, however, a consistent concern throughout the industry about the growing burden of government regulations and involvement in what we believe are industry prerogatives.

In this issue of *Aerospace* magazine we highlight two such issues in order to help our readers gain a better perspective of this dynamic but tightly regulated industry.

The first relates to government's continuing incursion into the marketplace as a supplier of goods and services. We call this problem "government competition with industry." In brief, government agencies are doing work that should be reserved for private business and industry. This work includes laboratory research, aircraft repair, building maintenance, printing, laundry services and a myriad of other big and little activities. If the problem were limited only to the aerospace industry, we might think we were out of step with the rest of America's business community. The situation, however, has become so pervasive that 16 industry associations representing 100,000 companies and 19 million employees in all parts of the private sector have banded together to express our concern directly to the government. This coalition is called the Committee on Contracting Out (COCO). It hopes to convince government to back away from its more expensive and less productive ways of doing some of the nation's business and to contract out to the private sector more of the jobs properly intended for business and industry in our free enterprise economy.

On page 8 we explain our point of view on contracting out in more detail. We think you will find the article interesting and the situation alarming.

Another concern of American industry, as for all Americans, is taxes.

Industry is sometimes accused of not paying its fair share of taxes. In turn, over the years industry has tried to explain how, in the complexities of the tax codes, we bear our fair burden of taxes. Now, come two Treasury Department studies totally refuting the myth that industry doesn't pay. They give a clear insight into the heavy tax burden that business and industry—rightfully, certainly—do bear.

The reports say that large American corporations pay very substantial portions of their income in federal taxes. In fact, they generally pay higher percentages than do small businesses.

The article on page 7 seeks to give you a better understanding of this matter.

Of course, there are other major problems facing this industry and we plan to make readers of *Aerospace* aware of them, as well as of our technological achievements, in the coming months. Transcending all such problems, however, is the industry's creativity, enabling it to solve the toughest technological assignments and to continue to do well in a highly competitive international market.



Solar Energy: POWER FOR TOMORROW

BY JAMES J. HAGGERTY
Associate Editor, Aerospace Magazine

Imagine a network of huge satellites orbiting more than 20,000 miles above the Earth, capturing the abundant energy of the sun and beaming it Earthward for use as electricity. A single satellite, more than 10 miles long, would supply the electrical energy needs of a city the size of New York and the whole network would generate a significant portion of the nation's power requirement. The energy source would be inexhaustible and the power generated would be virtually pollution-free.

A science fiction pipe dream? Not at all. The Satellite Power System, although so far confined to conceptual studies, already exists as a government-funded program, jointly sponsored by NASA and the Department of Energy. Some of the best scientific and engineering minds in the country support the concept. These experts acknowledge that development of such a system demands extraordinary technological advancement, but they consider the plan entirely feasible; a prototype space-based power station, they say, could be in orbit as early as 1995.

The Satellite Power System is the most exciting possibility among a broad range of solar energy projects being conducted by the Department of Energy and NASA. Solar energy, of course, is not by itself the complete answer to the world's energy problem. Solving the energy dilemma is not a matter of selecting one type of energy technology for crash development; rather it is a matter of pursuing all promising avenues of approach. Thus, the national energy research and de-

velopment plan embraces such other areas of high potential as nuclear fusion, geothermal steam, ocean energy, liquefying and gasifying coal, and converting wastes to usable fuels.

But solar energy is a prime candidate for emphasis. The idea of tapping the sun for clean and limitless energy has almost universal appeal and seems the approach most likely to generate the broad public support necessary to the outlay of large sums of government money. Given such support, solar energy development in the remaining years of the 20th century could snowball into a program of Apollo-like proportions.

The initial steps are under way, and in the forefront of the development effort are the people who brought Apollo to fruition—the companies which comprise the U.S. aerospace industry. In some cases, these companies are directly applying aerospace technology to energy needs; in others, they are employing their general technological expertise to develop new types of solar energy systems for public use.

THE SOLAR PROMISE

A basic energy measurement is the kilowatt hour, or the energy of one thousand watts applied for one hour. It is estimated that the world populace uses energy at the rate of 200 billion kilowatt hours a day.

This seemingly staggering figure pales to insignificance when one considers the amount of solar energy that reaches Earth's surface every day: four thousand trillion kilowatt hours! In other words, the sun daily makes available 20,000 times as much energy

as is needed by all the peoples of the world for their combined domestic, industrial, transportation and myriad other uses.

But solar radiation, in the form it reaches Earth, is not directly applicable to most human needs; it must be collected, concentrated, converted to useful form and distributed. In some instances—home heating, for example—this is already being accomplished, and on a growing scale. In other applications—such as converting sunlight to electricity—experimental systems are demonstrating feasibility but considerable technology development is required to make them suitable for practical, everyday use.

Solar energy is sometimes called "free" energy. It is, of course, free at the source but by no means free to the consumer, because each of the steps in the conversion process entails cost. In all but a few special cases, solar energy is not yet cost-competitive with conventional fuels. Its proponents, however, predict significant reduction in costs as development work brings forth more efficient systems and as the economies of mass production lower the cost of solar equipment. At the same time, the cost gap between solar energy and conventional fuels will narrow with continuing escalation of fuel prices; oil, for example, is expected to increase at the rate of 10 percent annually, meaning that its cost to the consumer will double in a decade.

The technological effort aimed at development of efficient, practical, economical solar energy systems is gaining momentum. With and without



At left, Grumman solar collectors enhance home design while capturing sun energy for home heating. Photo at right shows an experimental installation of a new General Electric solar array which uses vacuum tubes rather than the customary glass plates to trap solar radiation.

government funding, a great many private firms—aerospace companies, old-line energy companies, solar energy specialists, architectural engineers, glass and metal producers—are engaged in a variety of solar energy production, demonstration and development projects ranging from relatively simple home-heating equipment to long-term, technologically-demanding systems for large-scale conversion of sun energy. The nature of the work under way is exemplified herein by a sampling of programs in which aerospace industry firms are applying their technical expertise toward finding new ways to harness the sun's bounty.

SOLAR HEATING AND COOLING

The area of solar energy which promises earliest widespread application is heating and cooling of buildings—private homes, offices and industrial facilities. In the U.S., the heating/cooling and domestic hot water energy requirement constitutes more than 25 percent of the nation's total energy needs. Obviously, conversion to solar energy on even a limited basis could contribute significantly to reduced dependence on conventional fuels. According to one estimate, if solar energy could provide only 10 percent of the national heating/cooling/hot water requirement, the savings would be equivalent to 300 million barrels of oil a year.

There are many types of solar heating systems, but generally they share these components: an array of solar collectors, usually roof-mounted, which trap the sun's heat; a transfer system, such as fluid circulating through pipes, which distributes the

acquired energy for heating rooms and providing hot water; a thermal storage tank, wherein excess heat is stored for use at night and during cloudy periods; and a back-up system to supply heat by conventional means when the stored heat is depleted. With auxiliary equipment, solar energy can also cool air or water for air conditioning.

While costs of solar heating systems are relatively high, they are not so high as to deter growing adoption. Many people are willing to pay high initial costs to reap long-term benefit; they are aware that conventional fuel costs are rising faster than the inflation rate and there is the continuing threat of further price escalation by OPEC nations. Solar energy systems are in wider American use than is generally realized. Some 40,000 buildings in the U.S. have some sort of solar heating equipment, mostly hot water systems. About 5,000 homes and offices use solar energy for interior heating. Solar air conditioning has not yet made appreciable inroads.

Technology advancement efforts focus on ways to increase the efficiency of the individual solar collector to get more heat per unit installed; better means of storing heat for long periods, to eliminate or reduce the need for conventionally-fueled back-up systems; and development of less complex, lower cost combined energy systems, which would provide hot water, interior heating and cooling in a single package.

Examples of aerospace industry involvement in solar heating/cooling development and production includes:

- Grumman Energy Systems, Inc., a subsidiary of Grumman Corp., is manufacturing in quantity a commercial line of solar energy products, including several types of high-efficiency, long-life collectors. Grumman supplies more than 200 dealers in 43 states and four areas outside the United States. An interesting Grumman innovation is a collector that is not mounted *on* the roof, it *is* the roof; use of a collector array as roofing reduces construction costs.

- Lockheed Missiles & Space Co., a subsidiary of Lockheed Corp., is participating in a Department of Energy demonstration program which marks the first DOE application of solar energy to an industrial process. A Lockheed solar system taps the sun's energy to provide 40 percent of the heating needs for a hardwood lumber drying kiln in Canton, Mississippi. Lumber drying consumes great amounts of energy and success of this project could lead to large-scale fuel savings for kiln operators.

- General Electric Co. has designed a unique, high-performance collector which uses a series of vacuum tubes, rather than glass plates, to harvest solar energy. In a joint project with Washington (D.C.) Gas Light Co., GE has installed the collectors in two Washington-area homes for testing. According to Washington Gas officials, the vacuum tube approach provides higher temperatures, hence greater efficiency, than most solar systems. GE plans to market the collectors in pre-packaged form to minimize engineering and labor costs to installation contractors, thereby cutting overall

solar system cost.

- In a Department of Energy program, a Westinghouse Electric Corp. solar array consisting of several hundred collectors has been installed on the roof of a school in Atlanta, Georgia. The intent is to demonstrate the potential of solar energy for both heating and cooling of large facilities.

- United Technologies Research Center has designed and demonstrated an advanced solar heat pump system for cooling as well as heating homes, apartments, and office buildings. It features reduced complexity and lower cost; it is a development step toward the cost-effective combined heating/cooling system that will prompt broader application of solar energy.

WIND ENERGY

While solar heating/cooling offers considerable promise for reducing dependence on fossil fuels, an area of even greater potential is conversion of solar energy to electricity. The Department of Energy says that, if solar systems could provide only one percent of U.S. power demand, the savings would be on the order of one million barrels of oil a day.

There are a number of solar electric conversion systems already being demonstrated. One is a modern adaptation of the age-old windmill, considered a solar system because the sun influences all weather, including wind. The wind energy system consists of a large, propeller-like rotor and a turbine; wind force spins the rotor, which in turn drives the electricity-generating turbine. Use of this type of equipment will be limited to certain applications and to geographical areas where wind conditions are consistently favorable. Nonetheless, it offers promise as a low-cost, maintenance-free fuel-saving system which can supply electricity in appreciable amounts to local utilities, thereby trimming their conventional fuel needs.

Drawing upon their experience in turbine engine, aerodynamics, materials, propeller and rotor blade technologies, aerospace firms are engaged in a number of wind turbine developments. Examples include:

- Rockwell International is prime contractor to the Department of Energy for wind energy programs.

- In one such program, United Technologies Research Center is developing a system using a 28-foot-diameter rotor based on the tail rotor design of the Army's Sikorsky Black Hawk heli-

This Westinghouse solar installation atop a school in Atlanta, Georgia is part of a Department of Energy program to evaluate the efficiency of solar systems for heating and cooling large structures.



GE's Space Division is designing a five-acre solar cell system to provide both heat and electricity for facilities at Sea World, Orlando, Florida. Mounted on turntables, the solar concentrators automatically track the sun.



copter. This relatively small system is intended to provide electric power to single homes or to small equipment such as irrigation pumps. It produces up to eight kilowatts of electricity.

- Grumman Energy Systems has developed a 15-20 kilowatt wind turbine which utilizes a three-bladed rotor 25 feet in diameter. It is designed as a fuel-saver for a small community, supplying supplemental power to the local electric grid; it is also applicable to such jobs as water pumping, desalination and battery charging, and in one application it is providing electricity for a military barracks.

- Lockheed and Westinghouse, working with NASA's Lewis Research Center, are participants in a program involving four medium-size experimental wind turbo-generators. These windmills, some of which are already operating, measure 125 feet in diameter and produce 100 kilowatts.

- Studies indicate that the cost of wind energy drops as rotor size increases, so NASA and the Department of Energy are planning experiments with larger wind systems. General Electric is building one whose rotors span 200 feet; it has a design capacity of 2,000 kilowatts, enough for several hundred homes. The system, to be erected in 1979, will be tied into the local electric grid at Boone, North

Carolina. In development by The Boeing Co. is a still larger windmill, a 300-foot-diameter system capable of producing 2,500 kilowatts.

- United Technologies' Hamilton Standard division developed a 200-foot-diameter rotor blade and hub for a wind energy system. In a program funded by the Swedish government, Hamilton Standard is engaged in a joint development and production venture with a Swedish firm. HamStan and Statsforetag AB of Stockholm plan worldwide marketing of wind energy systems in the megawatt range (1,000 kilowatts or more).

SOLAR CELLS

The solar cell is familiar to observers of the space scene; for almost 20 years, solar cell arrays have been providing electrical power for spacecraft. In what is known as the "photovoltaic" process, solar heat acting upon a silicon cell creates a chemical reaction that produces an electrical charge. The resulting electricity is dc (direct current) power; for useful work, it must pass through an inverter for conversion to ac (alternating current) before being fed into a utility power system. Another necessary part of the system is a battery, or a series of batteries, to store the collected energy for periods when sunlight is not available.

Solar cells have demonstrated re-

liability and long life and they have been very effective in meeting the relatively low electricity needs of spacecraft. What is needed for large-scale Earth application is—as in other areas of solar energy—a sharp reduction in cost. Research focuses on two main areas: ways to increase the electricity-generating efficiency of the individual cell and ways to cut manufacturing costs. The current cost of solar cell electricity, is about \$12 a watt; the Department of Energy's target is 50 cents a watt by 1986. The long-range goal is development of cost-effective systems providing millions of watts of public use electricity.

Among projects under way:

- NASA's Jet Propulsion Laboratory is conducting a technology advancement program aimed at reducing cost and further extending useful lifetimes of solar cell arrays.

- NASA's Lewis Research Center is demonstrating the efficiency of solar cells in certain low-power applications, for example, a remote weather station on Long Island. From this and other experimental installations, NASA is learning more about the operation of solar cells in the terrestrial environment, information important to advanced development.

- Westinghouse Research Laboratories is developing an advanced manufacturing process for making cells, using thin-film cadmium sulfide rather than silicon, in an attempt to significantly lower production costs. Westinghouse is also conducting design studies on three types of solar cell systems: one that would generate one to 10 kilowatts for powering individual houses; another in the 10 to 100 kilowatt range for schools, shopping centers or small factories; and a huge central station power plant capable of producing up to one million kilowatts.

- General Electric Co.'s Space Division is engaged in a Department of Energy development project involving use of five acres of solar cells to provide both heat and electricity to the facilities of Sea World, Orlando, Florida. To be operational in 1981, the GE system consists of groups of high-intensity cells mounted on turntables which rotate automatically to track the sun in its daily passage. This approach greatly increases the energy output of the solar array. Each turntable grouping will generate 33 kilowatts of electricity; the nine arrays in the system will provide almost 300 kilowatts. The intent is to demonstrate the potential

of using any number of turntable-mounted solar arrays to produce power for large commercial or industrial facilities.

Thermal Electric Energy

Solar cells convert sunlight *directly* to electricity. An *indirect* method of generating electricity from solar radiation is the thermal electric system. In this approach, solar collectors capture sun heat in much the same manner as home heating systems. But instead of being employed to warm interiors, the

One concept for large-scale conversion of sun heat to electricity is McDonnell Douglas' solar thermal electric system. Some 2,000 sun-tracking "heliostats" reflect solar heat to a tower-mounted central receiver, which produces steam to drive an electricity-generating turbine.



sun heat is used to drive electricity-producing equipment; for example, the heat converts water to high pressure steam and the steam spins an electricity-generating turbine.

This approach has potential for providing electricity on a large scale, meaning individual systems capable of meeting the needs of a big city. Generation of thermal electric power in large amounts, however, will require very large "farms" of solar collectors. Because an effective system must operate in all kinds of weather, an important requirement is a very efficient, high-capacity thermal storage subsystem, from which heat can be drawn to power electric generators in no-sunlight periods.

Solar thermal electric conversion has been proved feasible in experimental projects, but its costs today are estimated at three to five times those of electricity generated by conventional stations using fossil fuels. However, experimental work indicates that further research may bring about significant reduction of thermal electric system costs, while costs of conventional fuels will continue to rise. One estimate holds that electricity produced from solar heat can be cost-competitive with oil-fueled generators as early as 1985.

In one Department of Energy pro-

ject, Westinghouse is designing a "solar total energy system" planned for operational service at Fort Hood, Texas in 1980. The system will use a number of sun-tracking solar collectors to capture heat, part of which will be used for hot water and interior heating and part for driving thermal electric generators, thus providing all the energy requirement for five buildings housing 1,600 troops. This experiment will provide a basis for evaluating the economic practicability of solar

total energy systems.

A major Department of Energy project contemplates development of a high power thermal electric system and construction of a pilot plant to prove the concept. A design competition last year resulted in selection of a concept formulated by McDonnell Douglas Astronautics Co., assisted by Rocketdyne Division of Rockwell International. Two other aerospace firms—Honeywell Inc. and Martin Marietta Corp.—are also working on system designs.

The McDonnell Douglas concept employs a large field of mirror-like "heliostats"—2,000 of them—and a heat-absorbing central receiver/boiler, elevated high above ground level on a tower. The computer-controlled heliostats track the sun and reflect its rays onto the receiver, which uses the heat to convert a flow of water into superheated steam. The steam is directed to a turbine, which produces electricity to be fed into the local utility grid. Excess heat absorbed by the receiver is channeled to an underground storage tank, from which it can be extracted as needed.

The Department of Energy's initial pilot plant will be capable of generating 10 megawatts (10,000 kilowatts) of electrical power, enough for the needs of a fair-sized city or a large in-

dustrial facility. To be located at Barstow, California, it is expected to be operational in 1981. Beyond that, DOE is thinking of plants of improved design providing 50 to 100 megawatts. Initially, the principal application of these central receiver power stations will be "re-powering" oil-fired utilities in the southwest United States; re-powering means part-time substitution of solar heat for fuel heat, which can cut oil consumption as much as 50 percent.

THE SATELLITE POWER SYSTEM

Promising as they are, ground-based solar electric systems have some disadvantages in that the energy source is not available at night or in bad weather; additionally, the layer of atmosphere between the sun and Earth's surface restricts the efficiency of solar collectors. Which gives rise to the idea of moving the whole electricity plant to space, where proper orientation of solar collection arrays can virtually eliminate "nighttime," where there is no atmosphere or weather, where the solar energy available is as much as 15 times that available on the ground.

This concept envisions enormous orbiting platforms, 10 miles or more in length, containing large farms of solar heat collectors—either solar cells or alternative equipment being considered for direct conversion of sun heat to electricity. The electricity generated would be changed to microwave energy and beamed to Earth. The Earth receiver, called a "rectenna," would reconvert the microwaves to electricity and feed it into the power network. The rectenna would itself be a huge structure, about five miles in diameter; built on low-value land or offshore, it would be located near a central power station to reduce transmission costs.

Using space construction techniques already being developed for experiments in NASA's Space Shuttle program, the Satellite Power System would be assembled in low-altitude orbit, then boosted to "synchronous" orbit 22,300 miles high; at that altitude, satellite motion is synchronized with Earth's rotation, so the orbiting solar farm would remain in a fixed position relative to a point on Earth. Construction of the concept-demonstrating prototype system could be handled by the Space Shuttle Orbiter; erection of larger operational systems would probably require a component-delivery vehicle of greater lift-to-orbit capability.

The potential of the Satellite Power

System is enormous. Studies show that a single satellite could continuously beam to Earth 10,000 megawatts (10 million kilowatts) of electric power; this, proponents claim, is more than four times the power producible by the largest nuclear power station that can be built in the United States.

The developmental effort required is similarly enormous. Major technological advances are needed for erecting very large structures in orbit; for development of highly-efficient, cost-effective solar electric conversion equipment; for reliability, because the system would have to operate for decades with only routine

This 125-foot-diameter wind turbo-generator, a modern adaptation of the windmill, is one of four similar machines in a NASA program designed to explore the potential of converting wind energy to electricity.



maintenance; and for large-scale microwave transmission of energy from space to Earth.

NASA and the Department of Energy have already embarked on a three-year study program, aimed at decision of whether to proceed with hardware development. NASA, assisted by aerospace contractors, is working on definition of the overall system. DOE's effort focuses on economic, environmental, health and safety considerations—for example, the question of whether microwave transmission of energy will produce adverse effects on the environment. The timetable calls for go or no-go recommendations by January 1980, but some members of Congress feel the program should be accelerated; bills in Congress would provide \$25 million toward that end.

The concept has wide support among technical groups. A number of scientific and industrial organizations have banded together under the Sunsat Energy Council, formed earlier this year "to foster the development of solar power satellites for the purpose of providing an inexhaustible energy source for the public benefit." The Council's board includes representatives of several major aerospace firms: Avco Everett Research Laboratory, Boeing Aerospace Co., General Electric Co.'s Space Division, Grumman Aerospace Corp., Lockheed Missiles & Space Co., Martin Marietta Aerospace, McDonnell Douglas Corp., RCA Laboratories and Westinghouse Electric Corp. Other organizations included are Aetna Life & Casualty, Arthur D. Little, Inc., Bovay Engineers, Inc., Massachusetts Institute of Technology, Southern California Edison and Universities Space Research Association.

The big question is what will the Satellite Power System cost to develop? The Sunsat group estimates \$40 to \$80 billion spread over the next 17 years, or less than \$40 per American each year. It's a big sum, but Sunsat says, not all that big in consideration of what the U.S. spends for energy; in 1976 alone, the bill came to \$123 billion, including \$23 billion for new electric power installations, \$55 billion for electricity and \$45 billion for imported oil. And, Sunsat adds, once the system becomes operational it could not only pay back the investment but also produce a healthy profit. Development of the concept poses technological challenges of tremendous order—but so did Apollo.

Form 1120 Department of the Treasury Internal Revenue Service	U.S. Corporation Income Tax Return For calendar year 1977 or other taxable year beginning 1977, ending 1977 (PLEASE TYPE OR PRINT)	1977
Check if a— A Consolidated return <input type="checkbox"/> B Personal Holding Co. <input type="checkbox"/> C Business Code No. (See Page 8 of instructions) 4041	Name ABC Corporation Number and street 10 Main Street City or town, State, and ZIP code River City, Iowa 50401	D Employer identification number 36-0537834 E Date incorporated September 8, 1950 F Enter total assets from line 14, column (D), Schedule L (See specific instructions) \$ 1,000,000,000
IMPORTANT—Fill in all applicable lines and schedules. If the lines on the schedules are not sufficient, see instruction N.		

Corporate Taxes: LARGE FIRMS PAY HIGHER RATES

Do large American corporations pay their fair share of federal taxes? They surely do, says the Treasury Department in two recent reports that explode another anti-business myth.

Critics have contended that some major corporations escape taxes altogether and that, generally, big business incurs lower rates of tax liability than small business. But, after investigation of the matter, Treasury says the reverse is true: large American corporations pay very respectable portions of their income in federal taxes and, on the average, pay substantially higher percentages than do small businesses.

For the most part, critics' erroneous contentions apparently stem from misinterpretation of tax information in corporate annual reports. Many a pitfall awaits the unskilled interpreter of such financial statements, according to Seymour Fiekowsky of the Treasury Department's Office of Tax Analysis. In a paper on computation of effective corporate tax rates, Fiekowsky says:

"Published income statements of corporations...invariably include an item labeled 'Federal Income Tax.' This encourages the unwary reader to compute the ratio of this number to the preceding number, 'Income Before Taxes', and conclude that it describes the effective tax rate paid by the corporation in question. In almost every case, however, the ratio thus computed tells little or nothing about the taxability of the corporation's income."

Fiekowsky cites four basic reasons why unskilled interpretation of company financial reports may lead to false conclusions. One is that the "unwary reader" may ignore foreign income tax paid by the corporation, yet include foreign income in the calculation; this, obviously, would give a much lower—and incorrect—effective tax rate. Another reason is that accounting rules for company financial statements are not the same as those used for tax accounting purposes. Similarly, there are differences in computing allowances for depreciation and depletion. Finally, current year tax accounts are "ambigu-

ous" in that a company's tax picture may be changed appreciably by prior year losses and other legitimate tax credits of which the financial statement reader is unaware.

The Office of Tax Analysis paper draws an example showing how a corporate financial statement might be misconstrued. From the figures supplied, an unskilled interpreter might conclude that the hypothetical "ABC Corporation" had an effective tax rate of only 10 percent; in fact, when the complex considerations outlined above are applied, the imaginary company's effective tax rate would be more than 40 percent.

In a separate Office of Tax Analysis report, the Treasury Department listed the results of the most comprehensive corporate tax survey ever undertaken, an investigation of enormous scope which covered data on 1.6 million non-financial corporations whose taxable income aggregated more than \$75 billion. The study report flatly contradicts critics' assertions that large corporations are paying less than their proper share of taxes.

Prepared at the request of two Congressional committees, the report was publicly released "to clarify widespread misunderstanding." Its basic finding: among all non-financial corporations, effective tax rates increase with the size of corporate assets and income.

Rather than company financial statements, which give rise to misinterpretation, Treasury used actual tax returns, considered "the best source of data on the taxability of corporation income." The study group examined returns for 1972, for which complete information was available, but updating would not materially change the results. Included in the computations were both foreign income earned by corporations and taxes paid to foreign governments. Lack of this data in other, less competent studies, is one of the factors responsible for the "common misconception" about business tax rates. Additionally, the report details the great variety of complicated busi-

ness adjustments to income and tax, authorized by tax law, which must be considered in arriving at accurate tax rates.

The study report measures effective tax rates in several different ways, but the fairest measurement, Treasury says, is one which compares worldwide taxes with worldwide income "because the numerators and denominators are most closely matched." Using the basis, the study shows that:

- The lowest effective tax rates were paid by small businesses with assets of less than \$1 million; their rates ranged from 20.6 to 34.3 percent.
- Corporations with assets of more than \$1 million but less than \$100 million had rates ranging from 39.7 to 40.6 percent.
- The biggest corporations—those whose assets are more than \$1 billion—paid the highest taxes: 40.6 to 46.2 percent.

Because of the many complex adjustments to tax and income, certain types of industries pay higher tax rates than others. Looking at the relative rates of 19 industries, the survey found that the top ranking group was the petroleum and natural gas industry; the report cautions, however, that this ranking is somewhat artificial, "swollen" by huge royalties and other payments to host countries. When oil and gas companies were excluded, the manufacturing industry paid the highest effective tax rate, whether worldwide income or U.S. income was used as the basis. Manufacturing's overall rate was 42 percent—but small businesses within the manufacturing industry paid only 32 percent.

So, it is obvious, large corporations have been taking a bad rap from critics who compare "apples and oranges" to arrive at erroneous conclusions about the relative tax rates of big and small businesses. To use Treasury language, "Much mischief may be done by mismatching of the numerator and denominator."

The government is taking business away from American industry by doing a great deal of work "in-house"—with government personnel and within government facilities—that could better be performed by the private sector.

It is taking jobs away from private industry and costing the taxpayer hundreds of millions because government in-house work is being performed at relatively higher costs and lower efficiency levels.

And this situation exists in contradiction of long-standing policies which dictate that government not compete with private enterprise.

These are points raised by the Committee on Contracting Out (COCO), an industry coalition opposed to the high level of government work retained in-house. COCO includes 16 industry organizations which collectively represent some 100,000 companies and 19 million employees. The group recognizes that some functions should properly be performed by government in-house, but that government is overdoing it at the expense of private industry. In Congressional testimony, Committee co-chairman K. Robert Hahn, executive vice president of Lear Siegler, Inc., summed up COCO's position:

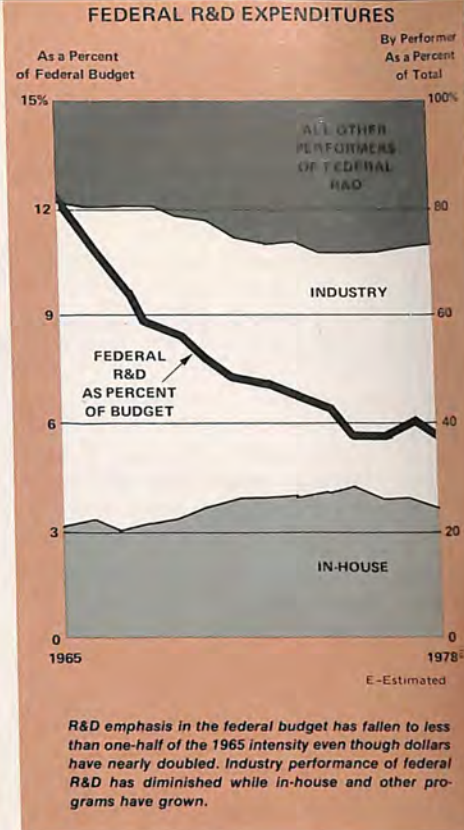
"Public opinion polls today reflect a growing resistance by the American public to too much government, ever higher taxes and inflation. Increased reliance on the private sector can be responsive to these concerns. If the job is commercial in nature, and can be done by the private sector, it should be. Government must stop competing with its constituents. The business of government is to govern. These truths are the very essence of our free enterprise system."

The matter of government competition with industry first came up in 1932 and a policy was established that the government would rely primarily on the private sector for provision of

goods and services. Over the years, the policy has been supported by a number of Congressional studies and commission reports, and frequently reaffirmed by the Executive Branch. It remains the policy today; President Carter presented his Administration's position with this statement: "When there is a choice to be made between the private sector and the government sector, my option would be for the private sector to assume the responsibility."

But policy is one thing and practice another. Actually, the policy is being circumvented in a great many instances, according to a study by Aerospace Industries Association's Aerospace Research Center, which states: "In the last decade there has been a distinct shift on the part of the government away from the traditional reliance on the private sector for needed goods and services."

The research center found that government contracts with private industry for goods and services dropped from more than half of the total federal budget in 1965 to about a third in 1976. The study focuses on two major areas—government research and development, and support services such



as operations and maintenance. In R&D, where industry firms have performed a major percentage of the work, the industry share has declined 10 percent since 1965, to less than half the total. A similar situation exists in operations and maintenance. Among the military services, for example, both Army and Air Force performance of depot-level maintenance have increased sharply in recent years; where industry contractual effort once accounted for about 60 percent of the total, it is now less than half that in both cases. Navy contracts with industry have increased somewhat, but even so the Navy is handling in-house a greater portion of its maintenance work than either of the other services.

"Without question," the Aerospace Research Center report states, "the government's stated policy of relying

How Government Competes With Free Enterprise



on the private enterprise system is not practiced by contracting officers responsible for implementing that policy."

Why? One major reason, the study finds, is pressure by federal employee unions interested in protecting the jobs of their members—at the expense of jobs in the private sector. "The cumulative effect of these pressures—the numerous protests, lawsuits and lobbying—makes an agency apprehensive about obtaining services from private industry even when the agency may believe such action is warranted under established policy. The motivation of the government employee unions, while understandable, is obviously the perpetuation and ex-

pansion of the federal payroll without regard to national policy or true efficiency in government operations. The unions in the private sector have not exerted comparable counterpressures and, in consequence, an imbalance of influences currently exists."

How can government agencies sidestep the policy? Because the governing directive—Office of Management and Budget Circular A-76—provides loopholes. The circular affirms the general policy but allows exceptions. The government may work in-house, for example, if procurement from a commercial source "would disrupt or materially delay an agency's program." Or when in-house handling is deemed essential "to maintain or strengthen mobilization readiness." These two loopholes are frequently used to justify in-house performance, but rarely is supporting evidence provided.

Then there is the matter of comparative cost; the circular authorizes in-house operations when "procurement of the product or service from a commercial source will result in higher cost to the government." Government agencies can make a case for higher industry costs because of an unrealistic method of computing government costs of doing the same job. Says the study report: "Allocations for many normal overhead items, such as the full cost of Civil Service retirement benefits, general and administrative expenses, and facilities amortization, are not made. These very real costs to the government and the taxpayers go ignored, as does the loss of state and local taxes that would be paid by industry."

Industry, on the other hand, must allocate all direct and indirect costs of a contract, so there is, in effect, a dual standard favoring in-house work. Unrealistic cost comparisons, together with other loopholes, allow a government agency to justify in-house work which could be performed more effi-

ciently by private industry. In addition, some government agencies, having acquired facilities and manpower beyond their needs, are now selling their services to other agencies in order to keep up their "business" volume.

These trends of government competition with industry, says the AIA study, result in growth of federal employment that inflates the national budget; reduce private industry employment; impede industry expansion; erode the technological capability of the private sector; and threaten U.S. ability to compete in world markets.

The situation demands correction and there is, in fact, a corrective effort under way. The Office of Federal Procurement Policy has proposed revisions in Circular A-76 which would resolve some, but not all, of the inequities. A major provision recognizes the current imbalance in industry/government cost comparisons and would require the government to allocate a higher percentage of Civil Service retirement costs in computing overall cost estimates. However, another provision dilutes the gain. Existing government in-house activities would not be converted to industry contract work "unless that action will produce savings at least equal to 10 percent of personnel-related costs." And new project starts will not be approved for contracting out "unless the savings are at least 10 percent of personnel-related costs plus 25 percent of facility and equipment costs." Generally, the revisions would overhaul cost comparisons and tighten other exceptions to the policy, but still leave what industry considers a degree of bias in favor of in-house effort.

In his Capitol Hill testimony, COCO's K. Robert Hahn noted the proposal's shortcomings but termed it a "significant improvement," adding: "We do note, however, that even the best policy is worthless unless it is promptly and effectively implemented."

**U.S. MILITARY AGENCIES
DEPOT LEVEL MAINTENANCE**
Aircraft, Engines and Accessories
Contract and In-House Performance
As a Percent of Total
FY 1966-1978^E



^E Estimated

Both Army and Air Force in-house performance of depot-level maintenance for aircraft, engines and accessories have increased dramatically since 1966.





AVIATION'S First 75 Years

This year marks the 75th anniversary of powered flight and, simultaneously, the 20th anniversary of the first commercial service by American-built jetliners. This article by noted aviation writer Robert J. Serling commemorates the dual anniversaries by detailing the benefits that have accrued to the nation's economy and its traveling public through the extraordinary growth and efficiency of the U.S. air transportation industry. Serling, former aviation editor of United Press International, is author of the best-seller "The President's Plane Is Missing" and a dozen other books on aviation.

By Robert J. Serling *

Man's first powered flight covered 120 feet.

The progress in air transportation since that blustery day of December 17, 1903, at Kitty Hawk, North Carolina, can be summed up in this single comparison: you could easily duplicate the entire length of that historic flight inside the cabin of a modern jetliner and still have room to spare.

Aviation's achievements are impressive enough, but they are even more remarkable when silhouetted against the backdrop of their brief time-span—three-fourths of a century is but a mere heartbeat in history. There are more than 8.7 million Americans living today who were living when Orville and Wilbur Wright launched not just an airplane, but a technological genesis.

What we take so much for granted today—the speed, comfort, convenience, reliability and safety of air travel—was beyond the comprehension of most scientific savants in the early 1900's. Flying was considered then the equivalent of science fiction—gadgetry, gimmickry and wildly impractical.

'Wholly Visionary' Ideas

A full decade after the Wrights put Kitty Hawk into more than just geography books, noted Harvard astronomer William Pickering firmly denounced the idea that the airplane would someday become a major transportation vehicle.



"The popular mind," he wrote, "often pictures gigantic flying machines speeding across the Atlantic, carrying innumerable passengers. It seems safe to say that such ideas must be wholly visionary. Even if such a machine could get across with one or two passengers, it would be prohibitive to any but the capitalist who could own his own yacht."

Let us not snicker, however, at Professor Pickering; he wasn't as pessimistic as Simon Newcomb, a respected mathematician and scientist. In 1902 he was handed a model of the Wright Flyer by the two brothers who proposed to build it. They wanted his opinion and he gave it—handing the model back with a smile, he shook his head.

"Man will never be able to fly a heavier-than-air machine," Newcomb decreed.

For that matter, the most famous aviation expert in the United States, 10 years after Kitty Hawk, was asked about the chances of flying across the Atlantic. The expert was dubious.

"It is a bare possibility," he explained, "that a one-man machine without a float and favored by a wind of, say, 15 miles an hour, might succeed in getting across the Atlantic. But such an attempt would be the height of folly. When one comes to increase the size of the craft, the possibility rapidly fades away. This is because of the difficulties of carrying

sufficient fuel. It will readily be seen, therefore, why the Atlantic flight is out of the question."

That clouded crystal ball was the property of none other than Orville Wright.

Rapid Growth

The U.S. airlines were born in 1926, nearly a quarter of a century after the Wrights' flight. In their first full year, the airlines carried 6,000 passengers; in 1978, more than 250 million people will use the nation's scheduled air transportation system, representing a cross-section of economic and social strata that would turn public opinion pollsters green with envy.

Less than 30 years ago, only 10 per cent of the U.S. adult population had ever stepped aboard an airliner. The 1977 figure was 63 percent and climbing. Air travel motivation has changed, too. In the 1930's and 1940's, 90 per cent of flights were made for business purposes. Today, approximately half of all air trips are for non-business reasons, mostly vacations and leisure travel.

Commercial flying was once limited mostly to thrill-seekers, who regarded the airplane in the same spirit in which they took roller-coaster rides. A typical passenger would brag casually about a recent flight with an air of bravado—"Oh, by the way, I flew up to New York the other day," much as he might say, "I went three rounds with Jack Dempsey." An air trip was some-

thing to brag about, sheer survival being considered more of an achievement than getting from one place to another.

The greatest tribute that can be paid to commercial aviation today is the fact that it is taken so much for granted, in every respect—particularly that all-important factor: safety. For example, air sickness affected at least half of the people who flew in the 1930's; motion was a prime cause, of course, but psychiatrists say that fear added to unusual motion was an important element. Air sickness among today's travelers is extremely rare; the smoothness of jetliners plays a major role in reducing such discomfort, and there is a direct correlation in the reduction of fear of flying.

Air Travel Confidence

It is simple to pick a one-word explanation for the increasing acceptance and popularity of air transportation—confidence. There is no other way to explain why the 41 million persons who used Chicago's O'Hare Airport in 1976 represented the same number of total annual air passengers carried nationwide by all the airlines as recently as 1955. In 1952, the airlines flew 27 million customers—which happens to be about the same number handled just by Atlanta's airport during America's bicentennial year, and only slightly more than the Los Angeles airport served in 1976.

U.S. air transportation is more than



*Excerpted from a commemorative report prepared by Mr. Serling for the Air Transport Association.

AIR TRAVEL: Safer Than The Bathtub

On the basis of fatalities per 100 million passenger miles flown, the most common standard of safety measurement, the airline fatality rate has declined steadily since the government began keeping accurate records in 1937. Using the fairest perspective, a five-year average, the U.S. carriers compiled these rates per 100 million passenger miles compared with automobile travel:

**Passenger Fatalities Per 100 Million
Passenger Miles (5-Yr. Averages)**

	Air	Auto
1942-1946	2.08	2.74
1947-1951	1.65	2.20
1952-1956	.43	2.74
1957-1961	.51	2.32
1962-1966	.21	2.36
1967-1971	.18	2.20
1971-1976	.09	1.56

In 1959 and 1960, the first full two years of worldwide jet operations, the new planes averaged one fatal accident for every 150,000 hours of flight. By 1977, the U.S. airlines were flying nearly three million hours per accident.

In 1976 and 1977, the U.S. scheduled airlines flew five billion miles and had a fatal accident rate of 0.002 for every million miles flown—the lowest 24-month fatality rate in aviation history.

U.S. carriers in the past five years have averaged more than two million flights for every fatal accident.

Based on the accident rate over the past five years, you could fly more than 300 million miles before an accident. The overall odds in favor of a safe flight are 99.99998 per cent—which compares most favorably with virtually any form of human activity, including taking a bath.

an industry—it is a *system*, literally linking Main Street with the rest of the nation and, for that matter, the rest of the world.

The airlines in 1978 account for more than 80 percent of all public intercity passenger miles, carry nine out of every 10 intercity first class letters, serve more than 600 airports and carry more than five billion ton miles of freight annually—much of it priority material demanding fast delivery. Entire industries have been changed radically by the commercial airplane—flowers and food, to mention just two. Lettuce picked in California on a Monday can be eaten in a New England home Tuesday night. Life-saving medi-

cine, emergency replacement parts to prevent major industrial outages—even valuable horses—these are some of the thousands of items dependent on air transportation.

And so are people. Each of more than 40 U.S. airports handle more flights a year than London's Heathrow Airport, Europe's busiest. The technological miracle that is the jetliner has altered the nation's travel habits. Pittsburgh is next door to Paris, Binghamton around the corner from Bombay, Tulsa only a half-day away from Tokyo. A family departing Washington at 9 a.m. can be seeing the wonders of Disneyland by 2 p.m. the same day. A sportsman is able to leave New York in the morning and be casting for trout in a Colorado stream or pulling in a fighting marlin off the Florida coast the same afternoon. By compressing distance, the jet also has expanded time, providing extra hours, or even days, of leisure that were once spent enroute. What used to require at least a one-week vacation because of travel time requirements can now be enjoyed over a single weekend. It is no wonder that U.S. tourism has become more than a \$100 billion a year business, opening new vistas to millions.

Role In The Economy

The increasing role of the airlines in the nation's economy is due to several factors—some obvious and some not generally realized or appreciated. Speed and efficiency are prime reasons; of course, no one has yet to calculate the enormous man-hour savings achieved by the nation's business traveler through use of air transportation, nor the economic benefit from the availability of vastly increased leisure time.

Less visible but equally vital is the industry's contribution to fuel efficiency. Although the airlines carry the bulk of public intercity passenger traffic, they consume less than four per cent of petroleum fuel used in the United States. In fact, the carriers have reduced fuel consumption even as they boosted traffic. In 1977, they used 400 million fewer gallons than in 1973, while flying 38 million more passengers and more cargo. Since 1973, when the fuel crisis began, passengers flown per gallon of fuel used have jumped some 21 per cent.

The airlines employ more than 300,000 men and women; another 125,000 persons are employed by companies producing aircraft, engines, spare parts and other related hard-

ware. Scores of thousands of other Americans work at jobs dependent on commercial aviation—at airports, hotels and motels, restaurants, travel agencies and public surface transportation businesses such as taxi firms and bus companies. In the average large American city, one the size of Pittsburgh, for example, approximately one out of every 20 workers is engaged in air transportation or a related job. A recent study of San Francisco International Airport shows that the economic impact of the airport on the Bay Area amounts to more than \$1.8 billion annually.

When the jet age began 20 years ago, prophets of pessimism claimed these new high performance aircraft were too radical a departure from normal flight. They said jets were too much plane for any mere man to handle safely, wouldn't fit into air traffic control, would be operating in the unknown environment of higher altitudes, and so on ad infinitum. In brief, these pessimists predicted that the airlines' fatality rate would climb higher than the new jets themselves.

They were wrong—by every statistical yardstick that can be applied to safety performance.

Rigid Safety Standards

Air travel is safe, largely because safety is not only the highest priority



of the industry, but is almost a religion. This is a statement buttressed by facts that go beyond cold statistics. Many foreign carriers send their flight crews to U.S. airline training centers, using American methods and techniques. The overwhelming majority of delays for mechanical reasons are based on safety considerations — no airline moves one inch away from a gate unless all components directly or even indirectly associated with safe operation are functioning perfectly.

Man and machine; there is no compromise with either. An airline pilot's training never stops, whether he has 3,000 hours in his log book or 30,000 hours. Flying ability and command capability are tested twice a year, and refresher courses are required annually. The same rigid standards are applied to the machine, from drawing board to operating schedules. The wings of a modern jetliner are 50 per cent stronger than required by federal regulations—in one structural test, a wing was deliberately deflected some 30 feet upwards out of its normal level without popping a rivet, and the flight tests for this same plane lasted a full year at a cost of \$28 million.

Just as training never ceases for a pilot or flight attendant, neither does the inspection, testing and maintenance of an airliner. A jet receives

five man-hours of maintenance for every hour of flight, at an annual cost of nearly \$1 million per aircraft. U.S. carriers average 23 mechanics for a plane in their fleets and spend approximately \$2 billion a year on maintenance.

The industry spends more than \$100 million annually for flight crew training—a sum representing the airlines' entire gross in 1940. After initial training, each flight attendant must undergo recurrent safety training twice a year.

The public takes safety for granted—simply because the airlines do not.

Technology and Productivity

Inevitably, the airline industry by the very nature of its expansion, is more mass-oriented than it used to be. In 1932, just before the dawn of the DC-3 era—the airlines operated only 700 flights daily. They now operate almost that many every *hour*—13,000 per day, in aircraft carrying up to 40 times more passengers at six times the speed.

To maintain, amidst a whirlwind of technological change, a service that still emphasizes personalized courtesy and understanding adds up to a remarkable philosophical commitment by a people-minded industry.

There are 300,000 reasons why the airline industry, more than any other, regards technology as a supplement to, rather than a replacement for, the human factor—namely the more than 300,000 men and women who make up the airline family.

Certainly one of the most compelling reasons for the success of the scheduled airline system is the fact that a member of the public can walk into the office of any scheduled airline or travel agent in any city and buy a ticket which will take him or her to any point served by that airline or any other scheduled airline throughout the world. The same service is available for freight shipments. The airlines' inter-carrier cooperative program for passenger and freight handling is unique among transportation modes.

Air travel is the epitome of applied technology. It is a jetliner containing 4.5 million parts, 100 miles of wiring and 2,000 pieces of tubing. An aircraft built from 75,000 engineering drawings, which requires 12,000 pages of maintenance manuals, and whose seats alone cost more than an entire twin-engine airliner of the late 1940's.

It is a single giant airliner costing up to \$50 million, a price tag five times the market value of the whole airline

industry in 1938. It is 2,300 modern aircraft which each year complete 97 percent of their schedules, often in weather that would have grounded them 20 years ago. It is a means of transportation that has gone from cold chicken and lukewarm coffee served by copilots to full-course meals and first-run movies.

Air travel is 15,000 travel agents around the nation bringing their expertise to millions of our citizens. A vital part of the airline industry's marketing and sales effort, travel agents today account for more than half of all airline tickets sold.

Air travel is a system providing the best air transportation in the world for the lowest cost; U.S. air fares are priced 50 per cent under European tariffs over similar distances. Today, more than 30 per cent of airline passengers take advantage of discount fares.

Air travel is technology in constant motion—it's handling 375 million individual pieces of luggage annually, but still trying to figure out ways to handle them better; it's completing 80 per cent of more than one million daily ticket reservations within three minutes by phone—while simultaneously working on new ways to speed the process.

Airline employees boast one of the highest productivity rates of any industry. Their output per employee, from 1971-1976, had an annual growth rate of 4.7 per cent; the rate for all U.S. industries was 1.2. One obvious explanation is that airline people work with superb technological tools, but that does not tell the whole story. One has to delve into the intangibles—an unspoken esprit de corps that has been part of the industry since the days of the rattling trimotors...a kind of gung-ho defiance of adversity...a reservoir of good humor and professionalism.

If it were possible to sum it up in one word, it would have to be Tradition.

The industry has changed.

But Tradition has never changed, not even in the technological revolution that has seen mankind go from a 120-foot flight of only 75 years ago to supersonic passenger travel spanning the Atlantic Ocean in less than four hours.

For Tradition lives in people—a state of mind and of heart as old as aviation itself. It is as much a part of the airline industry as the great silver birds that fly its routes. It is a link with the past—and a challenge for the future.





Shown at its first public display in Seattle, Washington, is the NASA/Boeing Quiet Short-haul Research Aircraft (QSRA), described as "the quietest jetliner ever built."

Aeronautical Research— CLEANER, QUIETER AIRPLANES

This summer the National Aeronautics and Space Administration will conduct initial test flights of a new research airplane designed primarily to demonstrate new forms of lift that may hasten commercial passenger service from small airports close to city centers.

But of greater interest to the public is the noise the airplane will make—or won't make.

Called the QSRA, for Quiet Short-haul Research Aircraft, the unique plane is the quietest jet ever built.

It's one of four significant programs now underway to improve the environmental characteristics of airplanes. The others have names also almost as exotic as QSRA: QCSEE, which stands for Quiet, Clean Short-haul Experimental Engine; SCERP, which stands for Stratospheric Cruise Emissions Reduction Program, and QCGAT, for Quiet, Clean General Aviation Turbofan.

On the decibel scale technical people use, QSRA's noise level is about *one-thirtieth* that of the noisier jetliners now flying. If that's not particularly meaningful, try it this way: You are standing two city blocks from the side of a runway and an equal distance from a highway; the noise you will hear from the QSRA is roughly equivalent to the mild rumbling hum of a well-tuned truck cruising the highway.

Built for NASA by Boeing Commercial Airplane Co., the QSRA exemplifies a relatively new directional thrust in NASA/industry aeronautical research. For decades, the principle goal has been advancement of aircraft performance. It still is, but there is a difference: performance gain must be accompanied by advances which benefit the public as well as aircraft operators. In other words, public attitudes and pressures have brought about a shift in research emphasis wherein reduction of noise, pollution and fuel expenditure have become priority targets of aeronautical research.

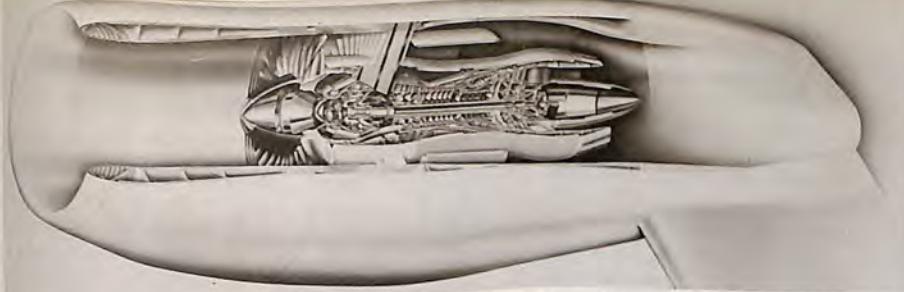
The QSRA is visible evidence of progress in noise reduction. It was designed so that plane noise will be essentially confined within airport boundaries. But its importance as a research tool extends well beyond noise; it has triple the lifting capability of any jetliner in service, exceptionally high climb and descent angles, and the ability to operate from very short runways measuring from 1,500 to 4,000 feet.

Success of the QSRA could spark formal development of the long-discussed separate short haul air transportation system, in which short take-off and landing (STOL) aircraft would operate independently of the primary,

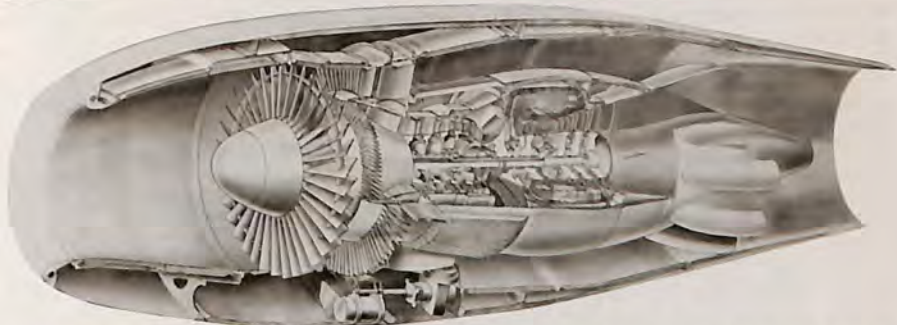
long-haul system. STOLcraft would siphon off much traffic from major airports and divert it to existing or new small airfields closer to population centers. This would solve a problem of major dimension which looms on the horizon—airport congestion.

The STOL concept has been studied for more than 20 years, but it was not until the start of this decade that it became technologically feasible. Active STOL development was not undertaken at that time for two major reasons: first, airport congestion predicted for the early seventies did not materialize, and second, a wave of public resistance to airplane noise blocked airport expansion in general and development of close-in airports in particular.

Now, however, commercial air traffic is once again on the upswing and snowballing, so the airport congestion problem threatens to become acute in the 1980s. Since short-haul trips of less than 600 miles account for about half of U.S. air travel, the STOL concept takes on new importance as a congestion-alleviating measure. Thus, the relatively unheralded QSRA has become important because it is a developmental pathfinder for future STOLs, and because a demonstrably quiet research plane could help change public attitudes.



Drawing shows nacelle of General Electric's Quiet, Clean Short-haul Experimental Engine (QCSEE), being developed in two versions. In this version, the turbofan's exhaust flows over the top of the airplane wing, which diverts sound upward and reduces the noise heard on the ground.



Garrett AiResearch's Quiet, Clean General Aviation Turbofan (QCGAT), one of two NASA projects designed to reduce noise and exhaust emissions of general aviation planes and helicopters.

The QSRA is not a prototype of an operation airliner, but rather a "flying workshop" to be used in testing advanced technology for future commercial STOL planes. A relatively small airplane weighing 50,000 pounds, its development began only two and a half years ago.

To minimize construction costs, Boeing started with a used fuselage from a de Havilland C-8A Buffalo, a twin-turboprop short-haul aircraft. NASA furnished a redesigned tail assembly and Boeing built an entirely new and aerodynamically advanced wing. Instead of the former turboprops, the developers installed four Avco Lycoming turbofans, each producing 7,500 pounds of thrust. The engines were mounted above the wing instead of conventionally below it.

This unique overwing engine mounting is the key to the major aim of the QSRA program: test and development of "propulsive lift" technology, which gives the airplane exceptional terminal area performance and contributes much of the noise reduction. The QSRA embodies a propulsive lift technique called the "Upper Surface Blowing" approach, or USB. In this technique the engine exhaust blast flows over the upper surface of the wing, then curves downward, following the contour of the specially-designed wing

and flaps. The down-directed air exerts an additional lifting force, permitting the QSRA to fly steeper approach and climbout angles. Part of the air is directed through wing and aileron surfaces to enhance low-speed performance and control, providing a bonus in maneuverability and safety.

The significant noise reduction is the result of three factors. The engines are "acoustically treated"—soundproofed—to muffle internal noise. The sound created by the high-speed engine exhaust is blocked by the wing and diverted upward, away from the "eardrum zone" below. And the airplane's steep climb and descent characteristics enable pilots to avoid flying over populated areas at the relatively low altitudes of normal take-offs and landings.

Boeing will conduct the initial series of test flights through September of this year, then the QSRA will be turned over to the NASA's Ames Research Center, Moffett Field, California, for a more extensive test program lasting perhaps two years. After that, QSRA will be used as a flying research laboratory for checking out still more advanced technology, such as anticipated improvements in propulsive lift, new engine soundproofing concepts, and new navigation, guidance and control systems. Although the QSRA

program focuses on short-haul airplane research, many of the current and anticipated technology advances are also applicable to tomorrow's conventional, longer-haul jetliners.

Says Boeing board chairman T.A. Wilson: "In the years ahead, when the air transport system requires a quiet, short-haul jetliner, much of the needed technology should be well in hand. Although it may be a decade or more before STOL operation becomes commonly accepted, it is not too early to start filling our technology bank.... We expect this airplane to make significant contributions to aerodynamics, noise, flight operations and guidance control. Past experience, however, indicates that we may reap unexpected benefits from the application of a new technology. The development of the jet engine and swept wings opened a new era in commercial air transportation. Perhaps this aircraft will help add another dimension to air travel."

The QSRA highlights a broad NASA/industry research effort which seeks major improvements in the environmental characteristics of airplanes—not only curbing noise but simultaneously reducing engine pollution. A second major project is QCSEE—pronounced Quicksee—which stands for Quiet, Clean Short-Haul Experimental

Engine. QCSEE is being developed by NASA's Lewis Research Center with contractor assistance from General Electric Co.

QCSEE goes beyond the QSRA, because the latter is a small airplane designed only for research work. NASA is looking ahead to the STOL of tomorrow and assuming a four-engine operational plane which could carry 150 passengers. This would require propulsion units with two to three times the thrust of QSRA's engines. Since noise and polluting emissions generally increase with power output, more extensive corrective measures are needed to make the operational STOL "clean and quiet."

The basic engine type being explored in the QCSEE project is a turbopan, which is inherently quieter than the turbojet. In the turbopan, some of the air goes through the combustion chamber to be mixed with fuel and burned; another portion, however, bypasses the combustor and is ducted—unburned—to the rear of the engine, where it merges with the burned exhaust gas. The cooler bypass air moves more slowly than the exhaust gas, and when the two airstreams merge the net result is reduced velocity of the total exhaust. This has a number of influences on engine efficiency in general and it also reduces the noise of the exhaust, a major component of overall noise. That is why the newer turbopan-powered wide-body jetliners are quieter than their turbojet predecessors.

One part of QCSEE research focuses on further reducing exhaust velocity without sacrificing engine performance. Another area of effort involves redesign of engine innards to lower the noise generated by rapidly-rotating machinery, such as the fan, compressor and turbine. Investigations also include ways of reducing combustion noise, the noise associated with pressure fluctuations due to uneven burning. Finally, advanced and more effective methods of acoustic treatment are being employed. In brief, QCSEE attacks each of the noise-producing elements of an engine in an effort to get an overall reduction of major order. Additionally, new techniques are being explored to promote more complete burning of the air/fuel mixture—"clean combustion"—which substantially reduces the amounts of objectionable emissions in the engine exhaust.

GE has built two different versions

of the QCSEE. One is the Over-The-Wing (OTW) configuration, which corresponds to the Upper Surface Blowing concept employed in QSRA. But to give airplane designers more latitude, researchers are also working on the more conventional Under-The-Wing (UTW) approach.

Both systems have been ground tested and NASA reports: "The results indicated that all major performance goals were achieved. The specific noise technology could provide a four-engine, 150-passenger STOL aircraft with a 90 (decibel) noise footprint of less than one square mile." Translated, that means there is real promise of developing engines with noise levels in the same ballpark as QSRA—but for a much larger airplane. The two QCSEE configurations are now at Lewis Research Center for advanced testing to verify noise levels with engine nacelles and wing flaps installed; this phase of the program will be completed next year.

QCSEE, like QSRA, focuses on short-haul aircraft research. But, once again, many of the research advances can be applied to conventional (CTOL) aircraft. Aside from specific projects like QCSEE, NASA is also conducting a "generic research and technology" program "which is broadly applicable and of fundamental benefit to many aircraft types." It includes, among other things, parallel research on clean combustion, noise attenuation by soundproofing, lowering machinery noise and improving general engine efficiency to reduce fuel consumption.

In a special project, NASA is looking at a matter of national concern, the question of how aircraft engine emissions at high altitude influence Earth's layer of ozone, and how potentially harmful emissions can be curbed. The Stratospheric Cruise Emissions Reduction Program (SCERP) seeks to develop hardware concepts for reducing discharges of nitrogen oxide by changing the ways in which fuel and air are mixed for combustion.

Still another area of aviation/environmental research addresses the noise and pollution problems of the general aviation community. NASA notes:

"In some areas, business jet aircraft are restricted from certain operations under strict local curfews. New airport construction is influenced by environmental concerns. Environmental impact of the general aviation fleet must be reduced both to meet regulations

and to become a more acceptable partner."

Most of the 1,600 business jets now flying in North America, NASA says, have engines not specifically designed for low noise. Therefore, NASA has instituted an experimental program "to demonstrate applicability of large engine research to the small turbopan."

The program is called QCGAT—"Quickgat"—for Quiet, Clean General Aviation Turbopan. QCGAT embraces two major projects being conducted by Lewis Research Center with the help of two contractors—Avco Lycoming, which built the QSRA engines, and The Garrett Corp.'s AiResearch Manufacturing Co., producer of engines for general aviation planes and helicopters. Generally, QCGAT involves development of small experimental turbopans which incorporate technological advances similar to, but less extensive than, those of the QCSEE program—for example, reducing the velocity of the exhaust stream, developing new techniques for cleaner combustion, and applying new types of soundproofing to engines and nacelles.

Garrett-AiResearch is working on a 4,000 pound thrust QCGAT, adapting new technology to the company's basic TFE731 engine, power plant for such executive craft as the Lockheed Jet-Star, Dassault Falcon and the Learjet. Lycoming is concentrating its efforts on an engine in the 1,600 pound thrust class, which could be used on light executive planes or commuter airliners. Both engines are running on test stands; after contractor checkout, they will be delivered to Lewis Research Center for further test and experimentation.

Going a step further, NASA is studying the possibilities of even smaller turbine engines of about 800 pounds thrust. Such engines could power light general aviation planes now propeller-driven.

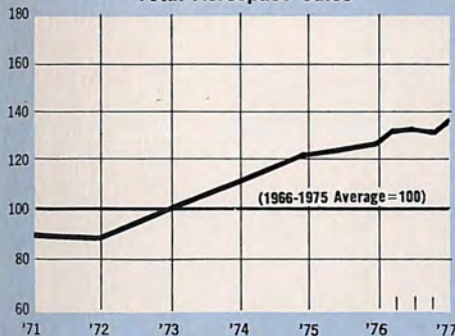
So, a lot of effort is being expended in "clean and quiet" research. Some of the technology is well-advanced, ready now or in the near future for application to production engines and airplanes. In other cases, like QCSEE, the new technology should be ready for the next generation of commercial jetliners, expected to debut in the 1980s. A great deal of research remains, but progress indicates that the civil airplane is well on its way to becoming a "more acceptable partner" to the community.

AEROSPACE ECONOMIC INDICATORS

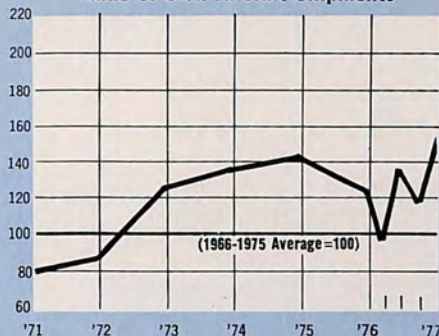
CURRENT

OUTLOOK

Total Aerospace Sales



Value of Civil Aircraft Shipments



New Orders — Monthly Average



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

ITEM	UNIT	PERIOD	AVERAGE 1966-1975 *	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD 4th QTR. 1977
AEROSPACE SALES: TOTAL	Billion \$	Annually	26.6	30.4	31.6	32.9
	Billion \$	Quarterly	6.4	7.5	8.0	8.8
AEROSPACE SALES: TOTAL (In Constant Dollars, 1972=100)	Billion \$	Annually	27.3	22.3	22.2	22.8
	Billion \$	Quarterly	6.9	5.5	5.6	6.1
DEPARTMENT OF DEFENSE						
Aerospace obligations: TOTAL	Million \$	Quarterly	2,720	4,355	4,785	4,058
Aircraft Procurement	Million \$	Quarterly	1,976	2,613	1,980	3,152
Missiles & Space Procurement	Million \$	Quarterly	744	1,742	2,805	906
Aerospace outlays: TOTAL	Million \$	Quarterly	2,424	2,381	2,392	2,056
Aircraft Procurement	Million \$	Quarterly	1,757	1,665	1,639	1,602
Missiles & Space Procurement	Million \$	Quarterly	667	716	753	454
Aerospace Military Prime Contract Awards: TOTAL	Million \$	Quarterly	3,327	4,424	4,597	5,010
Aircraft	Million \$	Quarterly	2,109	2,877	2,970	3,458
Missiles & Space	Million \$	Quarterly	1,218	1,547	1,627	1,552
NASA RESEARCH AND DEVELOPMENT						
Obligations	Million \$	Quarterly	780	1,032	541	1,001
Expenditures	Million \$	Quarterly	789	825	736	824
BACKLOG (70 Aerospace Mfrs.): TOTAL	Billion \$	Quarterly	28.6	37.7	39.5	44.3
U.S. Government	Billion \$	Quarterly	15.9	22.1	22.3	25.4
Nongovernment	Billion \$	Quarterly	12.7	15.6	17.2	18.9
EXPORTS						
Total (Including military)	Million \$	Quarterly	1,038	2,167	1,657	2,230
New Commercial Transports	Million \$	Quarterly	345	732	342	636
PROFITS						
Aerospace — Based on Sales	Percent	Quarterly	2.7	3.2	4.3	4.1
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	5.0	5.0	5.3
EMPLOYMENT: TOTAL	Thousands	End of Quarter	1,166	898	903	894
Aircraft	Thousands	End of Quarter	650	485	488	477
Missiles & Space	Thousands	End of Quarter	114	85	81	81
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	End of Quarter	4.38	6.69	7.05	7.23

* 1966-1975 average is computed by dividing total year data by 4 to yield quarterly averages.

† Preceding period refers to quarter preceding latest period shown.

Source: Aerospace Industries Association

AEROSPACE INDUSTRIES ASSOCIATION

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



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OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • FALL 1978



AIR
TRANSPORTS:
The New
Generation





Notable views of notable people on aerospace matters...

aerospace perspectives

Secretary of Defense Harold Brown, *writing in Command magazine, a publication of the Department of Defense:*

"We have no illusions about the Soviet Union. Their view of history, of the world, and of the future is very different from our own. We do not believe we should ever rely on good will as a substitute for good defense...

"Most Americans would prefer to use U.S. resources for other than military purposes. But as long as the world stays the way it is, and competition remains at least as important as cooperation on the international scene, U.S. military strength—like the postwar U.S. role and responsibility—will have to remain another fact of modern life...

"If we manage our resources properly, we do not have to outspend the Soviets by a large margin in order to assure our security. We can outthink, outdesign and outperform the Soviets with the resources we have and the steady increases we are requesting. I have consistently been of the opinion that careful, systematic and thoughtful analysis—unencumbered by ideological baggage—along with technical proficiency and efficiency in management are where our strengths lie.

"To keep our position in the long-run competition, these approaches must characterize our style. A dash less of alarm, more than just the flavor of analysis, a strong infusion of technology, and a double shot of efficiency are what we need."

Dr. Adolf K. Thiel, *Senior Vice President, Defense & Space Systems Group, TRW Inc., before the Subcommittee on Space Science and Applications of the House Committee on Science and Technology:*

"The dependence of foreign nations and foreign companies on U.S. space technology is far less than it was only 10 or 15 years ago. While it is still true that the U.S. has a broader space technology base, we must now expect some international competitions to be won by non-U.S. space organizations where the critical technologies lay in their area of particular expertise.

"Does this mean that the United States should view foreign competition with apprehension? Does foreign capability that we helped to create through cooperative programs post a threat to the future viability of our own aerospace industry and the U.S. economy? I believe that the answer is no, as long as we continue to progress.

"It is our advanced technology that has kept the U.S. in the forefront of the space age up to now, and will keep us there in the future. It is important to note, however, that the lead will become increasingly difficult to maintain and that there will be a growing necessity for government and industry to be mutually supportive in the planning and implementation of long-range space programs."

Thomas J. Murrin, *President, Westinghouse Public Systems Co., at the Aviation Week Conference on New Directions for NATO, Brussels, Belgium:*

"As we well know, the buildup of the Warsaw Pact military forces, both in quantity and quality, presents many difficult challenges to our NATO alliance...But, in my view, the most significant factor is that for the long-term future the Soviet leadership appear to perceive technology as the key to a permanent shift in the global balance of economic, political and military power. They are sustaining what may be the world's largest effort in basic and applied science and have the largest research and development workforce in the world—over 800,000 scientists and engineers. Since 1970 they are reported to have added as many scientists and engineers to the Soviet military R&D effort as we have currently in the entire defense-supported R&D effort."

Dr. Umberto Nordio, *Executive Chairman of the Board, Alitalia, in an address to the Aero Club of Washington:*

"In this Year of Our Lord 1978, this maddening—and to me fascinating—world we live in is split into two economic systems. What makes our system different from the other is not the presence of bureaucrats or consumers. These are to be found in either system. What makes our system, the free world system, different is the presence of businessmen. They are not to be found on the other side. Hit them, squash them, eliminate them, and you will have eliminated the difference."

John L. Frisbee, *Editor, Air Force magazine, in "The Heritage Of Kitty Hawk," an Air Force editorial commentary on the 75th anniversary of powered flight.*

"The miracle of flight through and beyond the atmosphere has opened men's minds to new ideas, to an extent unequaled since the Renaissance. The scientific and technical achievements that have advanced powered flight have also contributed to a bounty of creature comforts beyond the wildest dreams of past generations...

"That powered flight has not been an unmitigated good is no fault of an essentially neutral technology, but of the ways in which men have sometimes chosen, or been forced, to exploit it. We cannot change history, but we must try to control flight's future course for the good of this nation and of the world."

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CONTENTS

- 2 **AIR TRANSPORTS:
THE NEW GENERATION**
By JAMES J. HAGGERTY
Associate Editor, Aerospace Magazine
- 8 **VIKING:
MARS MISSION ACCOMPLISHMENTS**
- 10 **ROTORCRAFT R&D:
TOMORROW'S POTENTIAL**
- 14 **TECHNOLOGY:
BITING THE HAND THAT LEADS US**
- Back Inside Cover: **ECONOMIC INDICATORS**

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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EXPORT OUTLOOK BRIGHTENS

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



This issue of Aerospace magazine reports on the efforts of the aerospace industry to hold onto its strong position in two important export markets—commercial transport aircraft and helicopters. These two product lines are among the many reasons that the aerospace industry achieved a \$7 billion trade surplus last year while the nation as a whole was suffering a record trade deficit.

Unfortunately, American business—including the aerospace industry—has been concerned in recent years that our own government has become a negative influence in foreign trade rather than a supportive partner. A long list of impediments to successful foreign trade has built up as government has strapped layer upon layer of regulation upon American business. But recently President Carter and Secretary of Commerce Juanita Kreps announced a series of measures they believe will stimulate U.S. trade abroad. These include:

1. Increased direct government assistance to United States exporters.
2. Reduction of domestic barriers to exports.
3. Reduction of foreign barriers to exports and development of a fairer international trading system for all exporters.

All have great importance to the aerospace industry. It is in Item Two, however, that we see the most hope. Here the President has promised to have all executive departments take into account and weigh as factors the possible adverse effect on our trade balance of their major administrative and regulatory actions. The President says, for example, the Departments of State, Commerce and Defense will take export consequences fully into account when considering the use of export controls for foreign policy purposes.

He says he will eliminate the present uncertainties concerning the type of environmental reviews that will be applicable to exports. In both areas, American business has previously been stymied by our own government's policies, while foreign salesmen have rushed to sell their products free of such restrictions.

There are many other aspects of the President's statement, including a reasonable warning that the export problem, long in the making, will not be dramatically improved overnight.

But if the policies are effective, commercial transports, helicopters, other aerospace products and many more products of U.S. industry will be sold overseas with less government interference. Such sales will create jobs for American workers and profits to benefit American investors and to stimulate new research and development to keep America economically and technically strong.

On October 26, 1958, a Pan American Boeing 707 departed New York for Paris, marking the initial flight of an American-built jetliner in commercial service. The U.S. had arrived late on the jet transport scene; the British Comet, French Caravelle and Soviet Tupolev 104 had all preceded the 707 in passenger carrying operations. But by virtue of technological superiority, the latecomer American plane builders swiftly achieved dominance of the commercial transport market and held it through two decades; today, 85 percent of the jetliners flying the world's airways are of U.S. manufacture.

As we commemorate the 20th anniversary of U.S.-built jet service, American manufacturers face a new threat to their traditional lead in transport sales. The technology gap has narrowed and foreign competitors are mounting their strongest-ever challenge. The commercial transport segment of the U.S. aerospace industry is responding with plans to introduce a new family of advanced technology jetliners. Here is a report on the competitive situation and the types of airplanes and engines on which the U.S. is counting to maintain its leadership, an important factor in the U.S. economy as a whole and the international trade balance in particular.

The summer of '78 witnessed a number of major developments in the world of air transport production:

- Early in July, having received a substantial number of orders, the French/German consortium called Airbus Industrie formally committed itself to development of the A310, an advanced technology version of its Airbus twin-engine transport.

- Only a week later, while aviation observers were still digesting the significance of this new threat to U.S. air transport dominance, Boeing Commercial Airplane Co. threw a counterpunch. On the basis of an order from United Airlines, the largest commercial transport order in aviation history,

Boeing launched development of its new 767 widebody twinjet.

- In August, Lockheed Aircraft Corp. announced plans for an advanced technology, flexible-range version of its L-1011 TriStar called the Dash 400.

- At the end of August, Boeing announced still another new development: the twinjet standard body 757, a companion to the 767 aimed at a different segment of the market. Orders for 40 757s from Eastern Airlines and British Airways provided the production base which enabled formal start of hardware development.

These airplanes, along with the earlier launched McDonnell Douglas DC-9 Super 80, are the advance mem-

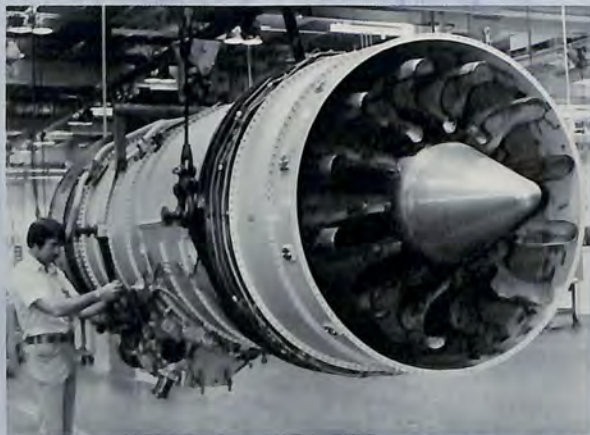
bers of a new generation of jetliners which will begin airline service in the early 1980s. Several other models, on both sides of the Atlantic, are waiting in the wings; years of research have produced firm designs, but transport builders cannot afford to lay out heavy development money—in some cases more than a billion dollars—until airline customers sign contracts.

There will be a great many orders. The airlines, financially pressed for several years, deferred orders for new airplanes to replace older, noisier and less efficient transports. Now that they are regaining financial health, they must not only replace older planes, they must also acquire additional capacity to meet rapidly-mounting demand; although airline traffic is already at record levels, estimates indicate that it will almost double between now and 1990. Thus, the greatest air transport production boom in history is forecast. Estimates of airline purchases over the next decade range upward from \$60 billion and the figure could reach \$100 billion.

The competition among aircraft builders will be—and already is—intense. European manufacturers have long thirsted for a greater share of the market and they are working hard to get it. American plane builders are equally determined to maintain their market dominance. The international struggle is far more than a battle among manufacturers—it has strong effect on the economies and the peo-

1. Pratt & Whitney JT8D Dash 209. The metal, sculpture-like fixture in the Dash 209's tailpipe is an exhaust mixer which reduces jet engine roar, one of the major causes of aircraft noise. In the turbofan type of engine, there are two separate streams of air. One flows through the combustion chamber, is mixed with fuel and burned, the other bypasses the combustor and is ducted—unburned—to the rear of the engine. The mixer combines the high velocity stream of exhaust gas with the slower bypass air stream to create a uniform-speed exhaust; the result is lower noise and lower fuel consumption. Noise and fuel burn of the Dash 209 are further reduced by internal design techniques. This engine, which will make its service debut on the McDonnell Douglas DC-9 Super 80, features lower levels of objectionable exhaust emissions in addition to sharply reduced noise and fuel expenditure.

2. McDonnell Douglas DC-9 Super 80. Scheduled for operational use in 1980, the Super 80 will be the first of the new generation of U.S. jetliners to enter airline service. It looks very much like earlier members of the DC-9 family, but it contains a number of advanced technology features. Principal among them are new turbofan engines which combine reduced fuel consumption with lower levels of noise and exhaust emissions, and a substantially larger wing which further contributes to fuel savings. The Super 80 is 43½ feet longer than the original DC-9 and—depending on customer's choice of seating arrangements—carries roughly twice the passenger load (137 to 172 passengers). The airplane will operate for the most part on routes of less than 1,000 miles, but its designers built in additional range capability to make it suitable for medium-range flights of about 2,000 miles with full passenger load.



ple of the various nations involved.

Of paramount importance is the international trade balance. The U.S. is already staggering under the impact of huge trade deficits which have caused an alarming decline in the value of the dollar and increased inflation at home. The nation can ill afford any reduction of transport sales abroad, which has been one of the bright areas of a generally gloomy export-import picture. In fact, a national aim is to increase exports; highly-valued high technology products, such as jetliners, offer the best opportunity for improving the nation's export posture.

New jetliner orders also mean new jobs, a particularly important matter at a time of high unemployment in the U.S. Tens of thousands of jobs are involved in the international competition; one indicator is a labor union estimate that a single United Air Lines order to Boeing may generate as many as 15,000 new jobs.

Elements of the Competition

One might assume that, having dominated the jet transport scene for two decades, U.S. manufacturers would be favorites in the new round of international competition. That's true to some degree, but there have been a number of changes in 20 years, changes that have considerably eroded the American competitive position. Still, U.S. industry retains some of its traditional advantages.

One of them is technology. Although foreign plane and engine builders have substantially improved their technological capability, the U.S. is still Number One. Another edge is the continuity factor. Most of the world's airlines are now flying American-built equipment. Operators know that U.S. planes perform well and that they are designed with utmost attention to operator profitability; they know, too, that they can count on effective post-sale support from U.S. producers. Like the home consumer pondering purchase of a new TV, airlines tend to favor manufacturers who have served them well—unless there are compelling reasons to change.

Still another advantage is the broader American product line. It must be remembered that the competition is not confined to the new generation of airplanes; there is a steady flow of orders for transports already in production, such as the Boeing 707, 727, 737, 747, Lockheed's L-1011 TriStar and the McDonnell Douglas DC-9 and DC-10. The U.S. offers current or new aircraft across the entire spectrum of airline needs with the single exception of the supersonic transport, which plays little part in the competition for the 1980s.

These American plus factors make it necessary for Number Two—foreign competitors collectively—to try harder. They are doing so, and they have one major advantage over U.S. manufacturers: the strong backing of their

governments.

Recognizing the economic value of technology advancement, foreign nations have made increasingly large investments in research and development, especially in commercial transport technology; by contrast, the U.S. R&D growth rate has declined. Foreign R&D investments are paying off in greater technological capability, evidenced by the growing number of foreign-built aircraft entering the world inventory.

Foreign government support goes well beyond R&D; it has several other influences in the current competition, one of them "directed procurement." Most foreign airlines are wholly or partially government-owned; this creates a situation whereby the government may tell its airline what type of airplane to buy, without regard for technological merit.

Foreign competitors have a big edge in government subsidization of commercial transport development programs. U.S. plane builders must raise development money from private sources. But most foreign manufacturing companies are either nationalized or government controlled. Thus, foreign governments are often participants in jetliner programs, absorbing most of the heavy financial risks and putting up 50 to 90 percent of the costs of launching a new program.

Foreigners charge in rebuttal that U.S. manufacturers are similarly subsidized by NASA technology develop-



Air Transports: The New Generation

BY JAMES J. HAGGERTY
Associate Editor, Aerospace Magazine



3

4

ment and by commercially-applicable fallout from military aircraft programs. It is not a valid argument. NASA research does make a contribution, but it is modest in relation to overall transport development requirements. As for the military fallout benefit, the argument suffers from outdated information. There was a time when commercial plane builders got a developmental headstart by applying some technology earlier developed for military aircraft. But in the last 20 years, there has been sharp divergence of military and commercial emphasis; today there is little fallout from government-sponsored programs. In fact, it sometimes works the other way. The recent military purchase of McDonnell Douglas DC-10s as transport-tankers is a case where the government got the fallout benefit, since the development costs had already been paid by private enterprise.

Additionally, government backing with regard to financing airplane sales make it possible for a foreign competitor to offer a prospective customer a better deal. In recent instances, foreign manufacturers have won important airplane and engine sales by providing—with government help—extremely generous loan terms, such as long-term, full-purchase-price guaranteed loans with no down payment. Such terms are in violation of an exist-

ing international agreement and would not have been possible had the airlines opted for American equipment.

Foreign government assistance takes other forms. A recent case in point was a competition involving the U.S. McDonnell Douglas DC-10 and the French/German Airbus; the customer was China Airlines of Taiwan. The Airbus won the order—but, some observers say, only because the French government sweetened the deal by throwing into the package landing lights in Paris for the Taiwan airline. This deal, another apparent violation of the international rules, drew the ire of Rep. Mark Hannaford of California, who protested vigorously and said he would pursue "a legislative solution to this kind of predatory competition."

So, in addition to improved technological posture, foreign competitors have a lot of advantages not shared by their American counterparts. The latter find themselves competing not only with foreign producers but with foreign governments as well. U.S. industry officials have sharply criticized unfair foreign competitive techniques and called for U.S. government action to correct the trend or to provide similar assistance to American airplane and engine manufacturers.

Areas of Competition

Excluding very short-haul commuter

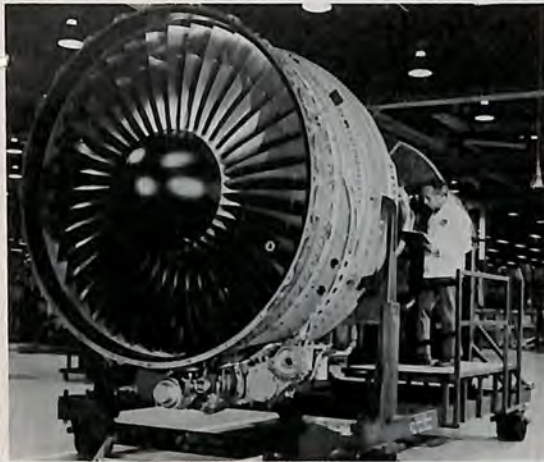
airliners, but including planes currently in production which will be flying throughout the 1980s, there may be more than a score of commercial jetliner types competing for sales.

Not counting the airlines of the communist world, there are some 4,800 jetliners in service today. About one-fourth of them are more than 10 years old; they constitute the replacement market, estimated at about 40 percent of the total market for deliveries in the eighties; the rest of the market lies in the need for additional capacity. Most of the aging aircraft to be replaced are in the medium-range, medium-capacity class. In addition, studies of projected traffic growth indicate that the greatest need for additional capacity will also be in the medium-range, medium-capacity category. The differing route structures and other requirements of the various airlines make it difficult to define this category precisely. For simplicity, industry marketing people are calling it the 200-seat class; actually, seating plans accommodate from 180 to 230 passengers.

There is also large market potential for new airplanes of lesser capacity, for use on short-haul routes or on certain medium-range trips where passenger demand does not require the higher-density of the "200-seat" jetliner. In this category are new generation airplanes ranging from feeder



5



6

liners with fewer than 100 seats to relatively large twinjets accommodating up to 180.

In the large airplane category—those seating upwards of 230 and having transcontinental or longer range—all currently operating jetliners are products of the last decade and do not figure in replacement plans. However, the demands of additional capacity for future traffic growth indicate that substantial new orders will be forthcoming. In this class, the U.S. has clear edge with its family of long-range, high-capacity widebody jetliners.

To give themselves widest sales latitude, manufacturers are designing jetliners to accommodate an airline's choice of different engine types. Engines are in themselves high-value, labor-intensive products, hence they play an important part in the competition with respect to the national economy benefits involved. The engine situation is complicated by the fact that a foreign-built airplane may be powered by U.S.-built engines, or vice versa; primary powerplant for the Airbus, for example, is a General Electric engine and at least one Airbus model will have Pratt & Whitney engines.

The national economy potential of jetliner sales is further complicated by a trend toward increasing international joint ventures. U.S. manufacturers already have, or are working on, a num-

3. **Boeing 767.** A \$1.2 billion United Airlines order in July launched full-scale development and production of the Boeing 767, first new Boeing jetliner since the 747 start of 1966. United's 767s will be powered by two Pratt & Whitney JT8D-7R engines; customers may opt for either of two other advanced technology engines. The 767 is aimed at the "200-seat" market, a convenient designation for medium-range aircraft accommodating from 180 to 230 passengers; the 767 seats about 200 in typical mixed-class configuration. Its design makes use of a number of advanced technologies to combat rising airline operating costs. Fuel burned per passenger seat, the company says, is 35 percent less than earlier medium-range jetliners; a 10-airplane replacement fleet could save an operator \$14 million a year in fuel costs. Other design achievements include the two-aisle passenger cabin pioneered in the 747, use of new structural materials for weight saving and longer airframe life, reduced noise and emission levels, and a number of advanced airplane systems. First delivery is scheduled for mid-1982.

4. **Pratt & Whitney JT9D-7R,** selected by United Airlines as the powerplant for its Boeing 767 widebody twinjets. A high bypass turbofan, the Dash 7R develops 44,300 pounds of thrust. The "R" stands for "rerated," meaning that the engine is designed to operate at less than maximum design thrust; this permits use of less complex turbine hardware, reducing engine weight, fuel consumption and maintenance costs. Pratt & Whitney's JT9D family consists of six models spanning the thrust range from 39,000 to 56,000 pounds; they are applicable to a variety of airplanes from the new medium-size twinjets like the 767 to the big, long-ranging transports powered by three or four engines. Pratt & Whitney is also developing a new, advanced technology turbofan specifically aimed at the new medium-range trijets; designated JT10D-132, it develops 32,000 pounds thrust and is scheduled for certification late in 1981. The company is studying other versions of the JT10D which would cover a thrust range from 25,000 to 35,000 pounds.

5. **Lockheed L-1011 Dash 400 TriStar.** Lockheed's new generation jetliner is an advanced technology version of the company's trijet which will have the same fuselage diameter but will be 20 feet shorter. The smaller airplane will accommodate 200-230 passengers, compared with up to 400 in earlier models of the TriStar. Thus, Lockheed is focusing on the upper end of the "200-seat" market and offering flexibility with regard to range—medium distance, transcontinental flight or, with an optional change, a nonstop full-load range of more than 5,000 miles; this would allow an airline to use a single type of 200-seater on a wide variety of routes, for substantial savings in crew training and spare parts costs. The Dash 400 is designed for the operator's choice of three advanced technology engine types in the 42,000 pound thrust class. Other advanced technology features include active controls which contribute to reduced drag, hence lower fuel consumption; additional fuel savings through an automatic engine control system which provides maximum fuel efficiency throughout a flight; a digital autopilot with five times greater reliability; and an automatic takeoff thrust control system for considerably longer engine life and reduced maintenance costs. Assuming a 1981 production start, the Dash 400 could be delivered in 1981.

6. **General Electric CF6.** This family of high bypass turbofans powers twin-engine (Airbus), three-engine (DC-10) and four-engine (747) jetliners. The CF6 is built in two basic models: the CF6-6 in the 40,000 pounds thrust class, and the CF6-50 with 50,000 pounds thrust or more. The family includes nine production models and three new models in development; among the latter is the CF6-32, which extends the thrust ratings of the CF6 family into a new area—30,000 to 36,000 pounds. This engine, to be certified in 1981, has the basic CF6-6 core but has a smaller fan and a number of other refinements; it is a candidate for powering medium twinjets and trijets of the new generation. Like other engine manufacturers, GE has focused developmental effort on reducing fuel consumption; the company says its CF6 engines have a specific fuel consumption level 25 percent below that of earlier turbofans. GE has been able to get an appreciable reduction of noise in the CF6 engines by means of a number of innovations, including changes in the fan design and new sound absorption materials in engine inlet and exhaust areas. Additionally, an advanced combustor design contributes to smokeless engine operation and substantially reduced pollutant emissions.

ber of arrangements whereby foreign companies participate on a cost-and-work-sharing basis in production of a U.S. airplane or engine. This reduces the financing need for a new development program and gives the U.S. teammate access to a foreign market that might otherwise be denied by the foreign practice of directed procurement. Although jobs and profits are divided, there is still substantial benefit to the U.S. economy in such arrangements.

The New Generation

Some may have expected the new family of jetliners to be dramatically different in appearance from their predecessors. They are not, for the reason that they are still subsonic airplanes operating in the same flight regime—500-600 miles per hour and 30,000-40,000 feet altitude—as the planes they will supersede. The dictates of aerodynamic science make all airplanes of similar flight performance more or less similar in basic design. So, with variations in wing shape, fuselage width and engine mounting, the members of the new family resemble their forebears, and they also bear considerable resemblance to each other.

Nonetheless, they are new airplanes, incorporating advanced technology developed over the last decade. For the most part they are "derivative" airplanes, derived from earlier designs; this is hardly surprising, because it makes design sense to use a proven technology that is still applicable. All of the new generation, however, have advanced technology features aimed at reducing airline operating costs, lowering maintenance requirements and improving environmental characteristics. The degree of advanced technology varies, but generally the jetliners of the new generation will offer some or all of these improvements:

- Dramatically improved engine performance with regard to fuel consumption, a particularly important factor in light of still-rising prices for fuel, a major contributor to total airline operating costs.
- Significantly lower engine noise levels and a reduction in objectionable exhaust emissions.
- Design innovations which allow longer engine life and reduced maintenance.
- Advanced technology aerodynamic improvements, particularly new wings, which contribute to lower rates of fuel consumption by easing the engines' workload.
- Advanced structures for extending airframe life.
- New flight and engine control systems and digital autopilots with substantially improved reliability.
- Interior improvements for greater passenger comfort, such as new seating arrangements, lower levels of cabin



7. *Boeing 757.* The twin-engine 757 is a short-to-medium range jetliner which combines the fuselage width of Boeing's 727/737 airplanes with an advanced technology wing and new engines. The new plane has certain features of both its predecessors and certain performance advantages, particularly in the important matter of fuel consumption: 40 percent less, Boeing says, than the airplanes the 757 will displace. Powerplants are two 33,500-pound-thrust engines; the customer may choose one of three optional types, and with any of the engine types the 757 would have lower noise and emission levels. Eastern Airlines and British Airways, first purchasers of the 757, both selected the Rolls-Royce RB211 Dash 535 engine.

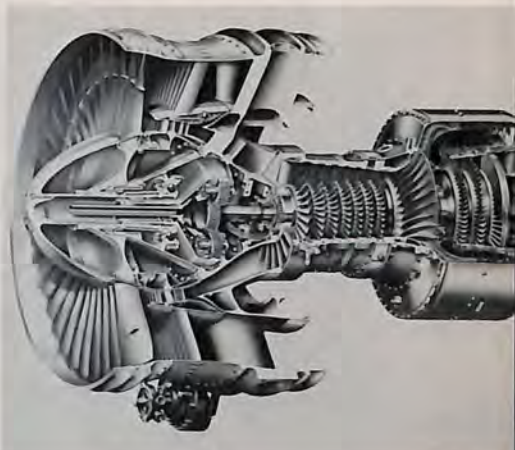
8. *McDonnell Douglas DC-10.* The airplane shown is the Series 30 model of the McDonnell Douglas trijet, already in airline service. The company is planning a "stretched" higher-capacity version of the intercontinental DC-10. It would be an advanced technology airplane incorporating new engines for reduced fuel consumption and a variety of advanced avionics equipment. McDonnell Douglas is also working on an all-freight DC-10.

9. *General Electric/SNECMA CFM56 turbofan.* The CFM56 is under development by the Paris-based CFM International, a company jointly owned by General Electric Co. and the French engine manufacturer SNECMA. The CFM56 is an advanced technology engine featuring improvements in fuel consumption rates along with reduced levels of noise and emissions. The engine is scheduled for certification late in 1979; initial versions will produce 24,000 pounds thrust but growth to more than 27,000 pounds is planned. The CFM56 is intended for use on short to medium-range transports, such as the European JET 1 and JET 2, and for re-engining some older planes, such as the Boeing 707 and the McDonnell Douglas DC-8.



10. *McDonnell Douglas ATMR*. The projected Advanced Technology Medium Range twinjet is aimed primarily at airline regional routes. Its design is based on an advanced supercritical wing and the airplane would also have the latest in propulsion systems for reduced fuel consumption and lower exhaust emissions. In various seating configurations, it could accommodate from 166 to 200 passengers.

11. *Avco Lycoming ALF 502H Turbofan*. A new but already certificated version of Lycoming's moderate thrust engine family, the ALF 502H will power the British Aerospace 146 four-engine feederliner, expected to debut in 1982. The ALF 502H produces 6,700 pounds of thrust in the feederliner installation, but more powerful versions have been developed. The engine offers exceptional fuel efficiency and extremely low noise levels; it is considerably quieter than turboprop engines now operating in short-haul aircraft. A simply-designed engine, it also features smokeless exhaust with minimal undesirable emissions.



11

noise and better pressurization/air conditioning systems.

New U.S. Transport Family

Among the new generation of U.S. jetliners already in development or projected are these:

- *Boeing 767*, in development with first deliveries scheduled for 1982. The 767 is a new twinjet widebody design intended for the 200-seat, medium-range market. It will be built in two versions: the 767-200, carrying about 200 passengers, and the 767-100 with 180 seats.

- *Boeing 777*, a three-engine companion to the 767 which would carry 210 passengers on longer-ranging and overwater routes.

- *Boeing 757*, a standard body twinjet targeted for the lower density market; it accommodates 174 in a typical mixed class configuration. First deliveries are scheduled for 1983.

- *Lockheed L-1011 Dash 400*, a shortened, reduced-capacity version of the company's TriStar aimed at the higher end of the "200-seat" market with accommodations for 220-233. If airline orders are forthcoming in 1978, the plane could be delivered in 1981.

- *McDonnell Douglas DC-10*. The company is planning an advanced technology, higher-capacity version of its trijet.

- *McDonnell Douglas ATMR*, or Advanced Technology Medium Range jetliner, a projected twinjet transport designed for the lower end of the 200-seat class (166-200 passengers).

Foreign-built Competitors

Lined up against the American jets are several new planes to be built in Europe, all of them multinational risk-sharing projects, some of them involving extensive American participation. They include:

- *The Airbus Industrie A 310 Airbus*, a twinjet transport already in develop-

ment and slated for initial deliveries in 1982. The 310 is an advanced technology, scaled-down version of the Airbus types now in production; it has a capacity of 200 passengers, compared with 220-345 in earlier models of the airplane. The 310 has been ordered by four foreign airlines and others, including one American carrier, have options for future orders. Airbus Industrie is a European consortium controlled largely by French and German interests, with lesser degrees of participation by The Netherlands and Spain.

- *The Joint European Transport (JET)*, which is actually two airplanes — Jet 1 and Jet 2 — in the short-to-medium range category. The JETs are relatively small twin-engine airliners; JET 1 has 130 seats and JET 2 accommodates 160. The proposed JETs would be built by the Airbus team, possibly with British participation.

- *The British Aerospace 146*, approved for development and scheduled for first deliveries in 1982. A feederliner for airlines serving small cities and towns, the 146 is essentially a short-haul airplane but it is capable of a maximum range of more than 1,000 miles. Powered by four American-built low-noise turbofans, the plane will carry 71 to 109 passengers. Avco Corp.'s Lycoming Division will supply the engines and negotiations are under way whereby Avco would also produce the jetliner's wings. Similar negotiations are being conducted for Swedish and Italian participation.

U.S. ENGINES

Among the major American-built engine types that figure prominently in the international competition are these:

- *Avco Lycoming ALF 502H turbofan*, powerplant for the British Aerospace 146. Rated at 6,700 pounds thrust and featuring exceptionally low noise levels, the 502H is an advanced

model of the engine family used to power a number of executive transports.

- *General Electric CF6-45B*, turbofan powerplant for the Airbus 310, with 46,500 pounds of thrust; a companion version of the engine is designed to power special performance models of the Boeing 747. GE is producing several other models of the CF6 engine family with thrust ratings ranging from 40,000 to 52,500 pounds of thrust; three new CF-6 models, incorporating further gains in fuel savings and other improvements, are in development.

- *General Electric/SNECMA CFM-56*, a 24,000 pound thrust turbofan being developed for certification in 1979. To be marked and manufactured by DFM International, a company jointly owned by GE and the French engine firm SNECMA, the CFM-56 is applicable to short-medium range members of the new jetliner generation, or for re-engining some of the older transports such as the Boeing 707 and the McDonnell Douglas DC-8.

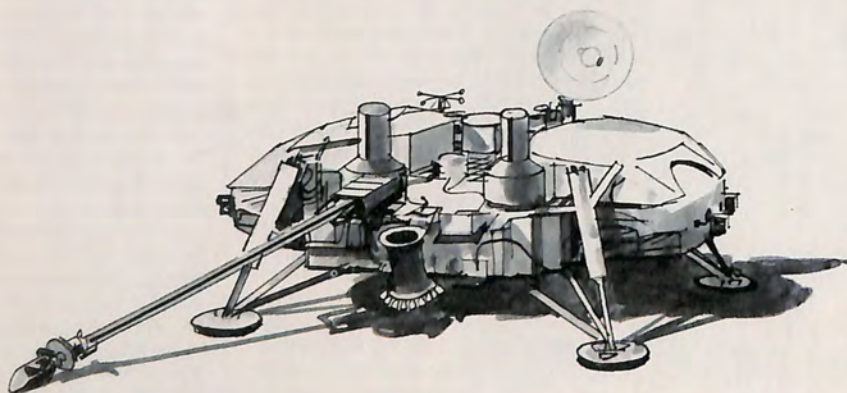
- *Pratt & Whitney Dash 209*, newest member of the JT8D family of engines, the most widely used commercial powerplants. The Dash 209 is the powerplant for the McDonnell Douglas DC-9 Super 80.

- *Pratt & Whitney JT9D-7R*, turbofan powerplant for the Boeing 767, which covers a thrust range from 39,000 to 46,000 pounds; other members of the JT9D family fit airplane needs from 46,000 to 56,000 pounds thrust.

- *Pratt & Whitney JT10D Dash 132*, a new turbofan development expected to be certified for airline use by the end of 1981. Rated at 32,000 pounds thrust, the Dash 132 is specially aimed at Boeing's 777 trijet; other models of the JT10D have thrust outputs ranging from 25,000 to 35,000 pounds and are applicable to twin-engine designs in the medium-size category.

VIKING

Mars Mission Accomplishments



Aerospace magazine is indebted to Martin Marietta Aerospace, principal contractor to the National Aeronautics and Space Administration for the Viking landers, for the dramatic Mars photos in the accompanying insert. These pages are extracted from the company's publication *Viking Mars Expedition 1976*. Material in the book was assembled with the cooperation of NASA, Jet Propulsion Laboratory, the Viking science teams and Martin Marietta's subcontractors.

On July 20, 1976, a Viking I lander made a soft touchdown on Mars and within a few minutes its cameras were taking pictures of the rock-strewn Marscape. It marked mankind's first landing on another planet and, appropriately, it occurred seven years to the day after the first manned lunar landing.

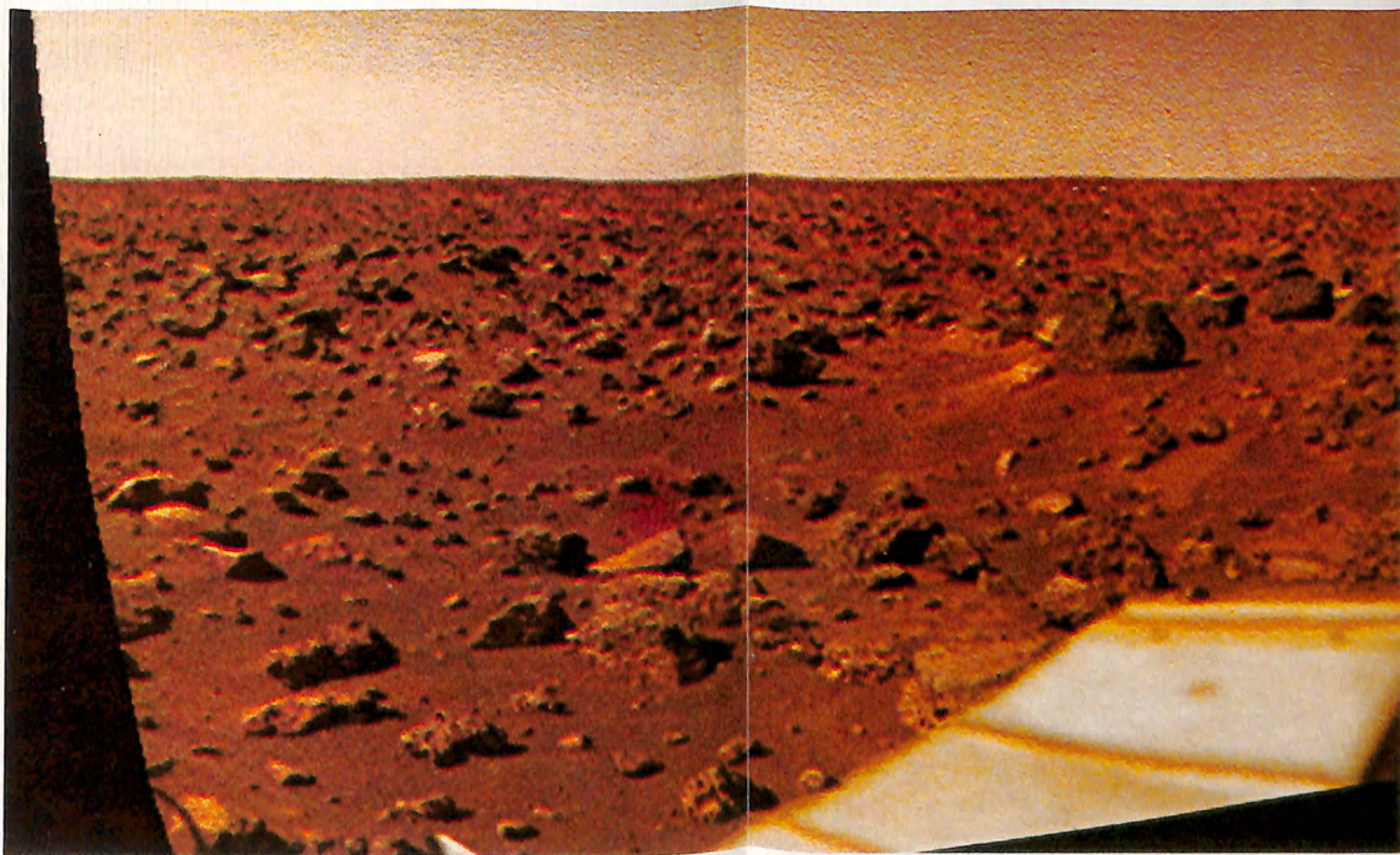
Six weeks after Viking I's arrival—On September 3, 1976—the Viking II lander dropped to the Martian surface some 4,500 miles from its companion. The other elements of the Viking spacecraft team included orbiters I and II, which circled the Red Planet taking photos and acquiring data from different vantage points and served as relay stations for transmitting the landers' findings back to Earth.

The four spacecraft, built by NASA's Jet Propulsion Labora-

(continued on page 9)

Many Hues of Mars

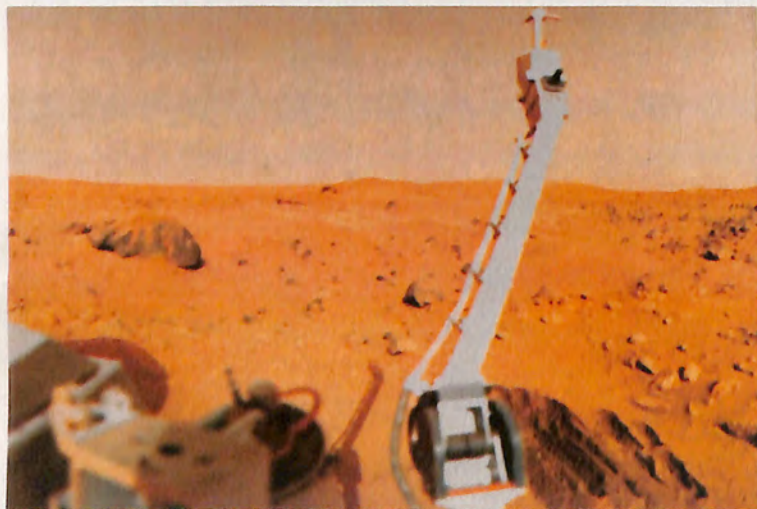
Nearly 200 degrees of the Martian horizon at the lander II site can be seen in this composite of three photos taken on three different days, September 4, 5 and 8, 1976. The surface sampler housing is at left and the antenna which receives commands from Earth is at right. The horizon is 1.8 miles from the lander. Dark volcanic rocks can be seen both to the left and right.





This dramatic scene near the north pole shows the region in midsummer when the seasonal carbon dioxide polar cap clears to reveal water-ice and layered terrain beneath. The variety of arc-shaped cliffs 1640 feet high at the top of the photo illustrates the complexity of erosion in the north polar region.

Deimos, smallest of the Martian satellites, is a uniform gray color, but appears to have tints of orange in the two combined images above taken by orbiter 1 through a violet filter and an orange filter.



This panorama of the lander 1 landing area February 19, 1977, shows the trench at right of the metrology boom being dug for soil samples as much as 12 inches below the surface. The unusually bright sky indicates an increase of suspended dust in the atmosphere.