AEROSPACE MAGAZINE - 1967-1970

TABLE OF CONTENTS

Winter

"Apollo 4: Proof Positive"
"Aerospace Notes"
"New Uses for Old Aircraft"
"A Strategy for Planning," Governor John A. Love, Colorado
"Space and Industry," John R. Moore, North American Rockwell Corp.

1968

Spring

"Applications Satellites: Harvest from Space"
"Aerospace Notes"
"50th Anniversary: Air Mail Service"
"Quest for Quiet Jets"

Fall

"Employing the Unemployable"
"Aerospace Notes"
"Jet Transports: The Third Generation"
"Your Share in Freedom"
"A Crucial Time for Technology," T. A. Wilson, The Boeing Co.

1969

Winter

"The Aerospace Industry: Today and Tomorrow"
"Aerospace Notes"
"Space Program: Spur to Soviet Progress," Dr. Charles S. Sheldon II, Library of Congress
"General Aviation: Climbing Strong"
"Airlines Set Records in 1968"

Spring–Summer

"The United States SST – Asset for National Progress"
"Aerospace Notes"
"The Financing Challenge – Aerospace Exports," Alfred H. Von Klemperer, Morgan Guaranty Trust Company of New York
"Tomorrow's Air Transportation"

Fall

"Goals for America" (Special Edition)

1970

Winter

"Aerospace Industry: 1969 Review and Forecast"
"Aeronautical Key: R&D"
"The Military–Industrial Complex: A Perspective," Eugene M. Zuckert, Former Secretary of the Air Force
"Wright Memorial Award remarks," William M. Allen, Boeing Co.

March

"Space and the National Economy"
"Aerospace Notes"
"Down With Costs"
"The Unk–Unks – Not Knowing You Don't Know"

June

"Power for Growth – Airport/Airways Development," Senator Warren G. Magnuson
"Aerospace Notes"
"Defense Profit Picture: Decline Continues"
"R&D – The Soviet Challenge," Dr. John S. Foster, Jr., Defense Research and Engineering

July

"The Supersonic Transport – The Ecology and Economics," Senator Mike Gravel
"No Smoking!"
"City–Center VTOL City–Center"
"Space Exploration in the 70s"

September

"Satellites: Environmental Sentries"
"Aerospace Notes"
"Air Travel's Spacious Age"
"The Assault on American Industry," Robert Anderson, North American Rockwell Corporation

November

"People Movers," Carlos C. Villarreal, Department of Transportation
"Aerospace Notes"
"Eximbank – Aerospace Export Generator," Don Bostwick, Export–Import Bank
"Air Transportation: The 21st Century"
"Contract Risk Profit"

AEROSPACE MAGAZINE - 1967-1970

INDEX

Employment

"Aerospace Employment," April 1967
"Employing the Unemployable," Fall 1968

General Aviation

"Business Aircraft – Stars on High," February 1967
"General Aviation," Winter 1969

Ground Transportation

"The ACV – Riding on Air," March 1967
"Industry's Stake in Clearing our Transportation Bottlenecks," William M. Allen, Boeing Co., March 1967
"People Movers," Carlos C. Villarreal, Department of Transportation, November 1970

Helicopters

"General and VTOL Aircraft – High and Rising," May 1967
"City-Center VTOL City-Center," July 1970

Research

"Aeronautical Research – Aircraft for Tomorrow," March 1967
"Aeronautical Key: R & D," Winter 1970
"R&D – The Soviet Challenge," Dr. John S. Foster, Jr., Defense Research and Engineering, June 1970

Revitalization

"Goals for America," (Special Edition), Fall 1969

Satellites

"Eyes and Ears on Outer Space," January 1967
"Applications Satellites: Harvest from Space," Spring 1968
"Satellites: Environmental Sentries," September 1970

Space Exploration

"Space Exploration – The Future Beckons," May 1967
"Space Exploration in the 70s," July 1970

Space Programs

"Lifting Bodies – New Shapes in Space," February 1967
"Apollo Applications," April 1967
"Progress in Peace and Technology," April 1967
"Neighbors in Space," Summer 1967
"The Big Shoot," Summer 1967
"Apollo 4: Proof Positive," Winter 1967
"Space and Industry," John R. Moore, North American Rockwell Corp., Winter 1967
"Space Program: Spur to Soviet Progress," Dr. Charles S. Sheldon II, Library of Congress, Winter 1969

Technology

"Space: Pacesetter for Technology," January 1967
"Systems Technology: Avenue to Social Goals," February 1967
"Opportunities in an Age of Complexity," John R. Moore, North American Aviation, February 1967
"Progress in Peace and Technology," Vice President Hubert H. Humphrey, April 1967
"Technology's Dividends," June 1967
"A Crucial Time for Technology," T. A. Wilson, The Boeing Co., Fall 1968

U.S. Government

"A Strategy for Planning," Governor John A. Love, Colorado, Winter 1967

aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · JANUARY 1967

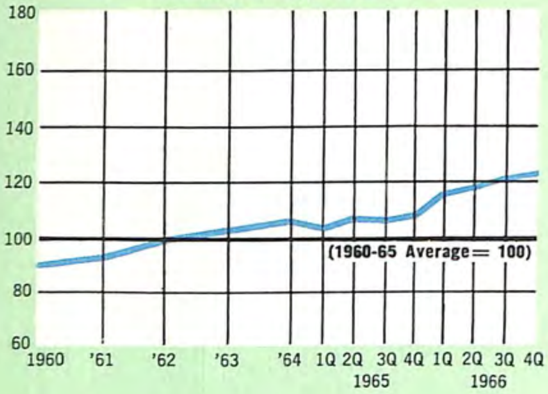
SPACE
PACESETTER FOR TECHNOLOGY

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

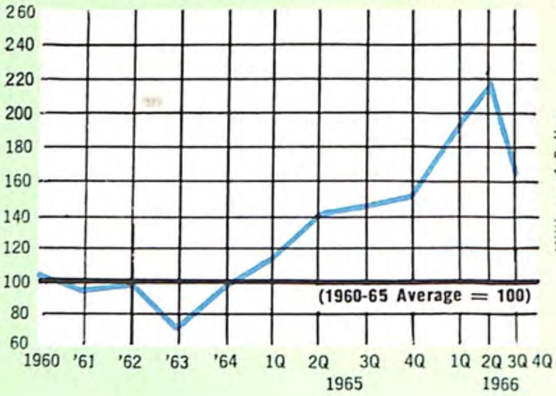
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

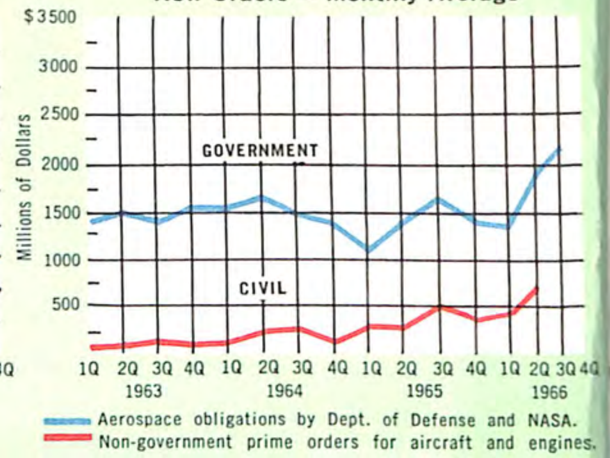


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-65 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Quarter Ending Dec. 31	20.7 R	23.5	23.8 E
	Billion $	Quarterly	4.8	1966	5.2	6.1	5.9
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	Sept. 1966	1,469	1,701	1,978
Aircraft	Million $	Monthly	601	Sept. 1966	860	1,087	1,205
Missiles & Space	Million $	Monthly	550	Sept. 1966	609	614	773
Aerospace expenditures: Total	Million $	Monthly	1,067	Sept. 1966	1,181	1,124	1,257
Aircraft	Million $	Monthly	561	Sept. 1966	774	694	777
Missiles & Space	Million $	Monthly	506	Sept. 1966	407	430	480
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Oct. 1966	345	551	332
Expenditures	Million $	Monthly	130	Oct. 1966	412	409	403
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	692	Nov. 1966	1,120	1,073	1,301
Value	Million $	Monthly	15	Nov. 1966	29	29	36
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	Quarter Ending	18.7	22.8	27.1 E
U.S. Government	Billion $	Quarterly	11.6	Sept. 30	12.7	13.6	15.7
Nongovernment	Billion $	Quarterly	3.7	1966	6.0	9.2	11.4
EXPORTS							
Total (Including military)	Million $	Monthly	110	Oct. 1966	95	109	152
New Commercial Transports	Million $	Monthly	24	Oct. 1966	11	22	57
New Utility Aircraft	Million $	Monthly	2	Oct. 1966	4	6	7
PROFITS				Quarter Ending			
Aerospace — Based on Sales	Percent	Quarterly	2.3	Sept. 30	3.6	3.2	2.7
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	1966	5.4	5.9	5.4
EMPLOYMENT: Total	Thousands	Monthly	1,132	Oct. 1966	1,181	1,339	1,349 E
Aircraft	Thousands	Monthly	499	Oct. 1966	472	583	588
Missiles & Space	Thousands	Monthly	496	Oct. 1966	538	583	588
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Oct. 1966	3.21	3.44	3.44 E

R Revised
E Estimate
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
# Averages for 1961-65.

AEROSPACE OUTLOOK

The outlook for the aerospace industry in 1967 is even brighter than the impressive gains reported for 1966 in an article on page 14.

Aerospace sales in 1967 are expected to exceed $25 billion, 23 percent higher than the average of sales between 1963 and 1965, and $1.5 billion more than the record sales of $23.8 billion in 1966. The growth rate of the industry is substantially more than the rate of gain in the U. S. Gross National Product.

Exports of aerospace products and services are expected to rise to $1.7 billion from an estimated $1.51 billion in 1966 which was a record year.

Employment in the industry should increase to 1,385,000 in 1967 compared to an estimated 1,349,000 at the end of 1966.

Earnings as a percentage of sales are expected to be above the 3.0 percent estimated for 1966. This new level is more than the 2.3 percent average for the period 1960-1965, but still well below the 5.6 percent for all manufacturing in 1966.

During 1967, aircraft sales are expected to reach about $13.4 billion — more than half the total of all sales — and missile sales are expected to remain at $3.8 billion, the same level as 1966. Sales of space vehicles will probably decline from $5.8 billion in 1966 to $5.4 billion in 1967. Non-aerospace sales, products not directly related to aviation or space, will increase to about $2.7 billion in 1966 compared with $2.5 billion in 1966.

The industry, after reaching a plateau of about $20 billion in sales between 1963 and 1965, is moving forward rapidly. Increases in commercial aircraft, growth in plant and equipment investment, and expansion to broadly diversified areas indicate that even higher levels can be anticipated throughout this decade.

Only decline in the 1967 demand for aerospace products is in the field equipment for space exploration. However, the long range requirements for space hardware and technology in the next decade will be substantially above the needs met in the 1957-1967 period. The major frontiers of space exploration lie in future programs.

The application of aerospace-developed techniques in systems analysis and management to social and economic problems holds a visible promise for a field of tremendous expansion for the industry.

Pilot studies aimed at utilizing this storehouse of knowledge have shown that systems techniques can be applied to virtually every pressure point of social and economic needs — crime control, waste disposal, urban transportation, pollution control, new methods of teaching — major problems that clamor for solution. The answers are available in the aerospace industry.

AIA

aerospace

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

PRESIDENT • Karl G. Harr, Jr.
PUBLISHER • Glen Bayless

VOL. 5, NO. 1 *JANUARY 1967*

EDITOR • Gerald J. McAllister
ASSOCIATE EDITORS • Richard W. Balentine
• William S. Evans
• John J. Lee
ECONOMIST • Gerson N. Chanowitz
ART DIRECTOR • James J. Fisher

CONTENTS

The purpose of AEROSPACE is to:

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

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

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

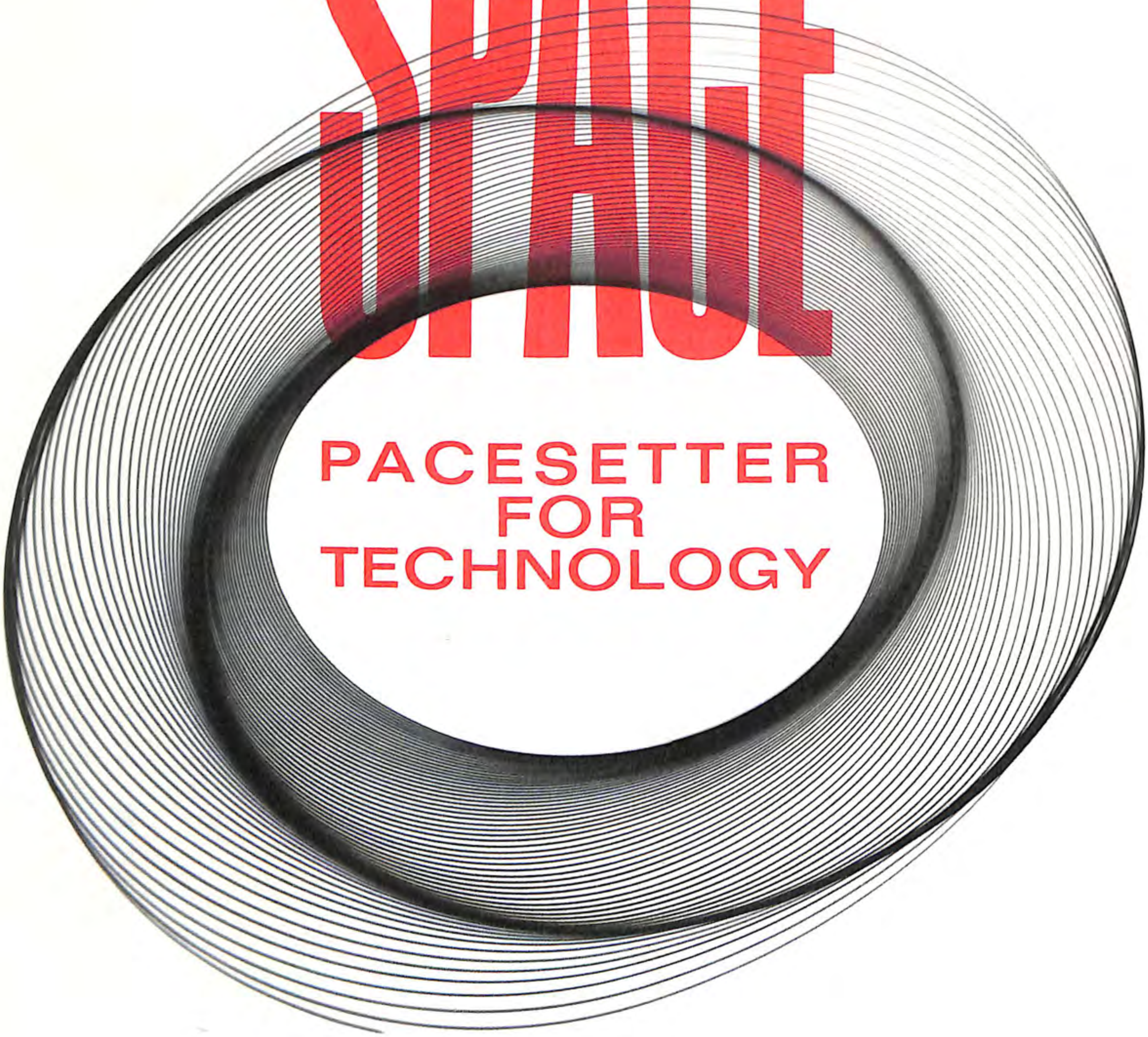
Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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

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

Western Office: McCulloch Building, 6151 West Century Blvd., Los Angeles, Calif. 90045

SPACE PACESETTER FOR TECHNOLOGY



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

In the few years we have been engaged in the planning and the implementation of our national space effort, the impact throughout our social, political and economic fabric has been enormous.

Almost every aspect of our lives from the superficial such as children in space helmets and advertising slogans, to the profound such as international scientific conferences and university courses are built upon it. It has brought a new vocabulary, perhaps even a new language. It has severely affected everything from our domestic economic structure to our relations with other nations.

All this has happened so fast and the new dimension involved is so vast, it is not surprising that many people have difficulty not just knowing what to think about space, but even how to think about space. How does one get a handle on this vast new dimension into which the world, with America in the van, has been so suddenly thrust, in terms of its relation to our total national interest?

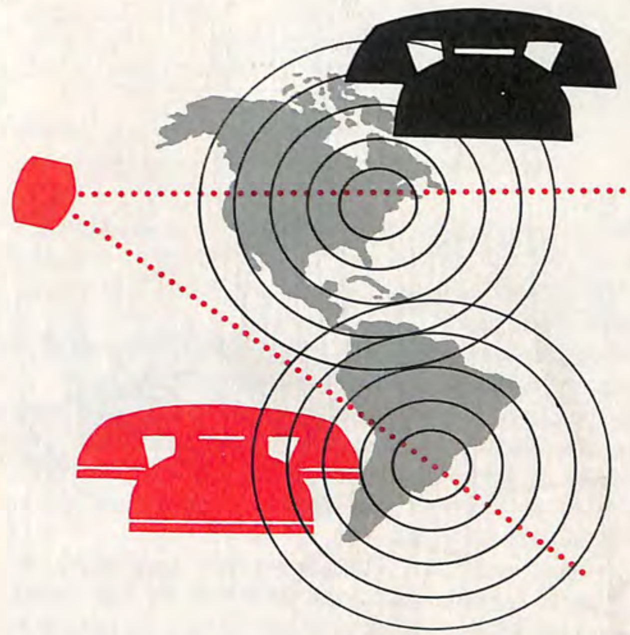
Many of us closest to it in the aerospace industry, in government and in the universities perhaps have been so preoccupied with the actual planning and doing that we have neglected effective articulation of the true significance of our nation's space effort.

But difficult as it is to find a handle to thinking soundly about the relationship between space and our total national interest, we can no longer afford not to do so.

Today we are both in midstream in our national space effort and at a crossroads of future efforts. It is essential to delay no longer in sorting out that which is valid and enduring, in terms of total interest, from that which is superficial or transitory.

The miraculous so quickly becomes commonplace that the true dimensions of our space achievements can only be appreciated if we go back a very few years to the time when space was a word used primarily to describe advertising.

Nine years ago a national magazine published an



article in the first hectic days following the launching of Sputnik I reporting on a poll of leading aerospace scientists and engineers as to the future of space flight.

A consensus of these experts predicted that man could expect to venture into earth orbit by 1970 and that a manned expedition to the moon might be possible by 1990.

Actually man was launched into space a little more than three years after publication of the article and today, still three years ahead of the then predicted timetable for the *first* manned space flight, there have been 24 such flights, half of them multi-manned missions. Man has already accumulated more than 2,500 hours of actual space experience.

As for man landing on the moon, whatever the Soviet timetable, America will beat the prediction by more than 20 years.

In terms of American programs alone, starting with the then seemingly presumptuous commitment to land man on the moon before 1970, in the span of five and a half years we have:

■ Pioneered and produced operational systems for global communications and weather reporting.

■ Sent a series of vehicles to crash-land, soft-land and orbit the moon, a program which produced tens of thousands of lunar photographs and more scientific knowledge of the earth's satellite than man had accumulated in all prior years.

■ Launched complex, data-reporting spacecraft to the vicinities of Venus and Mars. Mariner IV has flown more than one billion miles and continues to function properly. This Mars probe is sending data three times daily across a distance of more than 200 million miles and has exceeded its mission design life by a factor of 3, i.e., 17,000 hours versus 6,000 hours.

■ Conducted 16 manned space missions, twice as many as our competitor, acquiring almost 2,000 hours of manned space experience or 80 percent of the world's total experience.

What do these achievements mean? They mean many things.

They mean infinitely superior communication, navigation and weather prognostication systems.

They mean quantum jumps in our scientific knowledge about the universe.

They mean jobs by the hundreds of thousands involving new cities and towns.

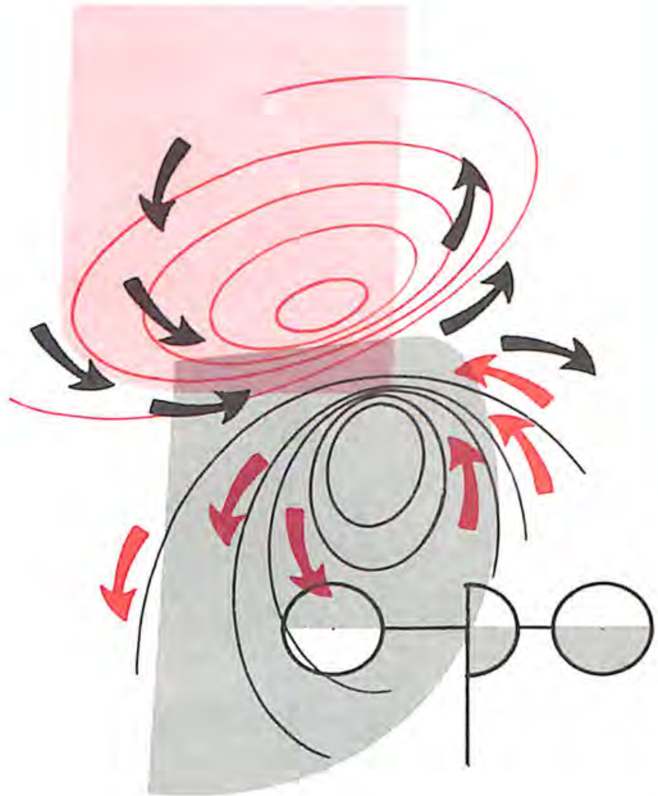
They mean new industrial techniques and procedures resulting in better ways of doing things and better consumer end products.

They mean inspiration from children all the way to graduate students both here and abroad.

They mean America's recovery from its prestige blow with all the concomitant international political implications of the immediate post-Sputnik era.

They mean insurance against the possibility that space can be used against us militarily.

They mean that America not only has the capacity but the will to accept perhaps the greatest challenge offered mankind and has made the decision to go forward as a growing, dynamic society rather than to get



off the mainstream of history.

They have meanings all the way from better razor blades and TV circuitry to the most fundamental national decisions as to the scope of our future.

Most of the foregoing has been said before. But there is one key element, perhaps most visible to the aerospace industry, which seems to have escaped attention.

This is the importance of our national space effort to our total technological advance.

Simply, this has required the greatest organized technological "reach" in man's history. It is the grandest in scope and the most difficult in its separate components. Hundreds of thousands of people in government, industry, the universities and elsewhere have had to join effectively in a systematized, flat-out effort to project man and machine into a strange and hostile environment.

Virtually every scientific and technological discipline has had to be factored into this effort.

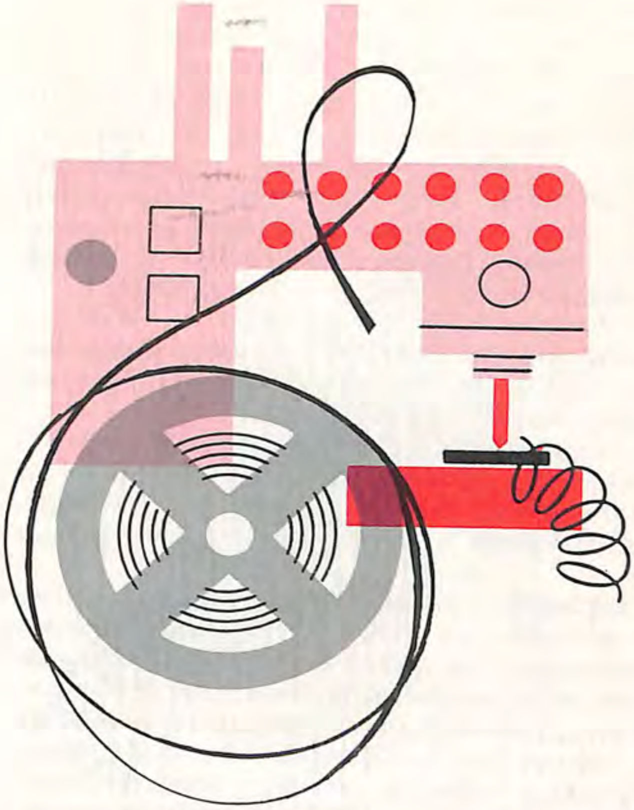
To the aerospace industry, reaching technologically under pressure is not a new experience. As a principal supplier of the nation's weapon systems aerospace companies have met the arbitrary performance requirements and deadlines imposed by defense needs in times of both hot and cold war.

But the complexity, difficulty and scope of the space challenge is of a whole new order of magnitude. The implications of a national commitment to land man on the moon within a specified short deadline at a time when neither had man been in space nor had any man-directed object ever touched the moon are staggering.

So what? So what if the aerospace industry has effectively organized to accomplish technological miracles?

So this: In the course of making this greatest and most difficult of technological reaches we learn more and more things. When we reach technologically for the moon and beyond we forge new technological muscle and sinew, new technological intellect and skill. We learn new processes, we develop new materials and new ways of using them, we develop new technical concepts, new industrial standards, new manufacturing techniques and tolerances. Above all we teach ourselves how to organize all of the components of such a technological reach, human and material, known and unknown, available and yet to be designed or discovered. As a nation, technologically speaking, we have probably never learned as much in so short a length of time as from our space effort.

In terms of total national interest the importance of this fact is that technological advance is largely indivisible, and that is true of every aspect of technological advance including the devising of new methods of organizing it. Just how widespread can be the effect of what we learn was brought into focus by a magazine article describing how the technique of systematizing and expediting research, as developed by NASA and industry in our space program, was being used to systematize and force the pace of research



looking to a cure for leukemia.

Because technological advance is largely indivisible, a nation either opts for technology or it doesn't. As some of our sister nations have learned, you either move with the tide of technological advance or you fall behind on all fronts. Senator A. S. Mike Monroney of Oklahoma describes it this way: "England's current trouble has been diagnosed as a case of technology neglected. . . . Starving technology mortgages the future of our society. Twenty years ago, Britain picked immediate social goals over technological progress. Today, it is paying the price, lacking the production base to support either social or technical progress."

Today the question is the same for us. It is not should we as a nation have space or other things, but rather can be have the "other things" if we reject the technological reach required by space.

Again, so what? So what if the technological advances forced by the space reach do spearhead the advance of our total national technology? How much is that really worth in terms of our total national interest?

There are several answers. The simplest one is that most of the important identifiable problems that lie before our nation are going to be solved primarily through organized technological reach of a high order. Such a list certainly includes controlling air and water pollution, solving the multiple problems arising from increasing urban congestion, providing adequate transportation systems for a rapidly growing population, insuring adequate food and water supply and distribution systems and even providing the housing and school systems which our burgeoning population demands.

But the simple listing of specifics does not convey the true significance of technological advance. The security, well-being and prosperity of our nation have always depended in major part on technological advance, and that dependence will increase as we move into the dangerous, crowded, swirling future. We comprise a tiny percentage of the world's population, and we seek not only to maintain the world's highest standard of living, but we seek to do so as free men living under free institutions. Constant technological gain is the key to achieving such national goals.

Advancing technology also provides far and away the best hope for retention of our individual freedoms. Throughout history there have been those who have warned of the evils of advancing technology in terms of its encroachment upon individual freedoms. But history has always proved them wrong. Today we have much more technology than we ever had before and we have more individual freedom because of it. If there is a danger in a growing world of men becoming enslaved by technological advance, that is a much more manageable danger than the alternative; and there are examples of this both in our depression period and today in technologically deprived nations where man is an inevitable slave to the primitive struggle for existence.

What lies ahead? There is a range of alternatives any or all of which, in varying degrees, will involve

extension of our technological reach.

Even the wholly automated program, new applications for earth orbiting spacecraft, unmanned probes to the moon, the planets and the void outside the ecliptic, which are at the lower end of our range of present possibilities, would represent a vastly greater technological challenge than those we have met.

Moving into more difficult areas we might adopt a program involving gradually extended earth orbital operations with manned spacecraft, building on our existing technology toward the large "permanent" space station supplied by earth-to-orbit ferry craft. Or we could gradually extend "stay-time" on the moon toward the construction of a manned lunar base.

At the far end of the spectrum, as currently envisioned, is the manned expedition to a nearby planet, most likely Mars, the celestial body least hostile to human exploration. Such a mission is deemed feasible in the decade of the 1980s, probably about 15 years after the initial lunar landing. We do not have the technology today for such a venture; but we can confidently calculate that we can build such capability within that time span.

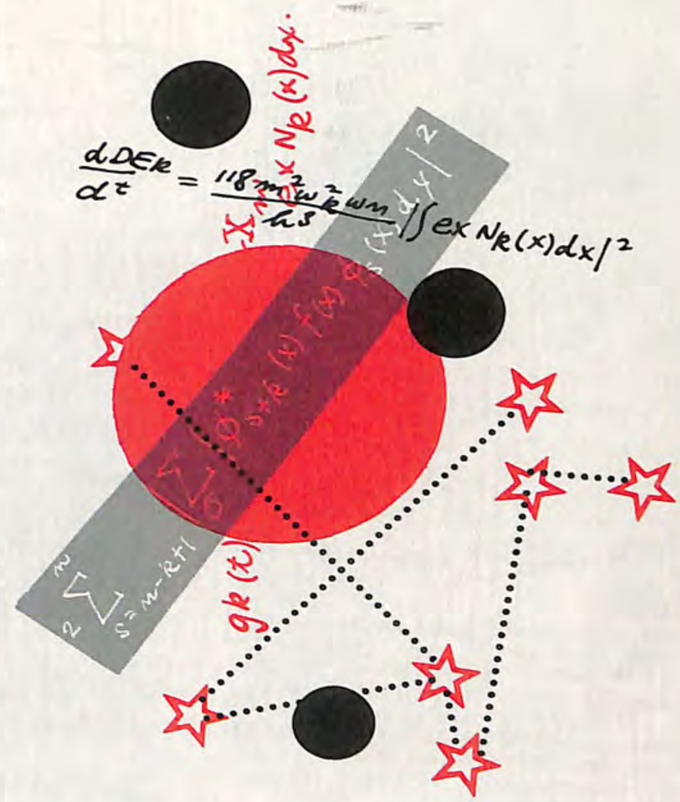
If we do all or most of these things, which incidentally would require approximately the same percentage of our gross national product as now allocated to space, we shall continue to force the future pace of American technology. As it has in the past, this will set the pace for our total national technological advance. Every aspect of our national life which is influenced in any degree by such advances will be the beneficiary.

Leaving aside the advantages in scientific knowledge, national prestige, defense insurance, domestic economics, and everything else, the task of conquering space requires far and away the greatest technological reach man has ever attempted. On a thousand interrelated fronts it sets the pace. Whether you call it forced technology, responsive technology, stretched technology or whatever, it will be this particular technological focus of our efforts that will lead the way of our whole national technological advance.

If we recognize our space effort for what it truly is — the pacesetter of our total technological advance — and if we believe that the nation's future well-being depends in many vital ways upon such advance, we can begin thinking more clearly about the true relationship between the nation's continuing commitment to space and our total national interest.

In evaluating our national space program, a society such as ours, hoping to remain strong, prosperous, free and well, must learn that it is necessary continuously to press for advanced technology not just for military or propaganda reasons but in order to insure the fundamental strength of our society.

The junkyard of history is full of nations that in one way or another have sold the day to profit the hour. Given the nature of today's and tomorrow's problems it is difficult to conceive of a surer way to join them than for us, in favor of short range palliatives, to turn our back on technological advance.



AEROSPACE NOTES

Curtiss-Wright Develops Jet Engine Analyzer

Curtiss-Wright has developed a sonic diagnostic engine analyzer for detecting malfunctions in the operation of rotating parts in a jet engine. Although designed primarily for use with gas turbine engines, the analyzer also can be used to check power transmission systems.

Curtiss engineers have found that the turbine engine and key components generate sound patterns which vary depending upon the condition of the part. Microphones are attached to the engine nacelle and the sounds picked up are carried to the monitor, converted electronically, and read out visually on the dials.

The operator of the analyzer compares the conditions of the engine being tested against acceptable limits. This tells him whether or not all parts being checked are operating within these limits and if not, what particular function or part is at fault.

Curtiss claims that the device can mean as much to the maintenance technician as the electrocardiograph does to the physician.

Firefighting Foam Traps Radioactive Gas at Douglas

Radioactive gases accidentally released from a nuclear reactor could be trapped by a common firefighting foam, according to a Douglas Aircraft nuclear engineer at Richland, Washington. Investigations have proved that a fog spray system producing a high volume of fine water spray could greatly increase the efficiency of reactor air filter systems when coupled in series with these systems.

In tests at Douglas, radioactive argon 41 and iodine 128 were released into the building air of a shutdown reactor. The air was exhausted from the reactor building without filtration and converted into foam at the base of a 200-foot high exhaust stack. It settled to the ground and released the radioactive argon and iodine gases to the environment slowly over a two-hour period.

A foam designed to break down more slowly would release the trapped gases into the atmosphere more slowly the engineer found. He estimates that during the test period, 85 percent of the reactor exhaust air was trapped in the 500,000 cubic feet of foam generated.

General Precision Developing Microparticle Laser Camera

General Precision's Link Group is developing a microparticle laser camera for measuring the size and velocity of extremely small particles travelling at speeds up to 45,000 mph for the Materials Physics Division of the Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio.

Purpose of such measurement is to help scientists determine the effect of micrometeorites colliding with space vehicles.

Using advanced optics, and electronics, the camera will be used to determine the speed and shape of a particle travelling through a series of laser beams. Scattering of the laser light rays provides a shape outline of the particle which is recorded on and measured from photographic film. The indirect method of photography that is employed eliminates the usual image blur caused by the speed of the particle.

Grumman Designs Electronics Warfare Aircraft for Navy

A new electronics warfare aircraft designated EA-6B is being developed by Grumman Aircraft Engineering Corporation as the successor to the company's EA-6A now in service with the Marine Corps.

Nose of the EA-6B will be 40 inches longer than that of its predecessor to accommodate an enlarged cockpit area which will seat four crewmen rather than two. The two additional crewmen will be assigned to the aircraft's second major improvement, a much advanced electronics counter-measures system.

Grumman was recently awarded a Navy contract to initiate design and development on the prototype.

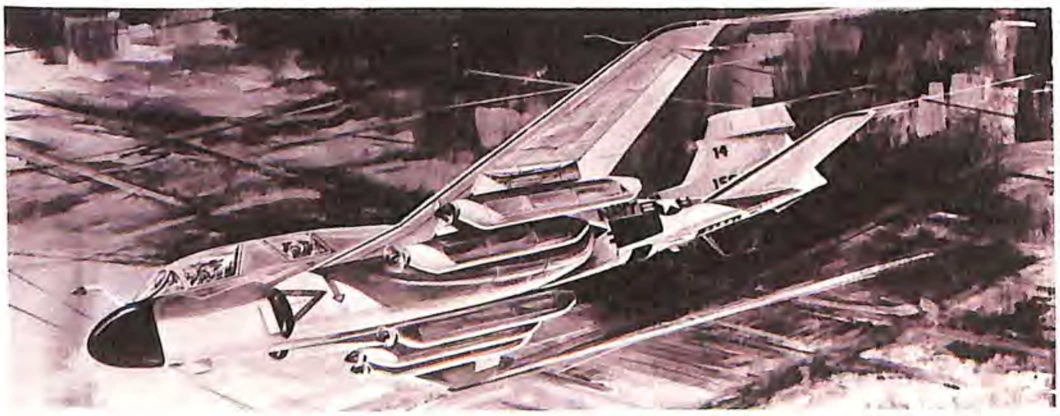
Honeywell Trainer Teaches Navy Crew How to Sink Subs

Honeywell Inc. has designed and developed a shore-based trainer for use by the Navy to teach surface ship crews how to sink enemy submarines on a make-believe ocean. The latest addition to these trainers is a $3.5 million attack system installed at the fleet's

anti-submarine warfare school in San Diego, Calif.

The Honeywell device is designed to instruct combat crews, from ASW task group commander to petty officer, in the operation and tactical use of anti-submarine rockets, torpedoes and the Drone Antisubmarine Helicopter vehicle.

Computer-controlled battles are fought with moving symbols on a make-believe sea that is displayed on a large projection screen. Six operating areas encompass 3,000 square feet of floor space, conning station, combat information center, underwater battery pilot, problem critique and display room, launcher captain's station and computer and projection equipment room.



Goodyear Arresting Device Shortens Aircraft Landings

Military aircraft are able to land on shorter runways in the combat zones of Vietnam because of a new polyurethane coated, nylon tape developed by the Goodyear Tire and Rubber Company.

Known as the M-21 arresting device, it is one unit in the Marine Corps short airfield for tactical support system (SATS) and has been operational since May. SATS embodies a complete airfield that can be transported by plane, ship or truck and set up ready for use in 72 hours. Use of short runways is made possible by a catapult take-off system and the M-21 aircraft arresting device.

Wound on reels, the tapes are attached to a cable stretched across the runway. When a plane engages the cable, the tapes play out as the plane is stopped. The tapes then pull the arresting cable back into position for the next landing.

Martin Develops Navigation Device for Combat Soldier

Army's Limited Warfare Laboratory, Army Proving Ground, Aberdeen, Md., is evaluating a fishbowl-like device developed by the Martin Company called a Man-Carried Auto Navigator (ManCAN) to help the combat soldier establish his exact position.

Worn on the belt, it is a compact fluidic navigation device which may number the days when foot soldiers must count steps, shoot azimuths and locate landmarks to determine their position.

It requires only three simple adjustments. ManCAN combines the functions of a magnetic compass and a simple pedometer with a novel fluidic computer. The only power required is suppulied by puffs of air generated by a foot bellows on the soldier's shoe.

Bendix Delivers First Sky Listening Post for EC-135

First of eight high-altitude listening posts to help connect earth with the Apollo voyagers to the moon has been delivered by Bendix Corporation's Radio Division to Douglas Aircraft for installation in the nose of an EC-135 aircraft.

The Bendix package, including a seven-foot, 750-pound parabolic antenna, is the communication system for the Apollo Range Instrumented Aircraft, designated A/RIA by the USAF Electronics System Division, which are the airborne additions to the ground and sea stations set up to maintain contact with the Apollo spacecraft prior to its being sent on its flight to the moon.

Total communications array weighs 13,000 pounds and includes 26 receivers, transmitters and multiplexers along with multicouplers, magnetic data and voice recorders, oscilloscopes, signal generators and teletypewriters. The antenna will be used to locate the relative position of the spacecraft as well as to receive all data and voice signals.

Bell Designs DMU to Propel Astronauts in Orbital Tasks

Preliminary design study and mission analysis is being conducted by Bell Aerosystems Company on a dual-purpose maneuvering unit (DMU) which can be operated in space by an astronaut or remotely controlled from a parent vehicle. This is being done under contract to the Research and Technology Division of the Air Force Systems Command, Wright-Patterson Air Force Base, Ohio.

The DMU is a small rocket-powered maneuvering spacecraft which is being considered for use in support of future manned space vehicles operating in earth orbit. It incorporates a television camera, stabilization and control systems, propulsion systems, life support, communications and radar as required by the operating mode.

Should a mission require it, a spaceman could don the DMU and assemble a station in space, repair a space vehicle or perform other orbital tasks. For unmanned missions the DMU could be guided remotely using its television camera and radio signals for such tasks as inspection of satellites and space vehicles, rendezvous, and in docking and transfer of space equipment.

EYES AND EARS ON OUTER SPACE

From its site in the barren Mojave Desert at Goldstone, California, a giant 210-foot-diameter deep space tracking antenna, the largest and most precise instrument of its kind in the free world, receives a steady flow of information from unmanned spacecraft either in orbit or hurtling toward the edge of the solar system. It relays this information to the Space Flight Operations Facility at Jet Propulsion Laboratory, in Pasadena, which operates the station for the National Aeronautics and Space Administration.

There the signals and photographs are studied by a staff of scientists, and from them the world then gets the word on what's going on in outer space.

Dwarfing the 85-foot antenna nearby, the 210, as it is called, has the height of a 21-story building, and from the air the "dish" has the appearance of a gigantic saucer. A closer examination, however, reveals that the saucer is a network of steel and aluminum which supports adjustable reflecting panels, perforated to reduce horizontal wind load.

This network and the perforated panels enable the system to operate with complete accuracy in winds up to 30 miles an hour, to survive a blow of 70 miles an hour with the reflector in any attitude, and, when stowed or secured, the instrument would be safe in a 120-mile per hour hurricane.

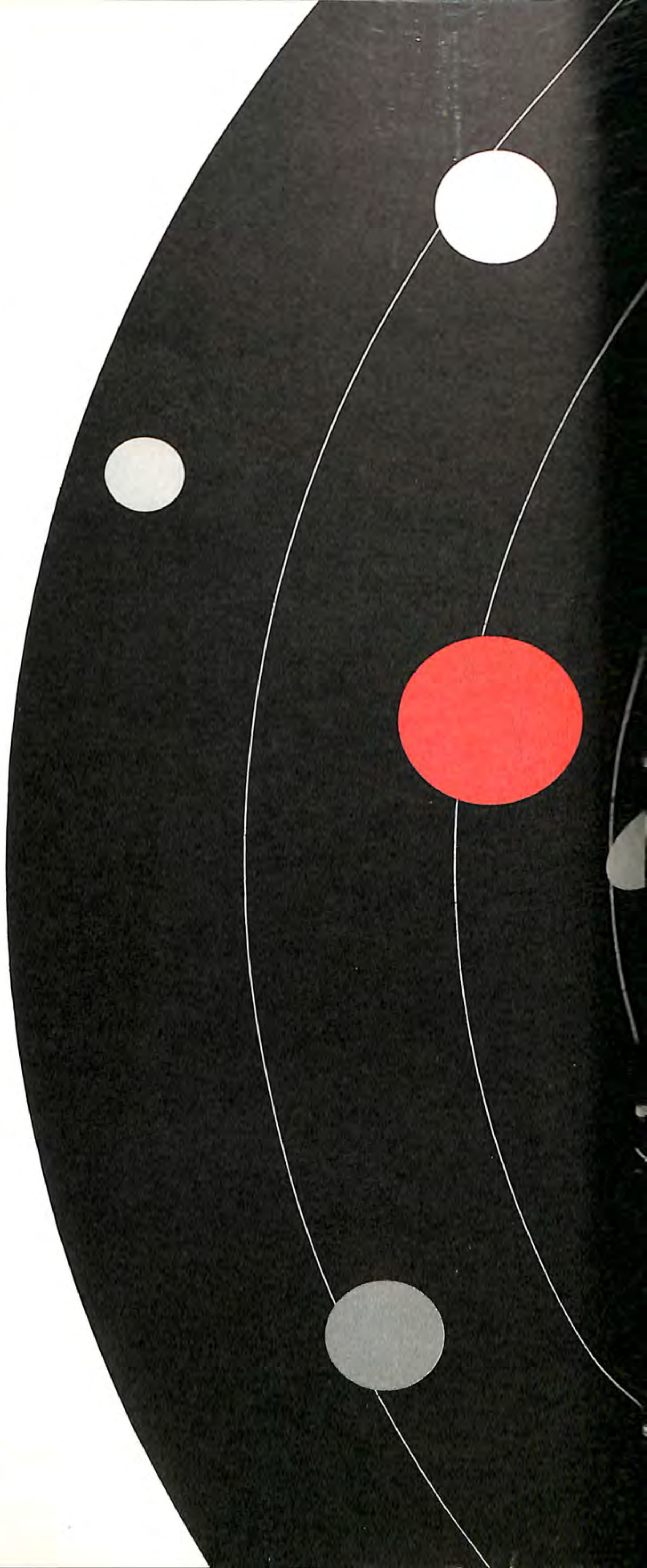
The 210 was designed and built by Rohr Corporation, Chula Vista, California, and became operational last April, a little more than two years after work started on the $12,000,000 system.

Prior to awarding the contract in 1963, the Jet Propulsion Laboratory, which is a part of the California Institute of Technology, at the request of and in cooperation with NASA had for nearly two years engaged in five feasibility studies—reflector analysis, dynamic analysis, control system analog study, error analysis and reliability analysis. Among the aerospace companies participating in these studies were Rohr, Westinghouse, Hughes and North American Aviation.

In 1963 Rohr was selected as the prime contractor to review all developmental work, evolve a final design and manufacture the system. The staggering engineering problems encountered were solved through system integration studies, which served as the principal means of evaluating, re-evaluating, integrating and optimizing the design concept into an advanced design. This combination and coordination of studies, which achieved a balance between performance and economics, enabled Rohr to complete the project within the originally quoted fixed price.

As the design developed, Rohr utilized subcontractors to provide specialized skills and components required to complete the highly complex system.

Fabrication of components for the instrument itself was accomplished at Rohr's Antenna Division, Chula



EYES AND EARS ON OUTER SPACE

Vista. After each segment was completed it was tested, then trucked to the Goldstone site where an erection crew with special cranes and handling equipment fitted the parts and assemblies together.

Beginning with the excavation of 1,300,000 pounds of earth, some of the statistics on the project are impressive. The maximum overall height of the antenna system is 234 feet, and the dish is 86 percent of an acre in size. Total weight of the system is 8,000 tons, of which 7,000 tons — including the dish, its support structures and the alidade — are carried on a 78-foot diameter hydrostatic bearing which floats on a film of oil .008-inch thick. The concrete walls of the pedestal are 42 inches thick.

Principal use of the 210 is tracking, telemetry and command of unmanned spacecraft, although it is equally useful as a radio telescope. It has 6.5 times the range of its 85-foot companion at the Goldstone site, and is capable of "reaching" the edge of our solar system.

Comparison of the 210's range with that of the 85 was illustrated in tracking Pioneer VI, which was launched last December. After six months the Pioneer's signals, then being received by the 85, faded out. This fading had been anticipated. The 210, which had been completed in the meantime, was turned on the spacecraft and the signals again came in loud and clear. Scientists say that as long as the Pioneer is aloft and capable of signaling it will be within range of the 210; its useful life has been prolonged indefinitely.

The speed of reception of signals by the 210 also is six and a half times faster than the speed of the 85. Scientists explained that signal reception speed of the 85 is equal to about 1/100 the speed of the human voice, and cited the example of the Mariner, then orbiting Mars. It required 12 days to receive 16 pictures from the Mariner, but had the 210 been available the task could have been accomplished in two days.

In tracking orbiting spacecraft, two other stations — one in Johannesburg, South Africa, and the other in Canberra, Australia — assist the Goldstone instruments in maintaining contact. Scientists at JPL hope that two additional 210s will be built, explaining that this would complete the system network and greatly expand the reception of signals from spacecraft not only in orbit but those farther out that are moving through space toward other planets.

Before a spacecraft is sent into orbit, or enroute to Mars, Venus, or elsewhere, its course is worked out on computers and, with this knowledge scientists can locate it at any given time, wherever it may be. Sending and receiving instruments on the spacecraft are pre-set to a specific wave length. By tuning in on that wave length, much as one tunes in on a radio station, contact is made, and since signals from each spacecraft have individual characteristics, identification is established. The pre-selected wave length is free from static interference, just as FM radio reception is free from the static that frequently blurs or blots out AM radio reception.

When the antenna system is used as a radio telescope, however, the sound it receives is entirely different from that from the man made spacecraft. Signals from stars, scientists said, come in with a "whish" that they call "white sound." Each star has its own peculiar tone, or sound, and this makes identification of each particular celestial object positive.

The 210 system at Goldstone is manned by a staff of 12. Signals received there are relayed to the Pasadena center, where they are "read." Commands to the spacecraft are sent from Pasadena to Goldstone from where they are sent out to the orbiting craft which, when commanded to do so, acknowledges receipt of the message. The signals between Goldstone and JPL in Pasadena are carried by microwave or, in some cases, by telephone lines.

In its production of the 210 and other antennae, the aerospace industry has in less than two decades expanded its role in scientific and industrial development from the exclusive manufacture of airplanes, to instruments that are the eyes and ears of outer space.

The knowledge gained in the development of aircraft, from the subsonic to the supersonic, has been an important factor in the development of precision instruments, such as the antennae and the spacecraft now aloft. Exotic metals, capable of withstanding the temperature extremes, structural members with strength-to-weight ratios undreamed of even a decade ago, precision miniaturization of delicate communication systems have come largely from the laboratories and plants of aerospace companies. These companies are pouring an increasingly large proportion of their earnings into scientific research, experimentation and technological improvement so that whatever flies in the future, whether within our atmosphere or far beyond to the edge of the solar system, will come from the industry that first got man off the ground.

Tie truss for the deep space tracking antenna at Goldstone, Calif., is laid out at the Rohr Corp. plant.

The radial rib back-up structure is installed for the 210-foot antenna.

The dish for the Goldstone antenna covers 85 percent of an acre.

The antenna, operated by Jet Propulsion Laboratory for NASA, is shown in the final stage of construction.

ıne 210-foot antenna is checked out by technicians at the servo control console.

Sales of the aerospace industry in 1966 amounted to more than $23.8 billion, a new peak of activity, with prospects of even greater growth in 1967.

Increase in sales was more than 15 percent higher than the $20.7 billion in 1965 with the demand for commercial aircraft one of the primary contributors to industry growth.

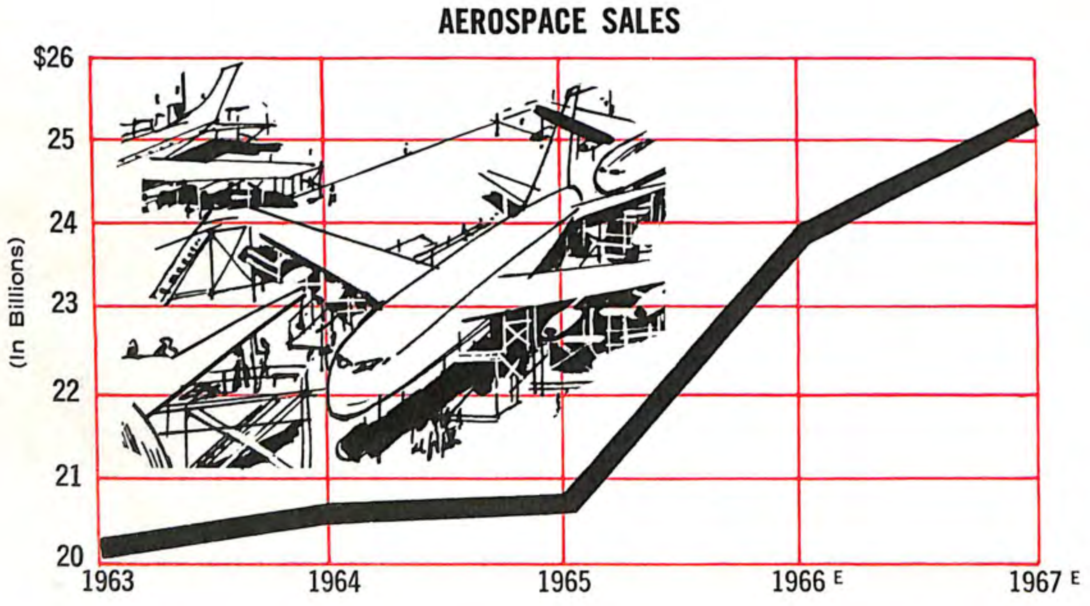
Other key economic indicators of the vitality of the industry during 1966 included:

- Earnings, as a percentage of sales, were 3.0 percent, one of the highest in recent years.
- Backlog of orders by the end of the third quarter of the year reached $27.1 billion, up from over $18.7 billion for the same quarter of 1965.
- Exports reached a postwar record of $1,512 million, an increase of nearly three percent above the $1,474 million in aerospace products exported in 1965. This is the ninth year since World War II that aerospace exports have exceeded $1 billion.
- Employment is expected to reach 1,349,000 by the end of 1966, an increase of almost 11 percent above that at the end of 1965. Scientists, engineers and technicians account for a substantial part of this gain.
- Capital expenditures increased sharply to $730 million in 1966 compared to $410 million in the previous year.
- Aircraft sales — commercial and military — increased to nearly $11.8 billion, up from $9.7 billion in 1965. Demands from world airlines for U. S. commercial passenger and cargo transports were a major impetus to sales during the year. This combined with the U. S. military requirement for aircraft in Vietnam and other parts of the globe as well as heightened demands for general aviation aircraft to lead sales to new heights.

Total civil aircraft shipments approximated $2.4 billion in 1966 compared to $1.7 billion in 1965. Shipments of general aviation aircraft during 1966 reached 15,700 compared with about 12,000 in 1965. The dollar value of these aircraft should increase from $318 million in 1965 to more than $410 million in 1966.

Sales of space exploration equipment during the year approximated $5.8 billion, an increase over the

AEROSPACE: 1966



E — Estimated

$5.3 billion sold in 1965, reflecting a peaking of the space program during the period.

Missile sales gained from $3.6 billion to more than $3.8 billion in 1966. Gaps left by the phasing out of some missile projects have been filled by increased activity on the Minuteman III and the Poseidon missile programs.

Sales of non-aerospace products and services by aerospace companies increased to about $2.5 billion in 1966 from $2.0 billion in 1965. This is a rapidly growing area of aerospace industry activity which includes commercial and military electronics, submarine construction, water purification, oceanographic activities and various other applications of aerospace technology to non-aerospace problems.

Despite record sales in 1966, however, profits in the industry remain at a relatively low level in comparison with those of all manufacturing industry. The 3.0 percent of profit to sales is based on reports by aerospace manufacturers to the Securities and Exchange Commission and the Federal Trade Commission and is considerably lower than the 5.6 percent average for all manufacturing in the United States.

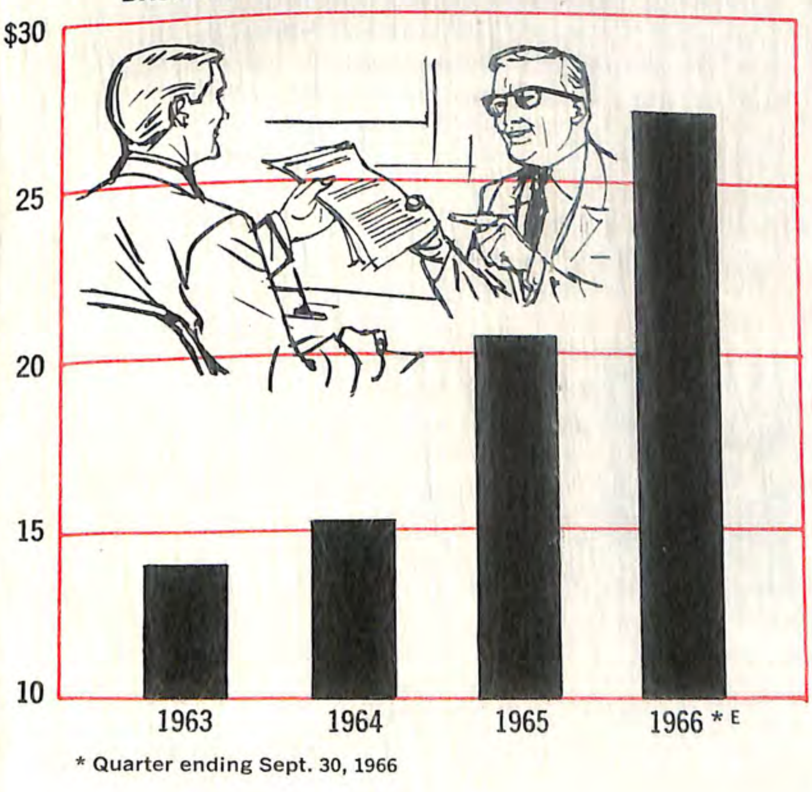
The postwar record in exports recorded in 1966 largely resulted from the demand for commercial air transports. Expanded foreign sales programs by U. S. manufacturers have stimulated buyers abroad as well as improved export financing programs by U. S. banking and government agencies which have provided necessary credit arrangements for foreign nations in the purchase of aerospace products.

Payrolls in 1966 increased by 18 percent above 1965 to $10.7 billion. This reflects not only the rising level of employment but the increased wage scales for aerospace employees.

The number of scientists and engineers within the industry is expected to rise from 203,000 in December 1965 to 230,000 in December 1966. Much of this increase was reported by aircraft manufacturers. At the present time, scientists and engineers constitute 17 percent of the total aerospace work force and make up nearly one-third of all scientists and engineers engaged in U. S. industrial research and development.

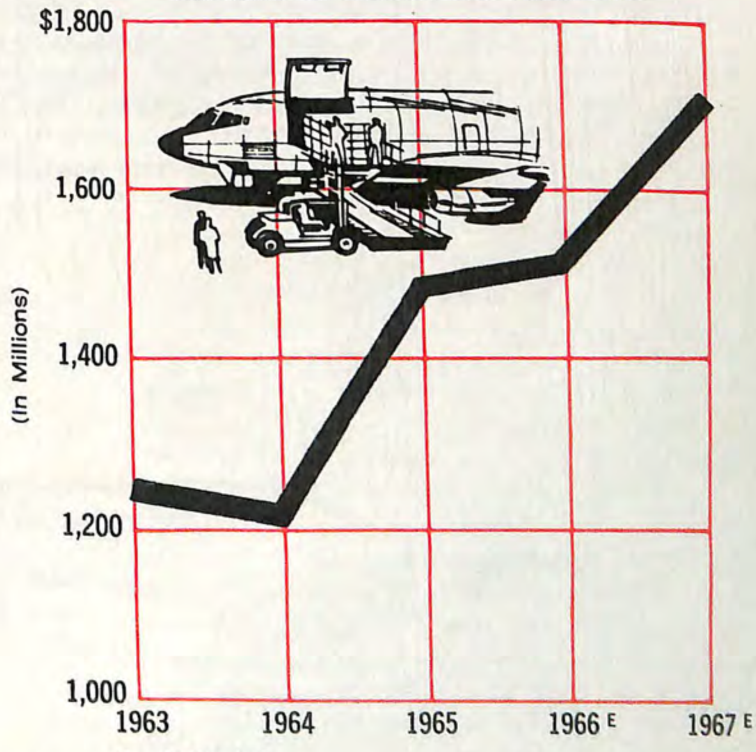
The dramatic increase in capital expenditures for the year is evidence of the basic stability and growth potential of the industry.

BACKLOG OF MAJOR AEROSPACE COMPANIES



* Quarter ending Sept. 30, 1966

EXPORTS OF AEROSPACE PRODUCTS



E — Estimated

AEROSPACE COMMENTS

James H. Binger
Chairman of the Board, Honeywell Inc.
before the Executives' Club of Chicago

"Today, instead of being concerned with man's productive capacity, or with the sustenance of life, we must become concerned with higher levels of human need, and it is in filling these needs that computers will play their most vital role.

"These are the needs that make headlines every day. Their existence is part of the modern social drama. They include, in my mind, the whole cloth of human relationships. Let's call them the high-order needs.

"They include, first and foremost, communications. Communications among people. Among various vested-interest groups. Among governments. When we think of the growing confrontations of business and labor, labor and government, government and business, we gain solid proof of the need for better communications. When we observe the confrontation of races, we see the same set of proofs. When we watch the subtleties of the Cold War over a period of 20 years, we observe how humanity is struggling to solve problems through persuasion and psychology rather than resort to the dread instruments of war that our modern world has created. Indeed, this new 'war for men's minds' is being waged with the weapons of information.

"We can already see that the tools by which this process of communication will be carried out are computers. For computers are the tools of information handling and transmission. They are the engines that will drive us toward faster, more complete and more factual communications — in business, government and all areas of human relations.

"Facts can be marshalled swiftly, where in the past only opinions were available to resolve problems. Common information pools shared by all vested interest groups can provide the same data to each, with the same swiftness. International communications systems will some day eliminate the critical time lag in transmitting information around the world. These new capabilities will contribute toward maintaining an equilibrium of reason upon which the future will depend. Computers and the product of computers — information — will make them possible.

"The second of these high-order needs is highly dependent upon communications and information technology. I am speaking of the education process.

"Disparity describes the relationships in world education. The greatest enemy any race or nation or group of people faces is ignorance, for ignorance is a more durable form of bondage than any other. And even in advanced nations, such as our own, where educational facilities more generally are available, refinements of the education process are needed — and coming.

"Computers are playing a pivotal role in this renewed effort to broaden educational opportunities and sharpen standards. Already one thousand computers are in use for pupil administration, training and research. They are finding their way into primary and secondary school districts to help allocate facilities, keep records, establish curricula, and perform other non-teaching tasks.

"And in the vast virgin territories of vocational training, computers are now being used in administration and in pupil training functions. This is happening now. But the best is yet to come. For if the computer is to be the engine of education, it must become involved in the learning process. And it will."

Alexander B. Trowbridge
Assistant Secretary of Commerce
for Domestic and International Business
before the National Foreign Trade Convention

"This Administration, like those before it, has adopted the realistic policy of maintaining maximum flexibility in dealing with the Communist areas. From such areas as China, Cuba, North Vietnam and North Korea, we hear nothing but strident antagonism. But with most of the European Communist countries the horizon does look brighter. The area of economic contact is decidedly one where 'peaceful engagement' is not only possible but desirable. Here we can talk contacts instead of contrasts.

"It appears to me that more and more American businessmen are in agreement with this concept of 'peaceful engagement,' and are doing something about it. I'm struck with the increasing number of business voices, in groups as well as individually, which call for increased trade contacts with the Soviet Union and the nations of Eastern Europe. The recent tour of Hungary, Rumania, Czechoslovakia, Poland and Yugoslavia, organized by Time Magazine for executives of 24 of America's most important corporations, illustrates the increased interest on the part of the American business community. When we organized our recent Government-sponsored Trade Missions to Rumania, Poland, Hungary, and Bulgaria, we had no lack of candidates anxious to participate.

"This is further borne out by the trade figures for the first eight months of this year. Indeed, if the statistics of our trade with the Soviet Union and Eastern Europe for the balance of the year continue on this trend, we will find that total trade has reached in 1966 the highest level since 1947, excepting only 1964 when there was that unusual export of nearly $180 million worth of wheat to Eastern Europe, including the U.S.S.R.

"Our total two-way trade with Eastern Europe and the U.S.S.R. in the first eight months of this year was over $240 million, whereas total trade for the equivalent period in 1965 was about $161 million. Our records show that in the January through August period this year, American exporters sold to Russia and Eastern Europe goods valued at $123,141,000, while our importers purchased from them products worth $117,120,000.

"It seems possible then that our two-way trade level with the European Communist nations may reach $350 million for the full year, and we can look forward to continually improving peaceful trade in 1967 and the years to come.

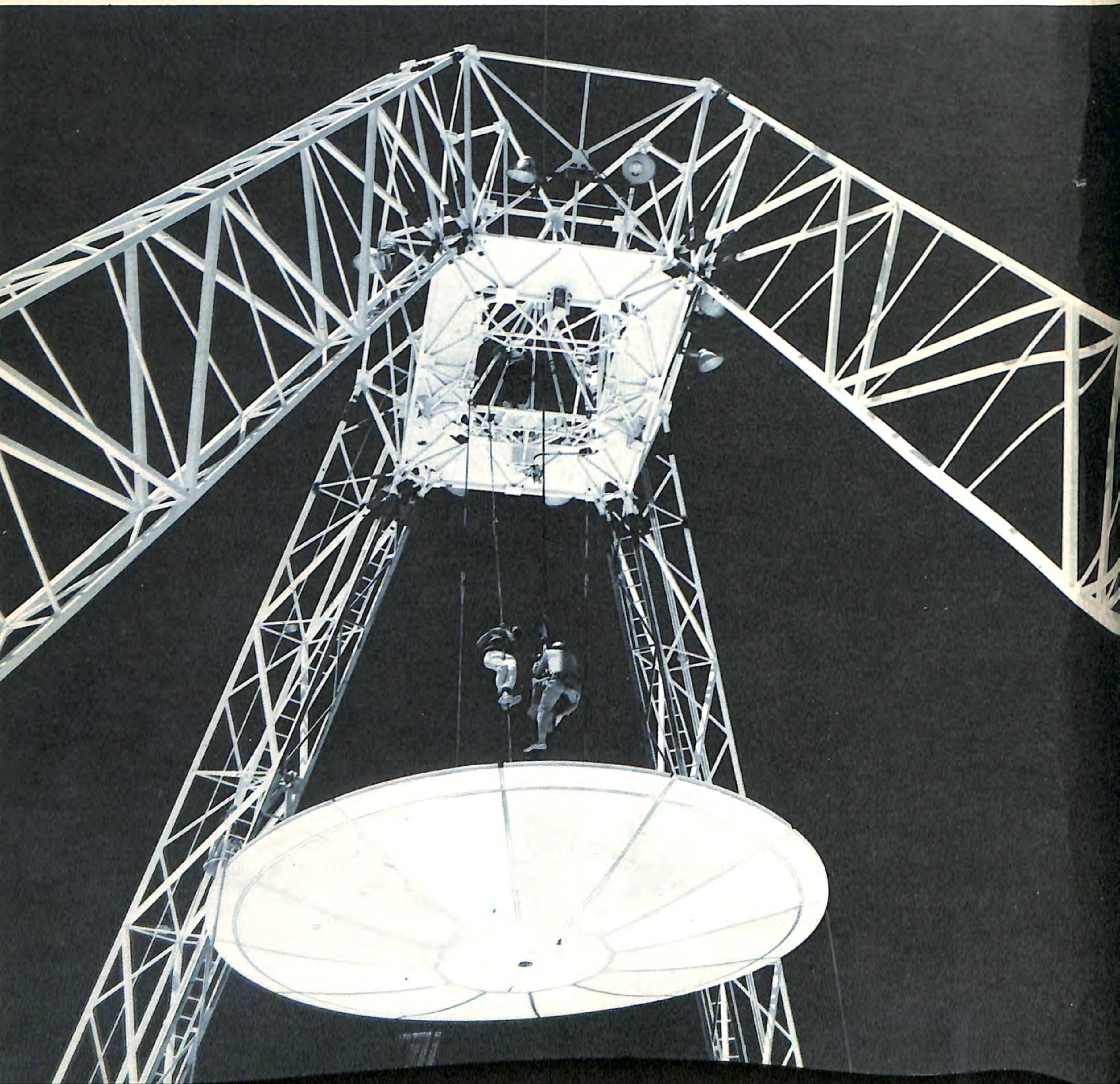
"To be sure, these trade figures are not large when compared to America's total world trade level, which in 1965 reached $48 billion and which is currently running at an annual rate of over $53 billion. If, however, the value of U.S.-origin technical data and know-how that we have licensed this year for export by U.S. industrial and engineering firms to Eastern Europe were available, the resulting total would turn out to be significantly higher than for goods alone."

AIA MANUFACTURING MEMBERS

Abex Corporation
Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Aeronutronic Division, Philco-Ford Corporation
Aluminum Company of America
Avco Corporation
Beech Aircraft Corporation
Bell Aerospace Corporation
The Bendix Corporation
The Boeing Company
Cessna Aircraft Company
Chandler Evans, Inc.
  Control Systems Division of Colt Industries, Inc.
Continental Motors Corporation
Cook Electric Company
Curtiss-Wright Corporation
Douglas Aircraft Company, Inc.
Fairchild Hiller Corporation
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Defense Electronics Division
  Flight Propulsion Division
  Missile & Space Division
  Defense Programs Division
General Laboratory Associates, Inc.
General Motors Corporation
  Allison Division
General Precision, Inc.
The B. F. Goodrich Company
Goodyear Aerospace Corporation
Grumman Aircraft Engineering Corp.
Gyrodyne Company of America, Inc.
Harvey Aluminum, Inc.
Hercules Incorporated
Honeywell Inc.
Hughes Aircraft Company
IBM Corporation
  Federal Systems Division
International Telephone & Telegraph Corp.
  ITT Federal Laboratories
  ITT Gilfillan, Inc.
Kaiser Aerospace & Electronics Corporation
Kaman Aircraft Corporation
Kollsman Instrument Corporation
Lear Jet Industries, Inc.
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Company
McDonnell Company
Menasco Manufacturing Company
North American Aviation, Inc.
Northrop Corporation
Pacific Airmotive Corporation
Piper Aircraft Corporation
PneumoDynamics Corporation
Radio Corporation of America
  Defense Electronic Products
Rockwell-Standard Corp.
  Aircraft Divisions
Rohr Corporation
Ryan Aeronautical Company
Solar, Division of International Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company
  Sperry Phoenix Company
  Vickers, Inc.
Sundstrand Aviation, Division of Sundstrand Corporation
Thiokol Chemical Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory
  Marine Division

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

Workmen put a sub-reflector in place for the 210-foot deep space tracking antenna at Goldstone, Calif. (See *Eyes and Ears on Outer Space*, page 10).



aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • • FEBRUARY 1967

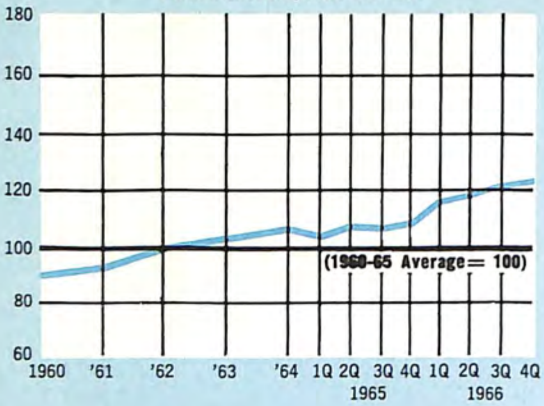
- Lifting Bodies — New Shapes In Space
- Systems Technology: Avenue To Social Goals

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

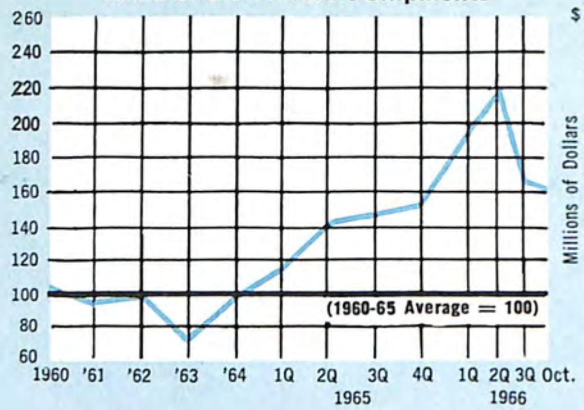
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

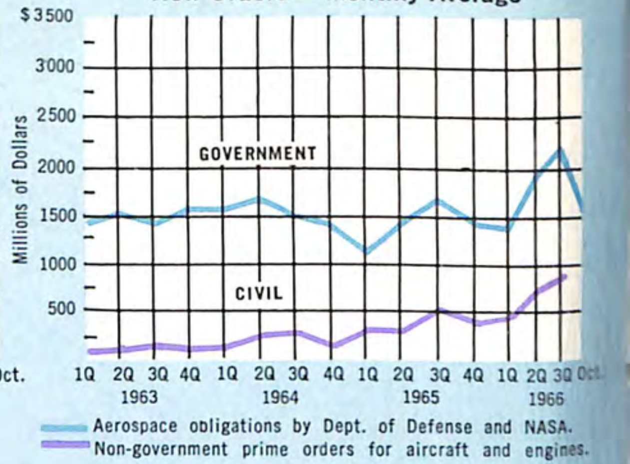


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-65 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Quarter Ending Dec. 31 1966	20.7 R	23.5	23.8 E
	Billion $	Quarterly	4.8		5.2	6.1	5.9
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	Oct. 1966	1,147	1,978	1,274
Aircraft	Million $	Monthly	601	Oct. 1966	684	1,205	823
Missiles & Space	Million $	Monthly	550	Oct. 1966	463	773	451
Aerospace expenditures: Total	Million $	Monthly	1,067	Oct. 1966	833	1,257	1,069
Aircraft	Million $	Monthly	561	Oct. 1966	444	777	668
Missiles & Space	Million $	Monthly	506	Oct. 1966	389	480	401
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Nov. 1966	408	332	267
Expenditures	Million $	Monthly	130	Nov. 1966	372	403	371
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	692	Dec. 1966	1,111	1,301	1,211
Value	Million $	Monthly	15	Dec. 1966	38	36	30
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	Quarter Ending Sept. 30 1966	18.7	22.8	27.0
U.S. Government	Billion $	Quarterly	11.6		12.7	13.6	15.8
Nongovernment	Billion $	Quarterly	3.7		6.0	9.2	11.2
EXPORTS							
Total (Including military)	Million $	Monthly	110	Nov. 1966	136	152	96
New Commercial Transports	Million $	Monthly	24	Nov. 1966	39	57	7
New Utility Aircraft	Million $	Monthly	2	Nov. 1966	6	7	6
PROFITS				Quarter Ending Sept. 30 1966			
Aerospace — Based on Sales	Percent	Quarterly	2.3		3.6	3.2	2.7
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		5.4	5.9	5.4
EMPLOYMENT: Total	Thousands	Monthly	1,132	Nov. 1966	1,200	1,350	1,369 E
Aircraft	Thousands	Monthly	499	Nov. 1966	483	589	600
Missiles & Space	Thousands	Monthly	496	Nov. 1966	547	587	595
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Nov. 1966	3.23	3.46	3.48

R Revised
E Estimate
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
# Averages for 1961-65.

AEROSPACE AND THE FEDERAL BUDGET

National security programs continue to be the most significant element of the Federal Budget for Fiscal Year 1968 which was recently presented to Congress by President Lyndon B. Johnson.

Expenditures for security programs during FY 1968 are estimated at $75.5 billion with the Department of Defense accounting for $72.3 billion. DoD expenditures amounted to $66.9 billion in FY 1967.

National Aeronautics and Space Administration expenditures are estimated at $5.3 billion in FY 1968 compared to $5.6 billion in FY 1967. The decrease is largely due to the completion of facilities for the Apollo program. However new obligational authority requested for NASA is $5.05 billion compared to $4.96 billion in 1967. This increase is primarily due to provision for manned space flight beyond the lunar landing, and continuing build-up for unmanned Voyager and Mariner flights to Mars and Venus.

The Apollo Applications Program (AAP) will be a major undertaking. For FY 1968, NASA seeks $454,700,000 with more than half of the funds for space vehicles.

In major security programs, support of general purpose forces and operations in Southeast Asia will dominate defense spending. Action to deploy an anti-ballistic missile will not be taken, but intensive development of the Nike-X system will continue. Airlift and sealift capabilities will be increased by the procurement of the C-5A transport aircraft and the purchase of five fast deployment logistics ships.

Defense expenditures for procurement are estimated at $21.6 billion, an increase of more than $3 billion over the previous period.

New obligational authority of $22.9 billion is requested, approximately the same as in 1967.

Expenditures for research and development are placed at $7.1 billion during 1968, an increase over 1967. New obligational authority of $7.3 billion has been requested. Major items in the R&D program are the Nike-X system, SAM-D missile, the Manned Orbiting Laboratory, short range attack missiles, the C-5A, advanced helicopters, and heavy emphasis on development of items for use in Southeast Asia such as counterinfiltration systems and antiradar attack missiles.

New funds for the supersonic transport are not included in the budget at this time. However, expenditures of $90 billion from previously appropriated funds are expected. The detailed design program competition is now complete. The budget message states: "A decision to proceed to prototype construction is under study. Recommendations for the program in 1968 will be transmitted to the Congress at a later date."

AIA

aerospace

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

PRESIDENT • Karl G. Harr, Jr.
PUBLISHER • Glen Bayless

VOL. 5, NO. 2 FEBRUARY 1967

EDITOR • Gerald J. McAllister
ASSOCIATE EDITORS • Richard W. Balentine
• William S. Evans
• John J. Lee
ECONOMIST • Gerson N. Chanowitz
ART DIRECTOR • James J. Fisher

CONTENTS

The purpose of AEROSPACE is to:

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

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

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

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

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

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

Western Office: McCulloch Building, 6151 West Century Blvd., Los Angeles, Calif. 90045

SYSTEMS TECHNOLOGY

MR. HARR

Karl G. Harr, Jr., President of the Aerospace Industries Association, last month testified before the Special Subcommittee on Scientific Manpower Utilization of the Senate Labor and Public Welfare Committee which held hearings on legislation to utilize systems analysis, engineering and management techniques for solving problems in social and economic areas. One bill (S.430) is sponsored by Senator Gaylord Nelson (D.-Wisc.), Chairman of the subcommittee; the other (S.467) is sponsored by Senator Hugh Scott (R.-Pa.), and other Republicans.

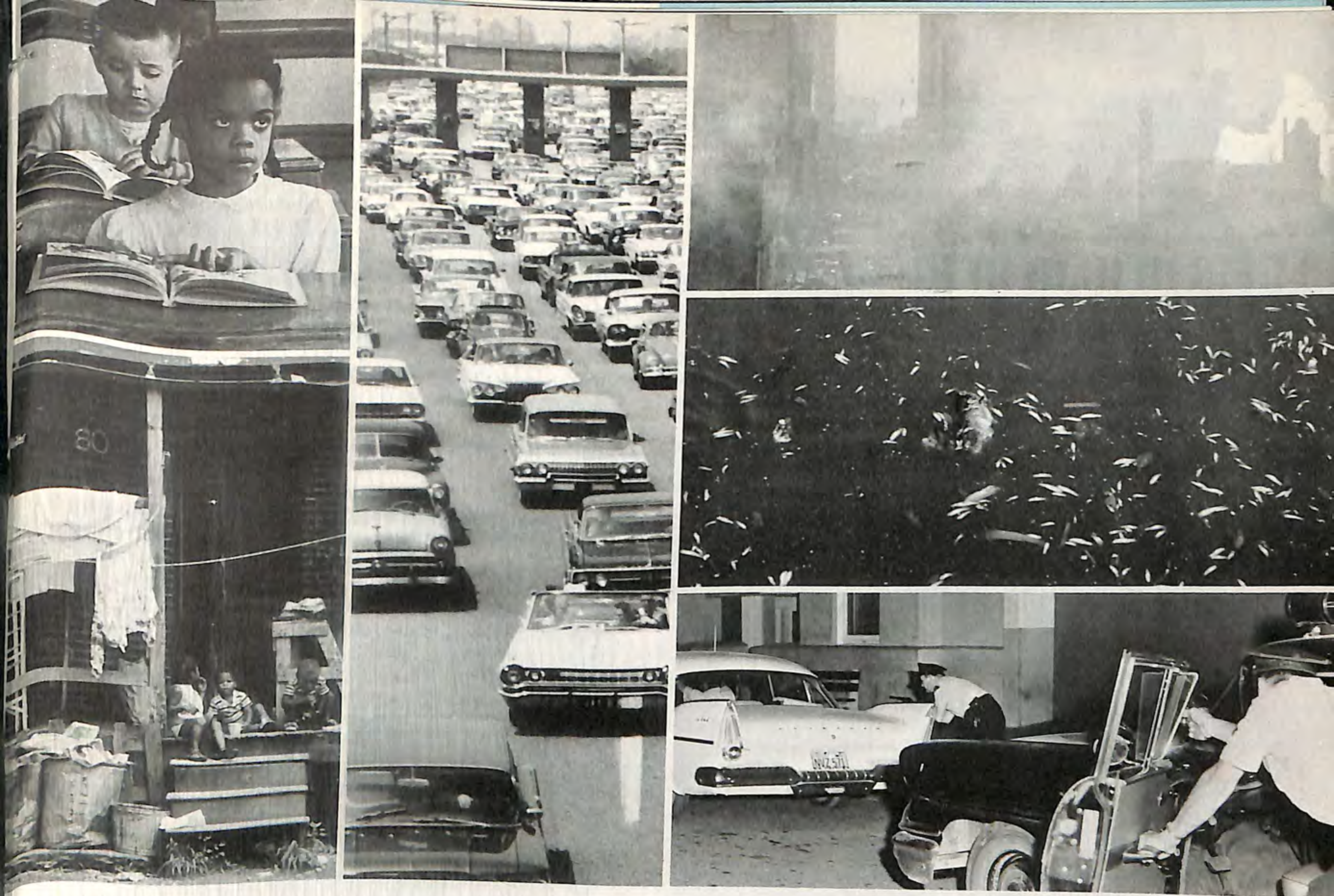
The following is Mr. Harr's statement.

The aerospace industry has been a principal partner with the government in the evolution of a body of highly developed capabilities for the solution of complex problems which are frequently referred to as the systems approach.

The feasibility of applying this approach beyond the national defense and space effort, particularly to problems connected with improving the quality of American life, is challenging and bright with promise.

Many of these problems, such as air pollution and water pollution control, relief of traffic congestion, provision of adequate food supply, school systems, housing, and crime control, are already fully identified and very much on the front burner of public concern.

The question is: How much if any of the systems approach techniques and capabilities developed in the course of our national defense and space efforts can be effectively transferred to the solution of those other problems?



Avenue To Social Goals

Certainly the answer requires, at least, understanding how the systems approach came about, what it is, the scope of its potential application and what is needed to effect that application.

Perhaps a word of caution is necessary. One of the greatest values of the systems approach lies in the enormous number of variables it can encompass. But there is a danger of being complex for complexity's sake, and that particular danger is nowhere more manifest than in the dialogue surrounding this subject.

Most of the important considerations involving the systems approach are, to the contrary, quite simple.

Such is certainly the case with respect to its genesis.

We are well aware of the technological revolution that has occurred since World War II. One of our most vital national concerns was to master this technological revolution at least to the extent of our national security interests. Because of the growing complexity of technology this task presented an unprecedented challenge both to federal agencies having national security responsibilities and to those segments of industry upon which such agencies rely. Their joint responses in terms of technological mastery, advanced managerial techniques and refinement of government/industry roles created the systems approach.

What is it? In terms of general definition it has three elements: systems analysis, systems engineering and systems management.

The first of these embraces techniques for making a problem understandable, offering possible avenues for its solution and establishing criteria for the selection of the best alternative.

Systems engineering consists of designing plans for the conduct of a system development program, including its schedules and costs.

Systems management consists of directing and controlling such a program to completion, on schedule and at the prescribed cost.

There are some general factors which bear somewhat on the question of its potential application to non-defense and non-space activities.

First, the extent to which the systems approach is something new or radical or unique is merely one of degree. It is not an absolute science or a magical new formula or a sudden discovery or a brilliant invention. It is merely an extremely high degree of capability to evaluate, plan and do certain complex and difficult things.

Its relevance lies in the fact that many of the things necessary to the improvement of the quality of American life require that high degree of capability.

Secondly, this improved capability called the systems approach is not the exclusive province of industry. The challenges to and the responses by government were no less staggering than those of industry, and the upgrading of industrial capability has had to be accompanied by a commensurate upgrading of the customer interface with which industry deals — primarily, in the case of the aerospace industry, two agencies of the federal government, the Department of Defense and National Aeronautics and Space Administration.

We must face the fact that at this point in time the advantages of the systems approach have been pretty well limited to those situations in which there has been recognition of a clear and present danger to the United States and for which there has existed an institutional framework able to exploit these advantages (in the form of agencies of the federal government having specific responsibilities to combat that danger).

The happy part of the story is that, whatever the genesis, in the course of forging these capabilities under the pressures of arbitrary and sometimes cruel national defense and space requirements, a new national asset has been created which obviously has broader application if the political and institutional keys can be found. The techniques and tools developed in fashioning an effective systems approach are in no way wedded to or limited by the purposes which created them. They are somewhat complex, and while cheap for the purposes involved they are not inexpensive. But though superlative techniques and tools for problem analysis (and therefore improved bases for choice and decision making), for program planning and for program management, they are of a more or less abstract character.

The questions seem to boil down to these: What is it about our national society that has permitted our federal government and certain segments of private industry to come so quickly and effectively to grips with the hideously complex problems of defense and space programs? Do these same characteristics of our society portend successful coping with the socio-economic problems that lie before us?

It is readily discernible that in achieving our national defense and space objectives, in being able to develop and apply the required systems approach to these problems, our society has had three things going for it:

- *A superb technological base* — a reservoir the scope and depth of which is unequalled anywhere else in the world or at any other time in our own history.
- *The incentives of the free enterprise system* — providing constant motivation for our competitive private industrial community to further refine techniques and capabilities; in short, to come up with better ways of doing things.
- *An adaptable and flexible governmental structure* which could adjust to the fulfillment of its responsibilities in a time of rapidly changing public needs.

Each of these three elements plays an essential part in our federal government/private industry achievement of national defense and space objectives. The first two — our national technological base and the motivations of private industry — are as applicable to the improvement of the quality of our environment as they are to achievement of defense and space objectives.

The third — the adaptability of our governmental structure — will be tested in a new way. Rather than the federal government, it will be the lower echelons of our government structure, that is, the state and local governments, which will have to demonstrate their creativity and adaptability, although the federal government will still play a role.

This is the nub of the problem. Will we, as a nation, be able to devise the formulae that will bring into play the full strength of our political system? The only significant respect in which applying the modern systems approach to socio-economic and human environmental problems will differ from its application to defense and space problems lies in the fact that, of necessity, the public authority will be primarily at a level other than the federal government.

Otherwise the fundamentals will be the same.

Clearly there must be a public/private mix. Ultimate choice and control obviously will have to rest with responsible public authority at the appropriate level.

Clearly there must also be a pin-pointing of responsibility for results. One of the most valuable lessons of our national defense and space efforts has been its demonstration of the values of competitive free enterprise in this respect. A company which risks its corporate life on the success of its performance experiences a pin-pointing of responsibility of the most acute order. Whether we like to accept the fact or not, experience has shown that the diffusion of responsibility in public authority rarely produces so sharp a focus.

Clearly also, regardless of what level of public authority is involved, it will remain true that the pertinent public authority must bear the responsibility of knowing what it wants. Those responsible to the public must put the rabbit into the hat. Otherwise the system breaks down. Not only is it inappropriate for the private contractor to go beyond a certain point in this part of the act, but it is also beyond his scope and undesired by him.

We have seen in the defense and space business that independent non-profit think groups can effectively supplement the government's in-house analysis capabilities, and that private industry can contribute by expanding and sharpening alternatives by "selling" privately sponsored technological advance, by advising and suggesting, and by aiding in the production of tools and techniques for systems analysis. But not only the weighing of alternatives but also the primary job of systems analysis must be wholly and closely under the control of the user.

There will be many differences between establishing effective public/private interfaces at the state and local level and that which was involved in creating the existing effective interfaces for our national defense and space programs.

What are the great positive assets we have to work with?

In the highly developed techniques comprising the systems approach we have a capability which, while not a magic new formula, is so different in degree from what has gone before as to be different in kind. It provides us the precious capability to assemble, digest, evaluate, decide, plan, program and manage an almost infinite number of factors, taking advantage of all available information. It permits us to provide public authorities with an intelligent choice among alternatives and these public authorities in turn to communicate these alternatives in comprehensible fashion for purposes of public participation in decision making. It permits decisions to be made in time to be effective, an increasingly precious characteristic in these complex and fast moving days. Finally, it permits intelligent choice among alternatives to be made at a time of minimum investment of resources.

We have an unsurpassed and expanding national technological capability and, as we have learned elsewhere, technological advance breeds technological advance in the areas in which it is applied, almost geometrically.

We have a reservoir of private industrial experience in joint public/private systems approaches coupled with a recognition by private industry that participation in such ventures is wholly consistent with its profit motive. In fact, given the scope of the problems that lie before us and the virtual certainty that many of the largest enterprises of the future will involve public/private joint endeavors, it is evident that some of the big markets of the future will lie in such areas.

But above all we as a nation are blessed with a flexible and creative multi-level political structure to serve as a vehicle for addressing ourselves imaginatively and effectively to the solution of whatever problems beset us.

We have all the ingredients of a formula that can marry the three great advantages of our national political and economic system — unparalleled technological capability, free enterprise incentives and a federal political structure affording opportunities for in-depth political creativity — toward the improvement of the quality of American life.

The single lesson that has been learned from our defense/space experience most pertinent to this subject is that the precise methods of state and local use of a public/private systems approach have to be worked out by experimentation. DoD and NASA have arrived at a point of considerable sophistication and expertise in this regard. They did not do so overnight or without considerable experimentation — and perhaps it was an easier task than authorities below the national level of government will face.

In the course of this experimentation they developed a high degree of appreciation of the strengths of the systems approach — and of its limitations — and of the optimum roles, all factors considered, of the government on one hand and of private industry on the other.

Similar experimentation must be undertaken if we are to expand the utility of the public/private systems approach to levels below the national government. We must be most careful to walk before we run, for there are as many added complexities to operating below the national governmental level as there are differences between the needs, structures and capabilities of each subdivision of our government structure.

For most of the large identifiable problems today the modern systems approach is obviously the essential tool. It remains for us as a nation to find the various political formulae for its application wherever needed. Whatever the cost it will be far cheaper to solve these problems than not to, and far cheaper to solve them well than to muddle through. It will also be much easier to answer the difficult question *"How can we?"*, than it will be to answer the impossible question *"Why didn't we?"*

AEROSPACE NOTES

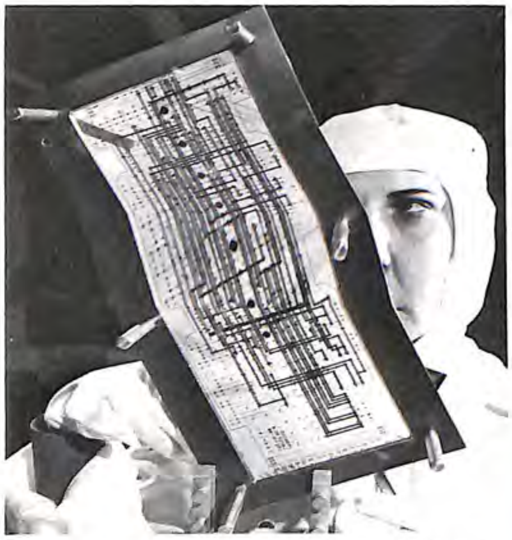
Aerojet Forms Tent Firm To Aid Watts Employment

Aerojet-General Corporation has formed a new company in the Watts area of Los Angeles known as the Watts Manufacturing Company. Expected to employ more than 200 people on a two-shift basis when in full production, the plant initially will produce large tents for use by the Army, Navy and Air Force.

A $2.5 million contract with the Defense Supply Agency calls for fabrication of 5,000 rectangular tents with production to begin shortly.

Training will be given those people who have the manual dexterity to use the tent-making machines but have never worked on this type of equipment before.

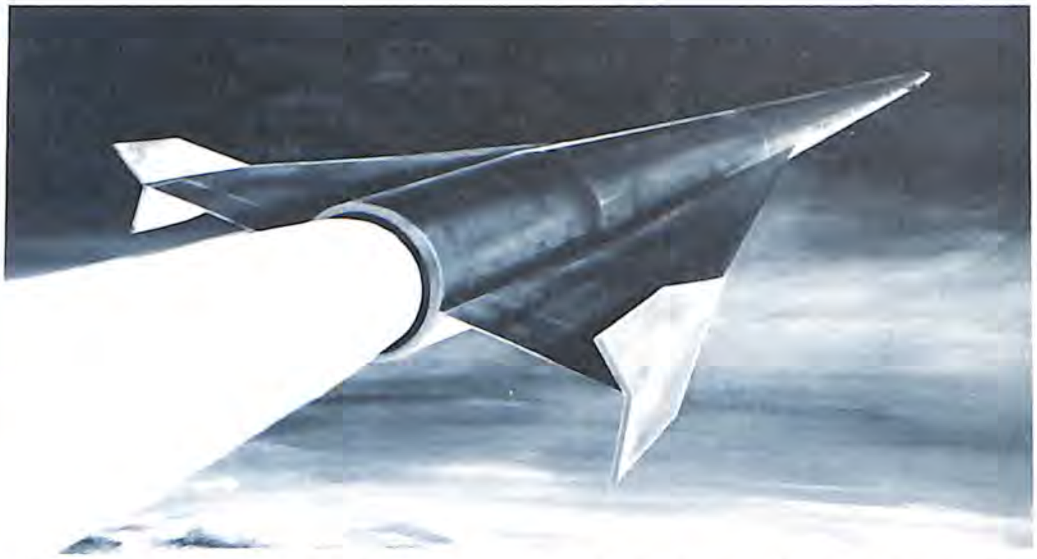
Vice President Hubert H. Humphrey called the new company "a significant breakthrough for all the nation in showing that it is possible to conceive and carry out the creation of new business and employment opportunities in those parts of our cities which have critical high unemployment rates."



Honeywell Uses Welded Wire Technique in Control System

A clean room assembler at Honeywell Inc. trims excess wire from the first of up to nine plastic layers holding a network of connections to other modules in an assembly which fits into the control system for the Apollo spacecraft.

A welded wire technique is used to enable quick-change of electronic modules in the stabilization and control system for the spacecraft. Honeywell builds the control system for Apollo.



UTC Builds Hybrid Rocket For Future Space Missions

United Technology Center will build an advanced hybrid rocket propulsion system as a technological demonstration which may also have near-term application as a propulsion system for a new multi-purpose target missile. This Air Force program will result in the first flight test of a hybrid rocket engine in this country.

The test vehicle to be used in the demonstration firing will be a modified AQM-37A target drone. It is expected that this propulsion system could provide the basis for a new Air Force target missile to be used for aerial gunnery practice, as well as for practice with air-to-air missiles.

UTC's hybrid rocket is expected to be less complicated, less expensive and less sensitive to its environmental conditions and will combine features of today's all-solid and all-liquid rockets.

It will use common plastic materials as a solid fuel and a combination of nitric oxides as the liquid oxidizer. UTC scientists predict hybrids will provide rocket power for numerous space mission assignments within the next 10 years.

Pan Am Pilots Train in New Link Dual 707 Simulator

The Link Group of General Precision has built a Boeing 707 dual-cockpit simulator for Pan American World Airways which has been installed at the airline's cargo terminal at John F. Kennedy International Airport for crew training. Other similar simulators are being built for Pan American for installation at Miami and San Francisco.

Representing a totally new concept in simulator design, the new simulators operate off a single, but specially programmed digital computer. The dual cockpits can operate simultaneously or independently, whichever is required.

Pan American plans to use the cockpits 17 hours a day, seven days a week training and requalifying flight crews.

As many as 160 simulated aircraft malfunctions can be interjected into the training course.

Northrop's Magnetic Simulator Counteracts Space Radiation

Northrop Space Laboratories has developed a magnetic shield simulator which enables scientists to measure directly the shape and volume of regions protected by an invisible magnetic line of defense.

Definition of these magnetic lines is necessary to the design of equipment capable of creating protective envelopes surrounding varying spacecraft configurations.

The simulator consists of a vacuum chamber, an electron gun, power supplies and the magnets with supporting equipment. A television tube yoke is used to direct the gun's electron beams at the magnets.

A screen grid system, coated with phosphor powder which fluoresces under electron bombardment, is used to provide three-dimensional photo coverage of simulation tests.

Actually, the magnetic simulator represents an active approach to counteracting space radiation. A strong magnetic field, if formed around the exterior of a vehicle in space, would reflect high-energy electrons and therefore serve as a protective shield for human occupants.

General Electric Develops New Transparent Ceramic

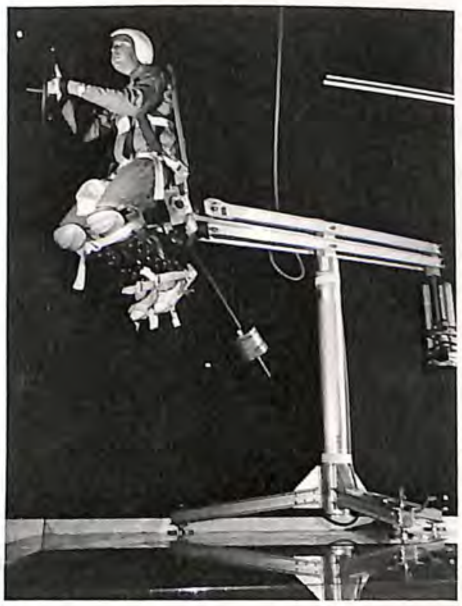
Scientists at General Electric's Research and Development Center at Schenectady, N.Y., have developed a transparent ceramic material which can withstand temperatures more than twice as high as glass. With a melting point in excess of 4,000 degrees Fahrenheit, GE's revolutionary ceramic is made primarily from yttrium oxide, an opaque white powder, which gives it the name of "Yttralox" ceramic.

Since it combines a number of desirable properties, "Yttralox" is expected to extend the range of instruments and devices that are presently limited by the physical characteristics of available materials. One application may come in improved high-intensity incandescent and discharge lamps. The ceramic also may find uses as an infrared "window" for heat-seeking rockets, as a "window" into high-temperature furnaces, and in lenses for microscopes used in the study of molten samples.

North American Testing Orbital Task Simulator

Critically balanced so that the movement of a finger can send him into sweeping gyrations, a test subject tries out a six-degree-of-freedom simulator developed by North American Aviation's Space and Information Systems Division. By using this device, studies can be made of the amounts of energy required to perform tasks in space.

North American's Rotational Research Facility is also involved in studies on prolonged rotation and its effect on astronauts. Men live and work inside a 30-foot cabin which is 10-feet in diameter on the end of a 150-foot beam for nearly 30 days.



Grumman Constructs Zero-G Simulator for Space Tests

Zero-G specialists at Grumman Aircraft Engineering Corp. have constructed a spaceman simulator to enable a man lying horizontally to achieve zero-G simulation in the laboratory. The man lies in a scooter-like device which is mounted on two tripods with air-bearing hooves. Lying in this device, a man can float freely a couple of thousandths of an inch above the completely flat floor.

During each test run, the man on the simulator controls air jets with waist, knee and foot movements. The jets move the 150-pound machine toward various objectives simulating tasks which an astronaut would attempt outside his space ship.

Goodyear Builds Brakes For Apollo Transporter

Brakes no larger than an automobile tire will handle the 17.5-million-pound loads of apparatus used in the Apollo moon program.

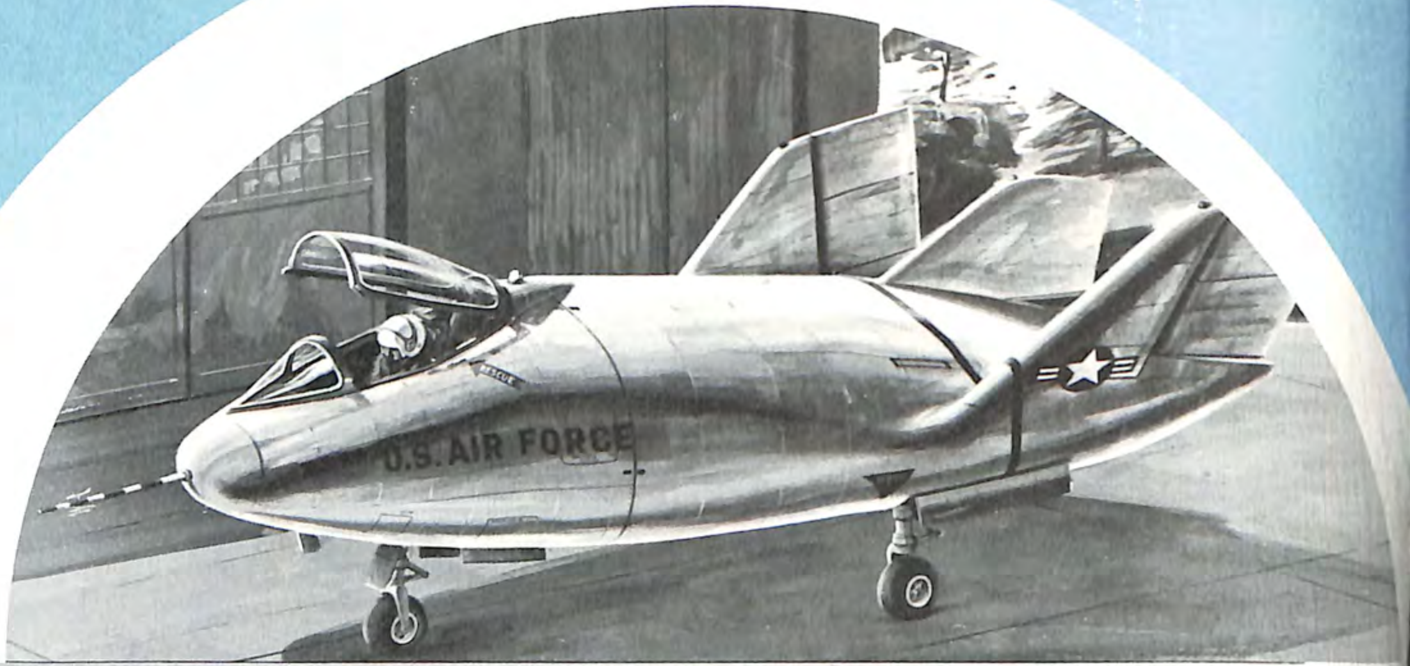
Developed by Goodyear's Aviation Products Division, the brakes are for the huge tracked transporters that move Apollo space vehicles from the Kennedy Space Center's vehicle assembly building to launching sites three and a half miles away.

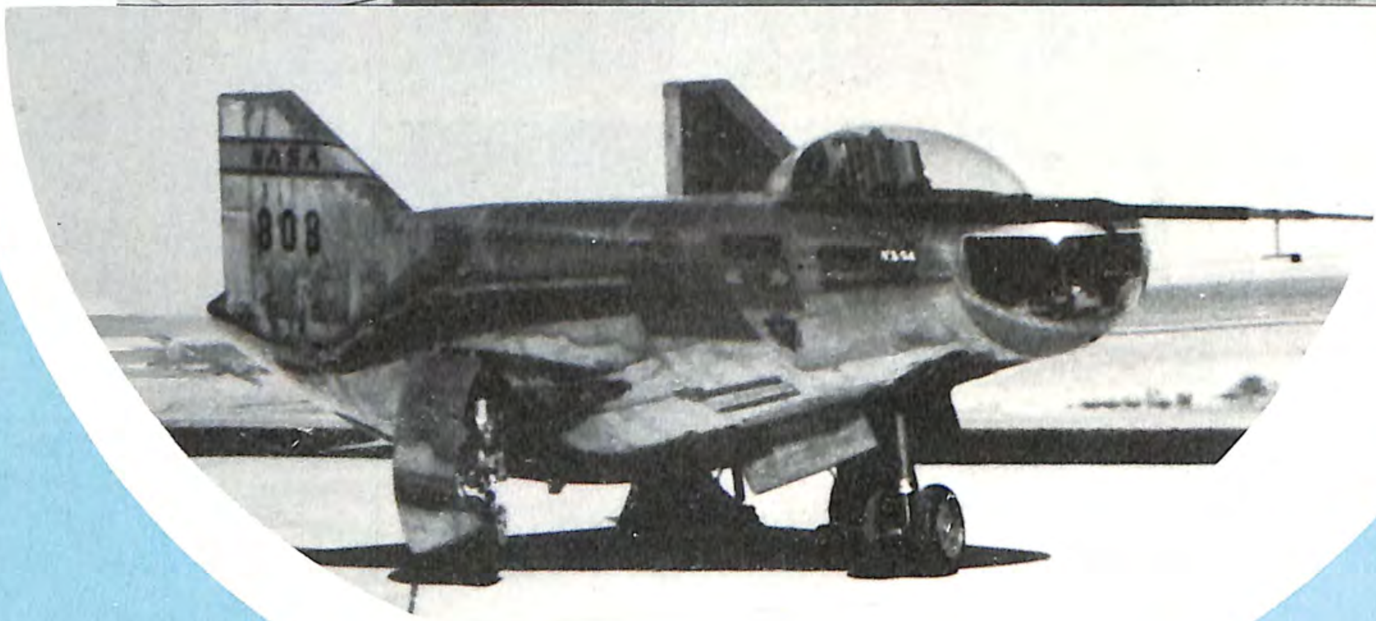
The transporter weighs about 5.5 million pounds and its cargo, the Apollo launch complex, adds another 12 million pounds. It towers more than 40 stories in the air.

Though the loaded transporter can move only one mile per hour on level ground and one-half mile per hour on a 5 percent incline, stopping nearly 18 million pounds of weight in motion generates extremely high temperatures. For this reason, special alloy discs were utilized to absorb and dissipate maximum kinetic energy input conditions.

To assure the maximum in mechanical dependability, the brake system has a "dual personality." A pressure-actuated service brake helps control travel speed. A "fail-safe" spring-applied brake is used to stabilize the transporter while cargo is being loaded, and to serve as a parking brake.

Sixteen brakes are used on each transporter.





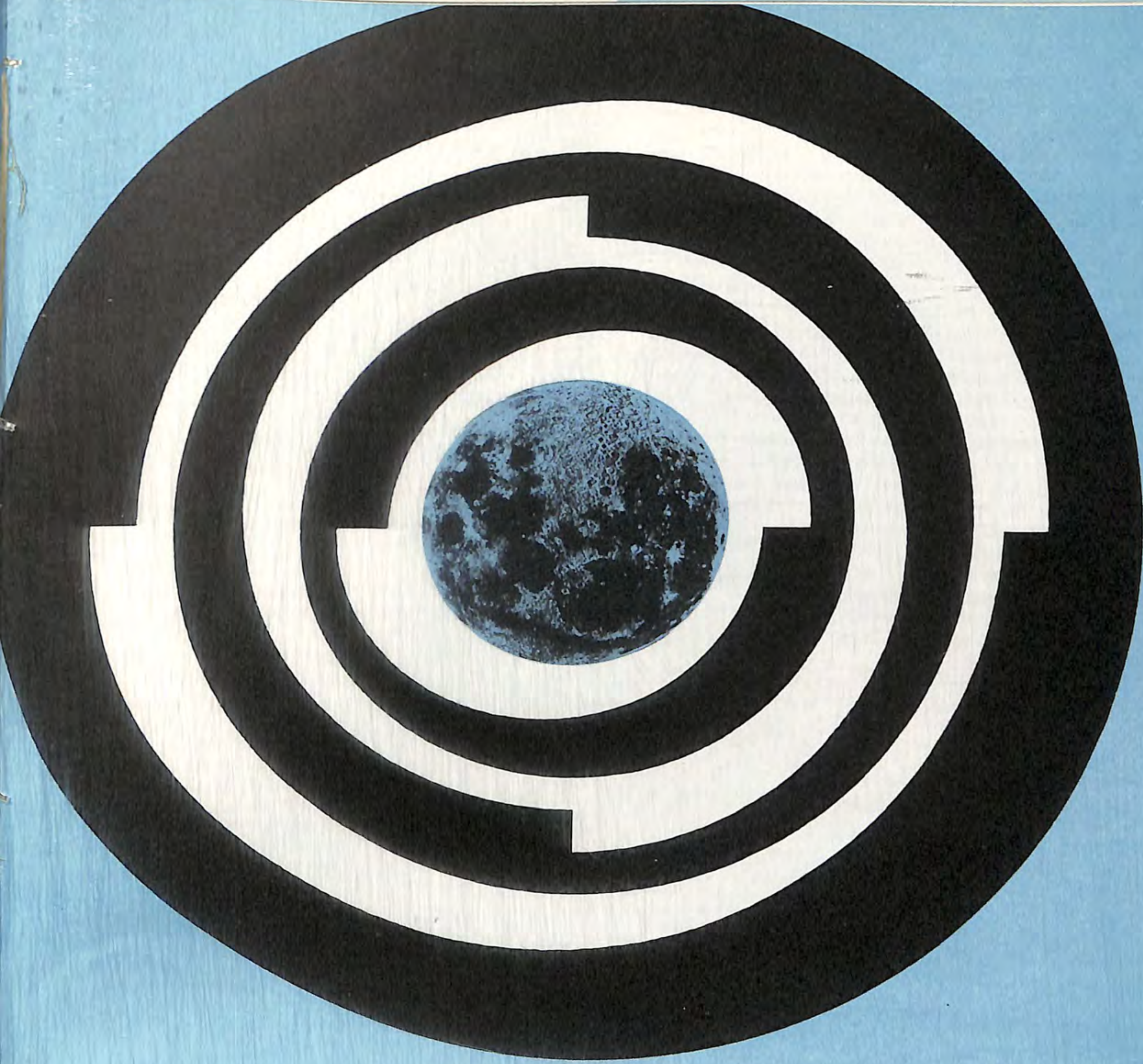
LIFTING BODIES– New Shapes in Space

A new type of spacecraft is being developed by the aerospace industry that promises to revolutionize space flight and open the door to a wide range of new missions for man in space.

The new craft, known as lifting bodies, will be able to fly home from space and land on special runways, maneuver so astronauts can change orbits, inspect or repair other spacecraft, rescue astronauts in trouble, and perform a variety of space jobs not possible with today's spacecraft.

Flight tests to perfect the spacecraft and landing techniques have already started on a limited scale. They will increase this year leading toward a flight into space with a dry landing return by about 1970.

The Northrop Corp. is developing flight models for the National Aeronautics and Space Administration. The Martin Company is doing similar work for the



U. S. Air Force. Other companies, including McDonnell Company, The Boeing Company, Lockheed Aircraft Corp., and General Dynamics Corp. have projects of their own.

In sharp contrast to the sleek needle-nosed shape of modern aircraft, the lifting body has purposefully been designed blunt and boxy to withstand the 3,000 degrees Fahrenheit temperatures spacecraft encounter as they come back to earth at 17,500 mph reentry speeds. Conventionally designed aircraft would burn up from this heat. The simplest design to withstand reentry temperatures is a cone fitted with a heat shield on its nose to dissipate this searing heat. The first generation of spacecraft — Mercury, Gemini, and Apollo — use this design.

These spacecraft can't be maneuvered extensively, however. To obtain maneuverability, aerospace designers have taken a half cone shape, to retain the heat resistance characteristics, streamlined it as much as possible and then added stubby vertical fins, elevons that recess and a retractable landing gear. The resulting lifting body flies due to a difference in air pressure created around its hull. The tail fins and elevons give it maneuverability. While the lifting bodies' performance is far short of conventional aircraft, it is sufficient to perform many new tasks in space.

Both the Air Force and the National Aeronautics and Space Administration, with coordinated programs to perfect the lifting body, expect these craft to become the workhorses of space in the future. They envision them in use to ferry personnel and supplies to large orbiting space laboratories, or to be sent up to inspect other spacecraft, possibly dispatched on rescue and repair missions, and other such jobs. Unmanned, the craft may be remotely controlled to do a wide variety of space experiments more economically than launching new satellites for each mission.

Two basic shapes are being tested in the development of lifting bodies. One uses a rounded under belly with a flat top, the other is just the reverse. Flight testing over the next couple of years is expected to reveal the virtues of one design over the other.

NASA is testing a basically flat-topped, round under belly design. The Air Force has concentrated on a flat bottomed version with a round top.

The big problem in perfecting a maneuverable spacecraft is to find a design that performs well in all speed ranges — subsonic, transonic, and hypersonic — speeds around 17,500 mph — that it must fly through. A design that flies well in one speed zone may go out of control in another, or present heat shielding problems.

The basic design for NASA's spacecraft is credited to Dr. Alfred J. Eggers, NASA Deputy Associate Administrator for Advanced Research and Development. His work started in 1957 while he was at the agency's Ames Research Center in California. The Martin Company design for the Air Force was largely perfected by their principal scientist, Hans Multhopp. Martin went through over 20 different designs and thousands of hours of wind tunnel testing before settling on their lifting body shape.

Because of its boxy configuration, the lifting body provides a high ratio of usable space for personnel or cargo. A spacecraft only 28 ft. long can carry 9 to 12 persons on short space journeys. Or, the space can be filled with fewer persons and more supplies for longer missions.

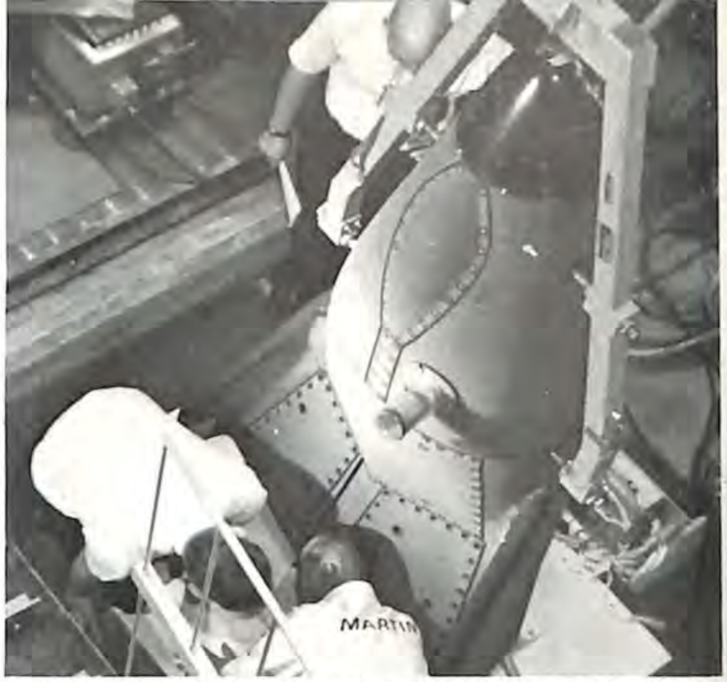
Currently, NASA is concentrating its testing in the subsonic and transonic speed ranges up to Mach 2. The Air Force will be testing in all three speed ranges, though unmanned craft are used in the hypersonic range. It will be about 1970 before manned orbital flights are attempted.

Initially, Northrop built a plywood model of a lifting body for NASA. Designated the M2F1, the craft was glide-towed by an automobile at Edwards Air Force Base in California, then later by a modified C-47. It never went much higher than 13,000 ft. or faster than 120 mph, however.

Experience gained from these tests led to construction of an aluminum follow-on version, the M2F2. Flight testing of this craft started last summer and will last for about two years. It is carried aloft by a B-52, then released at 45,000 ft. altitudes, gliding down at speeds up to Mach 2, eventually landing at about 170 mph, about the same as jet aircraft.

Concurrently with the M2F2 flights, NASA has started testing its slightly larger and somewhat modified HL-10 spacecraft through the same speed zones.

In the Air Force program, Martin has already tested a small 68.7-inch long unmanned lifting body craft in suborbital glide flight. Starting December 21, 1966, it launched the first of four unmanned spacecraft from Vandenberg Air Force Base, California. As part of Project PRIME (Precision Recovery Including Maneuvering Entry) the remaining three craft will be flight tested this year. Designated SV-5D, the 7-ft long, 890-



SV-5D lifting body is put through eight complete flight simulations prior to being shipped to the launch site. Martin Company engineers prepare the spacecraft for explosive bolt testing to simulate booster separation.

lb. model is subjected to heat of 3,000 degrees Fahrenheit for almost 30 minutes in order to test its heat resistance.

For the test, the craft is launched on top of an Atlas rocket to a 100-mile high altitude, then the rocket tilts over and drives the spacecraft on a long 4,000-mile path toward Kwajalein Island in the Pacific Ocean. Sensors on the model transmit data to monitoring ground stations. As it nears the earth, parachutes open to break its speed so that aircraft can recover it.

This summer, the Air Force will begin flight testing a manned lifting body now being built by the Martin Company. Designated the SV-5P, it will be 24-ft. long with a 10 ft. tail span, and flown through the same speed zones as NASA's M2F2 and HL-10 lifting bodies. Its different shape will allow a comparison of the two designs.

So far, NASA has only glide tested its vehicles, but powered flight will begin later this year. The HL-10

already has a small engine in it, and one is being installed in the M2F2. This will allow pilots to practice additional maneuvering as they descend after being dropped by the B-52.

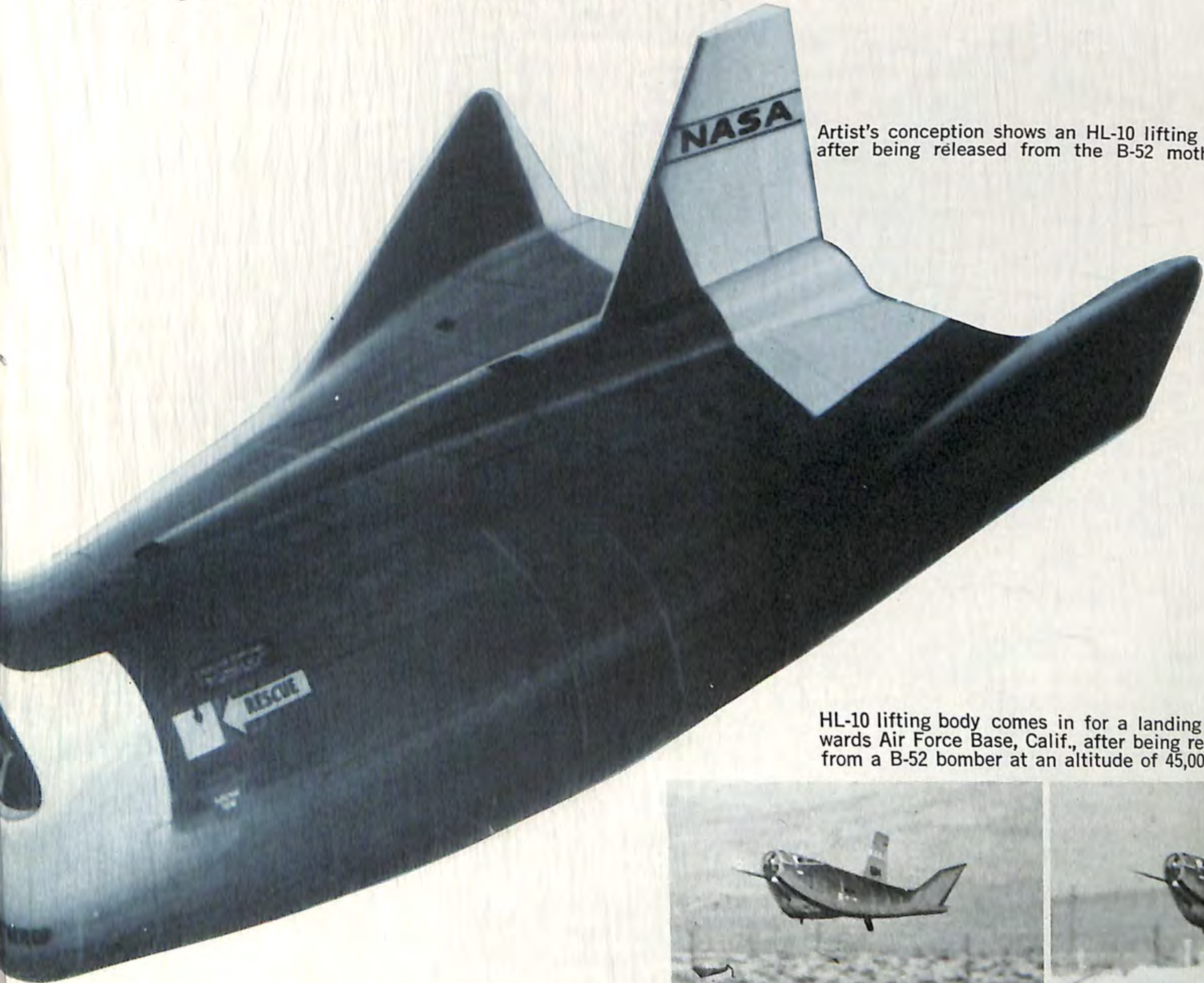
Experience gained from these flights which will last into 1968 will be used to design a spacecraft to perform in all three speed zones encountered by an astronaut returning from space. By about 1970, manned flights with lifting bodies, or a follow-on design, will begin. Initially, they will consist of suborbital flights just short of a full orbit. Astronauts will be launched from Cape Kennedy, go east across the Atlantic, Indian and Pacific Oceans, then come in for a dry landing at Edwards Air Force Base.

The Air Force has already contracted with the Martin Company and Douglas Aircraft Company for year-long parallel studies that hopefully will lead to the development of multipurpose, reusable spacecraft, building off of experience gained from the lifting body program.

With the prospect that space flight will increase rapidly in the future, making it economically necessary to reuse spacecraft over and over again, other companies are designing spacecraft of their own hoping to sell them to the Air Force or NASA. The Convair Division of General Dynamics Corp. has designed the VL3-A vehicle in the manned lifting entry vehicle race. A 39.2-ft. long model with a 12-ft. wide fuselage could carry six men to space and back.

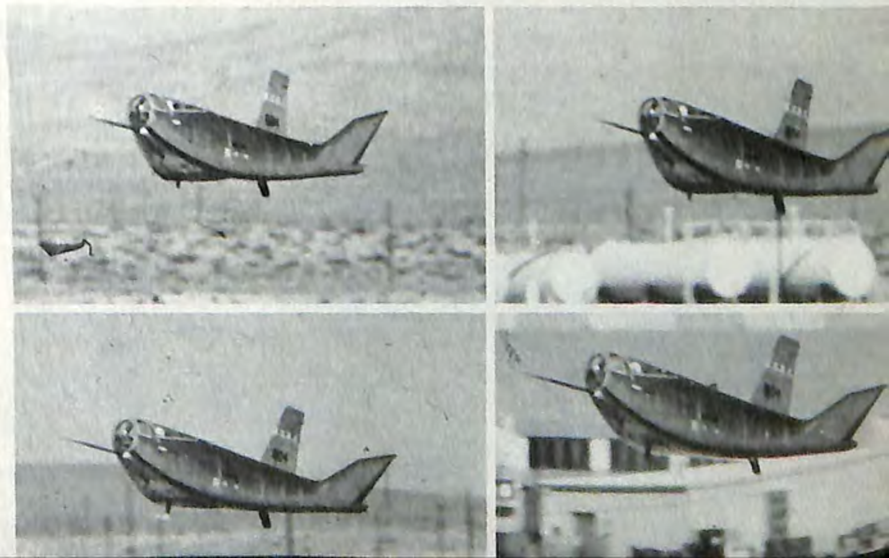
Lockheed-California Company, a division of Lockheed Aircraft Corp., has a version of an aerodynamic maneuvering reentry vehicle that has undergone wind tunnel testing. Other companies, too, are putting more and more effort into reentry vehicles.

One day, man may fly as routinely into space and back as he now rides an airplane.



Artist's conception shows an HL-10 lifting body model after being released from the B-52 mother aircraft.

HL-10 lifting body comes in for a landing at Edwards Air Force Base, Calif., after being released from a B-52 bomber at an altitude of 45,000 feet.



Business Aircraft

Stars on High

Frank Sinatra boards his Lear Jet for another flight to fulfill his busy schedule. Flags on side of jet represent the countries Sinatra has visited.

An Aero Commander Jet Commander made it possible for entertainer Barbra Streisand to meet the demands of an extensive concert tour.

The demanding schedules of celebrities require them to be men and women on the move. Whether statesmen, film stars or popular athletes, their time requirements make them seek travel efficiency.

All of these people use the airplane to overcome the problem of being in many places in a short period of time. More and more of them are finding that scheduled airlines do not meet all their transportation requirements, and are turning to buying or leasing their own aircraft.

Movie stars who have become so successful that they are corporations in themselves favor the new business jets, both to fulfill their entertainment travel requirements and to check on their many business ventures.

Frank Sinatra, for instance, says: "My original need for private air transportation came when I moved to Palm Springs. I had to make frequent trips to work at the studios in Hollywood plus singing engagements out of state, so it made sense to be self-sufficient. So Sinatra Enterprises bought the first of several aircraft. With the company growing in recent years, there was a need for a larger plane, and we bought a Lear Jet. This comes in handy for concert tours where you need people to work out the details, plus equipment."

Sinatra gets full use out of his Lear Jet which will carry eight people, and cruise at about 450 knots on its two General Electric turbojet engines.

On one ten-day tour, Sinatra performed a charity concert in St. Louis, attended a New York premiere of one of his new movies, and went to Israel where he was on location for another movie.

More than 17,000 miles of travel were involved in this unusually tight schedule of personal appearances.

Chartering business jets is also becoming an increasingly popular practice. A Lear Jet was used as James Coburn's private aircraft when he starred in the picture "Our Man Flint," and then film producer Saul David kept the aircraft to scout for locations in the Caribbean area for another movie in the series.

"We were able to cut our travel time to a bare minimum and stretch our working time in each place to a productive maximum," he said. "Day-long road trips were avoided; we even had the distinction of being the first jet aircraft to land at several 3,000-foot runways in out-of-the-way areas."

Tournament golfer Arnold Palmer is another celebrity who finds that his aircraft helps him fulfill his heavy schedule of golf matches and manage his many business ventures. He also represents another growing trend in that, since 1956, he has been a pilot himself.

Starting with smaller aircraft like the Aero Commander 500, Palmer has now graduated to an Aero Commander Jet Commander, which he flies on almost all his business trips to the ten cities in which there are Arnold Palmer Enterprises, and to his twenty-five golf tournaments a year, as well as a minimum of twenty exhibition matches.

"Virtually all the jet's operations — at least 99 percent — are business trips. There hasn't been much time for pleasure flying," Palmer said.

The six-to-nine-place Jet Commander has two aft-mounted General Electric turbojet engines and cruises at about 410 knots. It recently showed its capabilities in a round-the-world demonstration flight with a five-man crew, one of whom was entertainer Arthur Godfrey, an aviation enthusiast who flies his own aircraft.

Among those who combine business with pleasure by satisfying their love of flying an airplane, as well as the need to meet their many engagements all over the world is Skitch Henderson, for several years orchestra leader for the Johnny Carson "Tonight" show and musical director for NBC.

Henderson has been a pilot since 1939, and was a P-38 fighter pilot during World War II. Now he usually flies a Cessna Skylane, commuting between New York and Sugarbush, Vermont, where his family spends the winter.

Skitch's enthusiasm for flying infected other members of the "Tonight" show. Johnny Carson, star of the "Tonight" show, has been a licensed pilot since March, 1964. He learned to fly in a Cessna Skyhawk.

Hugh Downs, star of NBC Television's "Today" show, took up flying in the fall of 1963. NBC filmed Down's progress through solo and showed the films in 15-minute segments over an eight-week period. Starting in a Cessna Skyhawk, Downs has continued his flying activities with enthusiasm. He presently has a multi-engine rating and regularly flies a Cessna Skylane.

There's no mistaking entertainer Edgar Bergen's twin-engine Beechcraft Travel Air. On the fuselage is a painted silhouette of Charlie McCarthy. Bergen and his friend Charlie today concentrate mainly on personal appearances, such as at colleges and night clubs. Travel and arriving on schedule is a constant problem. Bergen learned to fly prior to World War II and has owned seven airplanes during his twenty-five years of flying. As in the past, he feels a business airplane is essential to meet his demanding schedule.

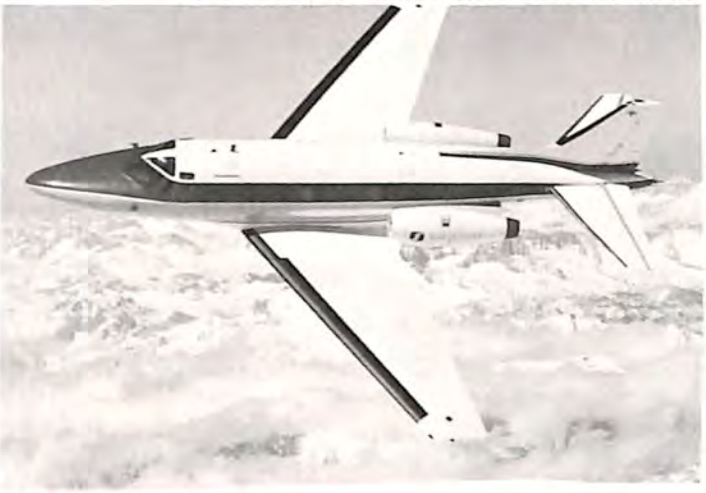
Another celebrity who is an aviation enthusiast is Danny Kaye. He owns a Beechcraft Queen Air, a six-to-nine place aircraft equipped with Lycoming engines which cruises at about 200 knots. Kaye is a highly qualified pilot, and holds a commercial license with multi-engine and instruments ratings. Kaye is one of the very few persons in the history of civil aviation to

President Lyndon B. Johnson prepares to climb aboard a Lockheed JetStar which he often uses for short trips.

Johnny Carson, star of the NBC television "Tonight" show, flies a Cessna Skyhawk. Orchestra leader Skitch Henderson, an aviation enthusiast, first interested Carson in flying.

Grumman Gulfstream II is one of the most recent models of high-speed, turbojet-powered corporate transports.

North American Aviation's Sabreliner carries up to seven passengers and two pilots, and has a range of about 1,500 nautical miles.



Actor Bob Cummings has been a pilot for many years. Here he gets ready to take off in his two-engined Piper Aztec.

Former Air Force Chief of Staff General Curtis E. LeMay stands beside his single-engine Beechcraft Bonanza. With him is General William M. Morgan, an official of Beech Aircraft.

learn to fly in a twin-engine aircraft without previous flight training.

Astronaut Leroy Gordon Cooper, one of the original seven spacemen, flys his own twin-engine Beechcraft Baron. The Baron is a four-to-six-place aircraft equipped with Continental engines and will cruise at 196 knots for about 710 nautical miles.

Former U. S. Air Force Chief of Staff Gen. Curtis LeMay is an enthusiastic light-plane pilot and owns a single engine Beechcraft Bonanza. General LeMay's aircraft cruises at about 160 knots and has a range of 538 nautical miles.

Many notables also fly Piper Aircraft Corporation aircraft for both transportation purposes and for pure pleasure. TV and motion picture star Robert Cummings owns and flies a Piper Aztec. The Aztec is powered by two Lycoming engines of 250 horsepower each and cruises at 179 knots, with a range of 920 nautical miles.

Mel Tormé meets his heavy schedule of singing engagements all over the country by often using his Piper Comanche, a four-place aircraft powered by a Lycoming engine of 400 horsepower. It cruises at about 182 knots with a range of 940 nautical miles.

Another group, somewhat different from the entertainers mentioned above, but with many of the same problems that the airplane can help solve, are high government officials, especially politicians. Increasingly the private airplane has become a must for the campaigning politician. Winthrop Rockefeller, in the midst of campaigning to become Governor of Arkansas, bought a Fanjet Falcon. The Falcon is another of the big business jets. Originally a French aircraft, it is now fitted with General Electric fanjet engines and is sold in this country by Pan American World Airways. The Falcon will carry 8-to-10 people and cruise at 405 knots.

Eleven VIP versions of the Lockheed JetStar, known as VC-140Bs, are used by the Air Force's Special Air Missions unit to fly top government personnel. President Lyndon B. Johnson has found the small plane convenient for many trips, and has pointed out to newsmen that its operating cost represents a considerable saving over the big Air Force One presidential jet. Secretary of State Dean Rusk and Secretary of Defense Robert S. McNamara also have made frequent use of the JetStars. The JetStar is used by many heads of state including the chief executives of Canada and West Germany, and the Shah of Iran.

The Lockheed JetStar is powered by four Pratt & Whitney engines, has a range of 2,185 miles, and cruises at 430 knots with 10-to-12 passengers. A new and more powerful version of the JetStar, called the Dash 8, will soon be available.

Similar to the JetStar is the North American Sabreliner, which has the same powerplant as the JetStar, except that there are only two of them. It carries up to seven passengers and will cruise at 420 knots for 1,500 nautical miles. Two of the Sabreliners, called the T-39 in the military version, are operated for Ambassador Henry Cabot Lodge in Southeast Asia.

Whatever the requirement, the general aviation industry has the plane to suit the need.

Opportunities in An Age of Complexity

The following is excerpted from an address by John R. Moore, Executive Vice President, North American Aviation, Inc., before the annual banquet of the Tulsa Chamber of Commerce.


Mr. Moore

Many of us have come to think of the age in which we live as the "space age." But really, space is only a dramatization of the more fundamental characteristic of the era we are entering. This characteristic is complexity — increasing with the birth of every baby — with the geometrical multiplication of knowledge — with the depletion of our natural resources — with the contamination of our air and water — with our insatiable appetite for electric power — and with the congestion on our land, our thoroughfares, and even in our thoughts. Complexity seems destined to be man's ever present companion in greater and greater significance as long as he walks the earth and probes the universe. And so, the era we are now entering may properly be termed "The Age of Complexity."

Any discussion of the implications and opportunities of the Age of Complexity may quite appropriately start with a consideration of the so-called population explosion. We are told that world population is now doubling approximately at the rate of once every 35 years. It is estimated that there are 100,000 more people in the world tonight than there were this morning. If the earth's 3 plus billion people were evenly distributed over the earth's entire land surface, there would be approximately 50 people for every square mile. At the present growth rate, we will reach the fantastic number of one trillion people by the year 2250. This will be about 25 people for every acre of dry land — mountain, desert, streambed, jungle.

Obviously, some sort of world population control will have to take over long before we reach this point. There are differing estimates of how many people the world can feed, depending on what assumptions are made about farming the oceans. One of these, I recall, is about 25 billion people. Another is 100 billion. The difference is not important, because at the present rate of increase the limits are only 70 years apart. By the year 2066 there should be 25 billion people if the growth rate continues unabated.

The problem is hastened and compounded by the fact that urbanization is a global phenomenon. Soon more than half the world's population will live in crowded cities. This phenomenon is already well advanced in the United States. Our country is going through the painful process of jamming 85 per cent of our population onto 2 per cent of our land — a remarkable change for a nation that was rural in the recent past.

Thirty years ago nobody realized even approximately how many automobiles would soon jam our roads. At the 1939 World's Fair the General Motors exhibit predicted that by 1960 there would be 38 million cars in the country. This sounded extravagant and fanciful to most people, because it implied a 50 per cent increase over the 1939 total. But the number of cars actually in use by 1960, despite a world war and a Korea, turned out to be not 38 but 61 million. And how many cars would you guess there are in the United States today? Would you believe 90 million? That happens to be the current figure. . . .

Here is a dramatic example of the penalties of nearsightedness in planning. Nobody foresaw this trend soon enough. So despite our building roads and superhighways and parking areas at top speed, freeway tie-ups are multiplying to the point where at least 25 cities now have traffic spotters in helicopters, broadcasting advice about freeways to avoid. The congestion in some larger cities is approaching that of ancient Rome, when Julius Caesar found it necessary to ban all wheeled vehicles during daylight hours.

We have traffic jams not only on the ground but in the air over airports. We have noise abatement problems. We have water shortages that will be serious in more than a thousand U.S. communities next summer. We have water pollution that will require an expenditure of over $900 million per year to bring under control, according to figures from the U.S. Public Health Service.

As for air pollution, meteorologist Morris Neiburger of the University of California at Los Angeles has warned that within a century the atmosphere will be too poisonous to support life unless we reverse the trend. . . .

Even our solid wastes — garbage and trash — are piling mountain-high. Our cities spend more than $1.5 billion a year to haul it away and try to dispose of it. But if they burn it they create air pollution. If they grind it up and flush it away they pollute somebody's water. . . .

Complexity has bred such problems because our civilization wasn't prepared. We didn't fully realize what was going to happen. We didn't identify some of our problems until they became major problems sociologically, politically, and scientifically. Like a victim of cancer, we cannot wait until we are seriously incapacitated to take action. By then it is far too late. . . .

It is fortunate that industries and government organizations which have been built up to deal with the complicated, highly technical problems of defense and space programs constitute a major resource for dealing with other problems of the age of complexity. They maintain the organizational, procedural, personnel, and management flexibility which is a primary ingredient of their success. They deal with all elements required for the assault on complicated programs, whether they involve the intensive work of experts in a narrow disciplinary area, or bringing together the activities of these experts in a harmonious and productive whole. Because science is such a large and fundamental ingredient of their products, whether they be goods or services, I call them the "Scientific Industries."

Thus, in today's scientific industries, laboratories are manned by technologists who are dedicated to continuing the progress which has doubled our knowledge in the last 15 years. (It is significant to note that 90 per cent of all scientists who ever lived are alive today.) But these people are no longer the wild-eyed dreamers which the public has so often come to associate with science. Although there are probably many more brilliant ideas being generated today than at the turn of the century, they involve scientific subtleties which most of the great inventors of the industrial revolution could not have comprehended. Whereas it is true that occasionally a brilliant piece of individual work opens up a new frontier, this is the exception rather than the rule.

Most of the simple, one-man discoveries in the physical sciences have been made. The problems are far more complex now. Of course ideas must come from individuals — but the technologists in our scientific industries have had to learn to work as members of a team to reduce ideas to practice.

Man is now reaching a degree of knowledge and competence where we even dare attack the complexities of the human body and brain with hope of quantitatively describing and controlling them. We are also developing machines which may be said to have reflexes and to learn and think. But these assaults on complexity can only be undertaken by combining the abilities of specialists, from medicine to mathematics, with a heavy dependence on physics, electronics, and data processing.

As equipment, functions, and organizations are combined, forming more and more complex relations, the word "system" begins to enter the picture and with it the new technology of systems engineering, operation, and management. Here is complexity in its most difficult form and yet a form which gives greatest promise of adding to the world's well-being. . . .

AIA MANUFACTURING MEMBERS

Abex Corporation
Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Aeronutronic Division, Philco-Ford Corporation
Aluminum Company of America
Avco Corporation
Beech Aircraft Corporation
Bell Aerospace Corporation
The Bendix Corporation
The Boeing Company
Cessna Aircraft Company
Chandler Evans, Inc.
  Control Systems Division of
  Colt Industries, Inc.
Continental Motors Corporation
Cook Electric Company
Curtiss-Wright Corporation
Douglas Aircraft Company, Inc.
Fairchild Hiller Corporation
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Defense Electronics Division
  Flight Propulsion Division
  Missile & Space Division
  Defense Programs Division
General Laboratory Associates, Inc.
General Motors Corporation
  Allison Division
General Precision, Inc.
The B. F. Goodrich Company
Goodyear Aerospace Corporation
Grumman Aircraft Engineering Corp.
Gyrodyne Company of America, Inc.
Harvey Aluminum, Inc.
Hercules Incorporated
Honeywell Inc.
Hughes Aircraft Company
IBM Corporation
  Federal Systems Division
International Telephone & Telegraph Corp.
  ITT Federal Laboratories
  ITT Gilfillan, Inc.
Kaiser Aerospace & Electronics Corporation
Kaman Aircraft Corporation
Kollsman Instrument Corporation
Lear Jet Industries, Inc.
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Company
McDonnell Company
Menasco Manufacturing Company
North American Aviation, Inc.
Northrop Corporation
Pacific Airmotive Corporation
Piper Aircraft Corporation
PneumoDynamics Corporation
Radio Corporation of America
  Defense Electronic Products
Rockwell-Standard Corp.
  Aircraft Divisions
Rohr Corporation
Ryan Aeronautical Company
Solar, Division of International
  Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company
  Sperry Phoenix Company
Sundstrand Aviation, Division of
  Sundstrand Corporation
Thiokol Chemical Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory
  Marine Division

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

Bulk Rate
U. S. POSTAGE
PAID
Washington, D. C.
Permit No. 2796

Business aircraft fill the bill for company executives, statesmen, athletes and entertainers. (See *Business Aircraft — Stars On High*, page 12).

aerospace

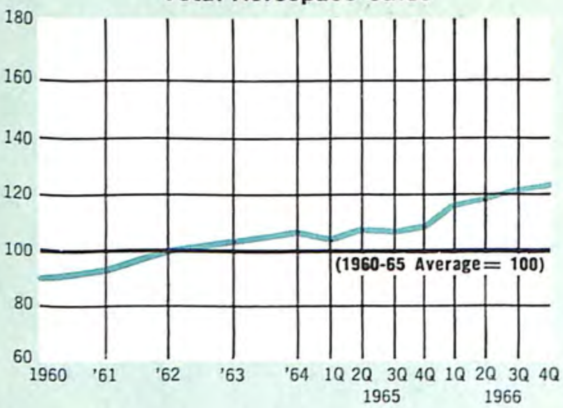
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · MARCH 1967

■ Aeronautical Research— AIRCRAFT FOR TOMORROW

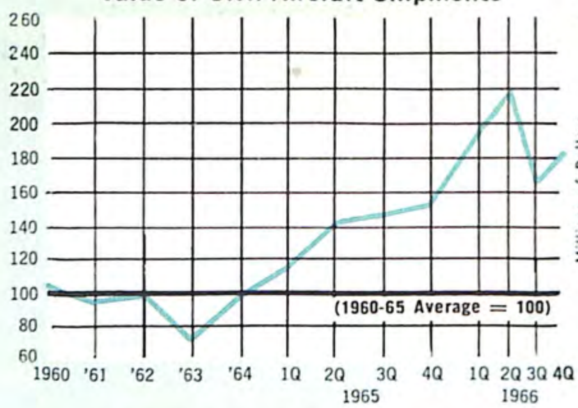
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

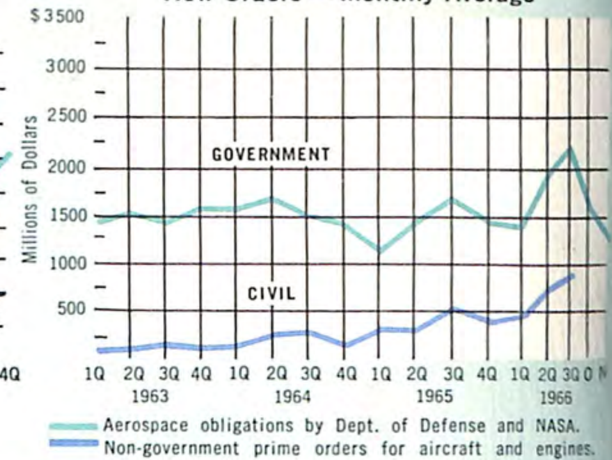


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-65 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Quarter Ending Dec. 31 1966	20.7 R	23.5	23.8 E
	Billion $	Quarterly	4.8		5.2	6.1	5.9
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	Nov. 1966	776	1,274	1,009
Aircraft	Million $	Monthly	601	Nov. 1966	569	823	686
Missiles & Space	Million $	Monthly	550	Nov. 1966	207	451	323
Aerospace expenditures: Total	Million $	Monthly	1,067	Nov. 1966	820	1,069	1,037
Aircraft	Million $	Monthly	561	Nov. 1966	469	668	623
Missiles & Space	Million $	Monthly	506	Nov. 1966	351	401	414
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Dec. 1966	357	268	364
Expenditures	Million $	Monthly	130	Dec. 1966	417	371	412
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	692	Jan. 1967	1,187	1,211	1,161
Value	Million $	Monthly	15	Jan. 1967	33	30	29
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	Quarter Ending Dec. 31 1966	22.2	27.0	27.7 E
U.S. Government	Billion $	Quarterly	11.6		14.4	15.8	15.8
Nongovernment	Billion $	Quarterly	3.7		7.8	11.2	11.9
EXPORTS							
Total (Including military)	Million $	Monthly	110	Dec. 1966	126	96	155
New Commercial Transports	Million $	Monthly	24	Dec. 1966	36	7	47
New Utility Aircraft	Million $	Monthly	2	Dec. 1966	7	6	5
PROFITS							
Aerospace — Based on Sales	Percent	Quarterly	2.3	Quarter Ending Sept. 30 1966	3.6	3.2	2.7
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		5.4	5.9	5.4
EMPLOYMENT: Total	Thousands	Monthly	1,132	Dec. 1966	1,220	1,367	1,373 E
Aircraft	Thousands	Monthly	499	Dec. 1966	494	599	607
Missiles & Space	Thousands	Monthly	496	Dec. 1966	555	594	593
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Dec. 1966	3.25	3.46	3.47

R Revised
E Estimate
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.

AEROSPACE INVESTMENT

The U. S. aerospace industry doubled its investment in plant expansion and equipment during the past three years, clear evidence of the growth it experienced during the first half of the sixties.

Aerospace capital investments rose from $390 million to $780 million between 1963 and 1966 at the same time that capital investments in all of U. S. business together increased only 54 percent from $39.2 billion to $60.6 billion.

Much of this investment is company-funded, a trend which reverses the situation just a few years ago when plant and equipment improvement intended for use in support of military and space programs was primarily government funded. A recent AIA survey of six major aerospace firms reveals that more than two-thirds of their plant and equipment investment was financed from company funds.

Not only is the industry obtaining more but also better equipment such as the numerically or tape controlled machine tools which expedite production and improve efficiency of aerospace manufacturing tremendously. Other automated high-speed machinery has been introduced in aerospace plants around the country which result in higher productive capacity to meet the stiff demands upon today's industry.

Since the outlook is bright for the industry, increased capital spending can be expected to continue. The projected expenditure of $630 million in 1968 is 54 percent above the $410 million funded by the industry in 1965. Funding of such programs as the supersonic transport, the C-5A, growth of related aerospace projects in the fields of oceanology, water desalination, deep submergence vehicles and many other areas not directly related to aerospace should result in continued growth of aerospace capital investment.

The need for these expenditures is demonstrated by the fact that the industry is now operating at the highest rate of capacity utilization of all manufacturing industries.

In the last half of this decade, demands for aerospace products, as reflected by huge backlogs, appear to assure increasing capital investment by aerospace companies.

AIA

aerospace

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

PRESIDENT • Karl G. Harr, Jr.
PUBLISHER • Glen Bayless

VOL. 5, NO. 3 *MARCH 1967*

EDITOR • Gerald J. McAllister
ASSOCIATE EDITORS • Richard W. Balentine
• John J. Lee
ECONOMIST • Gerson N. Chanowitz
ART DIRECTOR • James J. Fisher

CONTENTS

The purpose of AEROSPACE is to:

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

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

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

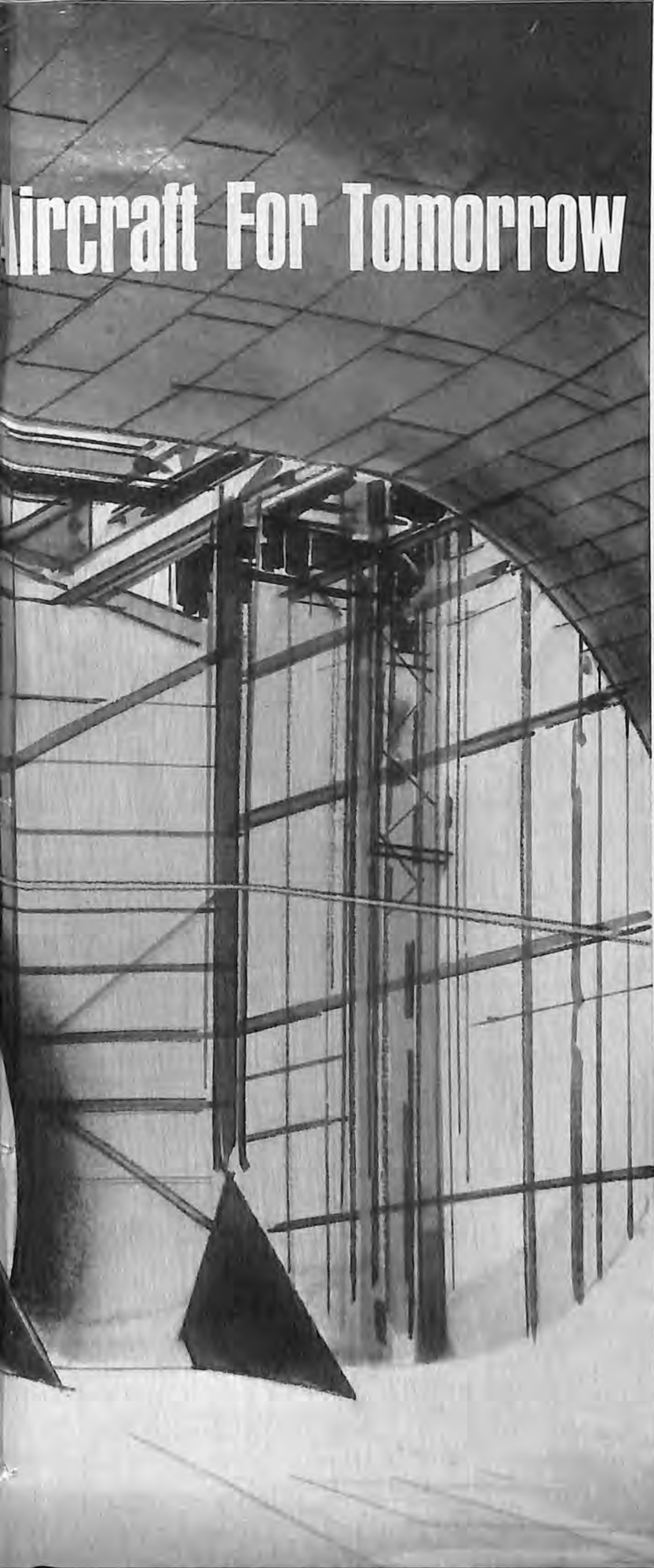
Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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

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

Western Office: McCulloch Building, 6151 West Century Blvd., Los Angeles, Calif. 90045

AERONAUTICAL RESEARCH



Aircraft For Tomorrow

Since the United States started sending experimental vehicles beyond Earth's atmosphere nine years ago, aeronautical research has been overshadowed by space exploration, as far as the annual budgets of the National Aeronautics and Space Administration are concerned. Where space expenditures have run to several billions annually, aeronautics had a funding level that never reached $100,000,000.

But dollar comparisons fail to tell the whole story. For its space work, NASA has had to build from scratch a variety of expensive ground facilities and equipment and to make heavy outlays for complex, non-reusable flight hardware. NASA's aeronautical research teams spend little on flight equipment and what they do buy is reusable; furthermore, they operate from facilities for the most part built and paid for prior to the Space Age. There is no question but that space has played the dominant role in NASA's programs, but the aeronautical research effort has been far more substantial — and more rewarding — than an examination of budget figures would indicate. In the coming year, assuming Congressional approval of the pending budget, it will be increased.

The Fiscal Year 1968 budget request for aeronautical research is larger than the total NASA budget for the first year of the Space Age. In FY 1958, when NASA emerged as a new agency from the nucleus that had been the National Advisory Committee for Aeronautics, the total appropriation was slightly over $117,000,000, and that included the humble beginnings of a space program. The coming year's planned obligations for aeronautical research and its attendant administrative overhead amount to $119,600,000.

The largest budget item — more than $18,000,000 — is "supporting research and technology." This is not a specific project but a broad research category, involving general investigations in the fields of structures, aerodynamics and propulsion, together with attempts to solve certain problems of flight encountered by the military services, the Federal Aviation Agency, aerospace companies and the airlines. The funding allocation is almost double that of the two previous years, but the real expansion of effort contemplated for 1968 comes in three other areas: the supersonic transport, hypersonic flight and aircraft noise reduction.

NASA's work in these and other areas of aeronautical research is backed by an extremely broad program of both basic and applied research conducted by companies in the aerospace industry.

The primary tool for NASA's SST research will be the Air Force's North American-built XB-70A experimental bomber, a vehicle which approximates the SST in size, weight and speed capability. With the XB-70, NASA will continue the sonic boom investigations started earlier, but the agency's major area of interest is "simulator verification."

Much of the detailed developmental work on the

Handling characteristics of the North American XB-70 will be studied by NASA as part of the supersonic transport development program.

X-15 will be modified to provide a delta wing configuration. This research aircraft, built by North American, will be flown at Mach 8 to obtain aerodynamic and structural data.

Lockheed JetStar has been fitted with "variable stability" characteristics to duplicate as closely as possible the control responses of the supersonic transport.

SST must come from simulators. NASA and the contractors will use a number of ground-based simulators and two flying simulators, a Lockheed JetStar and a Convair 990 jet transport, both of which have been fitted with "variable stability" characteristics to duplicate as closely as possible the control responses of a supersonic transport. But the characteristics built into the simulators are based on design predictions and they must be verified, perhaps modified. NASA will make a thorough study of the handling qualities of the XB-70A, stand-in for the SST. The big plane will be flown by the same pilots who fly the JetStar, the 990 and the ground simulators, permitting corelation of data among the various research tools. "In this way we can reproduce the SST on the simulators with greater confidence," says Charles W. Harper, Director of Aeronautical Research in NASA's Office of Advanced Research and Technology.

An associated research project stems from observations made during flight tests of the XB-70A. It was noted that wind gusts encountered at high Mach numbers produced a greater degree of motion in the XB-70A than they did in its closely-tailing chase plane, a General Dynamics B-58. This may prove to be a natural response of the elongated XB-70A configuration as opposed to the more compact delta-wing shape of the B-58, hence not a hazard. Nonetheless, it must be thoroughly checked out.

NASA's SST work embraces the propulsion system as well as aerodynamics. The Federal Aviation Agency has approved the basic design of General Electric's 60,000 pound thrust engine, but experience has shown that the initial power plant for a new airplane is rarely the ultimate; there is always "stretch" potential. So, while GE is developing the basic engine, NASA's Lewis Research Center will take another step, researching toward a more advanced second generation engine.

In another SST engine research project, NASA will study the intake of air and the discharge of gas under conditions similar to those in Boeing-designed SST's engine mountings, which are under the wing. For this purpose, Lewis is building an engine stand-in by modifying GE's small military turbojet, the J85, so that the inlet and exhaust nozzle correspond on a scale basis to the same components of the big GE-4 engine. The scale model will be tested in the transonic speed regime in an underwing mounting on a Convair F-106 delta-wing interceptor. Trials at Mach 2 and beyond will be conducted in a wind tunnel, with the engine slung beneath a model wing section.

In the area of hypersonic flight research, NASA will continue to design hypersonic shapes and examine their characteristics by testing models in wind tunnels, but there will also be an important series of flight tests with the North American X-15, the only winged hypersonic vehicle. The venerable X-15, which has already been flying eight years and seems destined for a career extending well into the 1970s, will be employed on two main projects. One of them involves preliminaries to mating the craft with a ramjet engine, the other an investigation of structural materials for hypersonic flight.

Initiating a program of hypersonic engine development, NASA last year awarded Garrett Corporation's AiResearch Manufacturing Division a contract to build a prototype ramjet engine, to be available for ground testing in mid-1968 and flight testing soon thereafter. The ramjet compresses air by "ramming" it into the intake, or by the very rapid passage of the intake through the atmosphere, so it operates efficiently only at very high speeds. The X-15 has already reached a top speed of 4,223 miles per hour, or more than six times the speed of sound, but for a complete investigation of the ramjet's potential it would be advantageous to fly even faster. So, while the engine is being developed, the X-15 will push the frontier of hypersonic flight further, probably above Mach 7.

Even that will not be the upper speed limit of the plane that has been termed "the most valuable research tool ever built." NASA has concluded from a feasibility study that it can obtain aerodynamic and structural data up to a speed of Mach 8 by modifying the X-15 to provide it with a delta wing configuration. The new wing would employ a lightweight structural material capable of prolonged resistance to extreme aerodynamic heating, so as a first step a sample of the structure must be checked out in flight. This will be accomplished by fitting one of the X-15s with wing tips of the new structural design and instruments to record the structure's reaction at very high speeds.

Of interest to practically everyone is NASA's third major area of research — the reduction of aircraft noise, focusing on commercial jetliners.

Douglas Aircraft Co. will work with NASA on the first of several approaches to noise abatement. This approach focuses on the fore and aft ends of the propulsion system, the engine's air inlet and its exhaust. It involves "acoustic treatment," or soundproofing of these areas by the application of sound-absorbing materials.

Soundproofing alone will not bring about the desired reduction, but the program also includes an attack on the primary sources of noise, the engine's fan and compressor systems. The rapid rotation of these components generates sound waves which propagate in a forward direction, toward the inlet. The idea is to block the escape of these sound waves. The method planned is to fit the inlet with an expandable "spike" or cone. For high altitude flight, where noise is not a problem, the spike would permit normal airflow into the engine. During the approach, the spike would be expanded, "choking" the airflow, causing the air to speed up to enter the smaller aperture. The choked air would reach sonic velocity and create a shock wave which would serve to block the sound waves emanating from fan and compressor. A major technical problem is to insure that choking does not interfere with the pilot's option of applying increased power quickly, should he find it necessary. On this avenue of noise research, The Boeing Co. will serve as NASA's partner.

From these two approaches, NASA hopes to develop a modification package so that significant noise reductions can be achieved by retrofitting existing fanjet engines. It is not, Harper cautions, an overnight program. Even after development and fabrication of sound suppressing equipment, about two years of flight test will be necessary.

A third and obvious method of reducing apparent noise is to move the source farther from the ground. This is being done by rapid climb after takeoff, but the comparable procedure for landing approaches — steeper descent — poses a problem. Jetliners generally approach the runway at a descent angle of about three degrees. An angle of six degrees would keep the aircraft twice the distance from the ground during approach, but it would complicate the process of flaring out, converting from angular to horizontal attitude

Boeing 707 prototype will be fitted with quick-reaction controls to test steeper landing approaches.

over the runway; even modern controls do not respond instantaneously and a slow response could mean a gear-damaging angular impact rather than the customary smooth touchdown. To make possible the six-degree approach with a safe landing, NASA has designed new quick-reaction control surfaces which will be tested on the original 707 prototype, loaned for the project by Boeing.

Looking farther down the road to an even greater noise reduction, NASA will initiate in FY 1968 the "quiet engine" program. This program goes directly to the source of the problem; it involves detailed studies of all the noise-producing elements of an engine, like the fan and compressor, to see what design changes can be made to effect noise reduction without impairing engine performance. It might produce, for instance, a different type of inlet or a new shape for a compressor blade. The goal is to develop the technology with which manufacturers can produce a generation of engines operating well within the tolerable noise limits.

In addition to the three general areas of research, NASA will continue its V/STOL investigations with ground tests of various lifting systems and flight operations with a variety of aircraft. NASA will also investigate a promising line of V/STOL research, the fan-in-wing concept, in which a jetpowered plane gets its vertical lift from large fans submerged in the wings. Ryan Aeronautical Co. built this design, designated XV-5A by the Army. NASA plans additional flight testing of this system.

AEROSPACE NOTES

No-Moving-Part Gyro Studied by Honeywell

This research model of a vortex rate sensor is used in the development of no-moving-part fluidic gyroscopes — integral components of future aircraft and missile flight control systems — by Honeywell Inc. scientists.

Measuring the tornado-like swirl of air rushing through plastic outlet tubes aids aerospace scientists in learning more about the rapidly expanding technology of fluidics.

RCA Provides USAF With New Data System

Radio Corporation of America has delivered to the U. S. Air Force an electronic system capable of unprecedented speed, accuracy and simplicity in collecting and assessing scientific information transmitted to Earth from space vehicles.

For the first time, a mission officer in a centralized headquarters will be able to program in advance the data desired from a spacecraft or missile shot.

This officer will be able to pre-select the kind of material he wants and to receive it on a real-time basis on direct relay from farflung remote stations in uniform digital form that can be stored, re-transmitted and modified by computer without error.

This will eliminate the need to station at these remote locations, as now required, numerous medical, engineering and aerospace specialists to interpret incoming data from space vehicles on the scene.

Data relayed by space vehicles will check such vital conditions as fuel flow, cabin pressure and health of the astronauts. Such information will be gathered by hundreds of sensors on and within the spacecraft. Since previously developed telemetry systems are not selective, all incoming data are relayed to headquarters, increasing the burden on the transmission system.

Westinghouse Proposes Telescope on Moon

Westinghouse Electric Corp. has proposed a telescope on the moon that would permit an astronomer on earth to make observations by remote control.

The moon is an advantageous site for sensitive astronomical instruments because it provides a more stable platform than satellites. The moon, unlike the Earth, has no dense atmosphere to distort the image-carrying light of distant celestial objects.

The Westinghouse study, made for the National Aeronautics and Space Administration, indicates the venture is possible through a combination of electronic advances which would provide unique observation capabilities in a telescope weighing only 100 pounds.

The telescope station is designed for easy installation by astronauts during a mission to the moon in the 1970s. The components of the station could be deployed by means of a lunar surface vehicle.

The complete lunar station would consist of three subordinate stations deployed around a central station with the telescope. The station would use nuclear power.

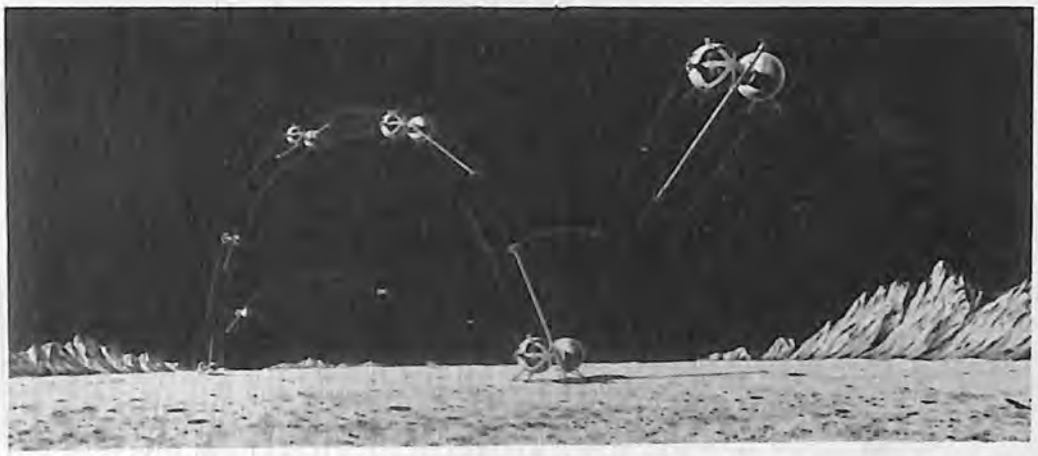
General Precision Builds Memories by the Yard

General Precision's Librascope Group is producing a revolutionary electronic memory system which is woven automatically like cloth on a loom.

The new process which makes it possible to produce computer memories by the yard may eventually replace the more expensive hand-fabricated units commonly used in computers and other electronic systems.

The woven plated wire memory is made of fine high-quality copper wires woven on a specially designed loom. The loom weaves these wires which are plated with a special magnetic film, with insulated wires. At each junction, a magnetic field is created in such a way that a bit of information can be stored.

Because weaving provides added strength, the memory has increased reliability under extreme environmental conditions.



UTC Foresees 'Pogo Stick' For Travel on Moon

A concept of moon travel based upon the principle of the pogo stick has been developed by a scientist at United Technology Center, a division of United Aircraft Corp.

Dr. Howard S. Seifert envisions huge pogo stick-like transporters leaping over the moon's surface in 400-foot bounds. Just as a person's weight compresses a spring which then decompresses to propel a pogo stick and its rider for a short hop, the machine would bound along on a steel pole containing a cushion of gas.

The lunar leaper would consist of two space cabins, one on either side of a hollow 40-foot tube. Pilot and passenger would ride in one cabin, while the powerplant, flight control and life support systems would be housed in the other.

The cabins would ride up and down the pole along with a piston device, which would compress the gas upon landing and be driven up the pole by the gas for acceleration. About 30 feet up the pole, the cabin structure would lock in place and carry the pole with it into the air.

Rocketdyne Power System Adjusts Agena Orbits

Rocketdyne, a division of North American Aviation, has developed a secondary propulsion system for the Agena spacecraft.

The system will be used in the Agena to make orbital adjustments. The system includes separate engines, each developing a fixed thrust of 48 pounds for a total thrust of 96 pounds.

Designated SE5-3 by Rocketdyne, the system incorporates spacecraft innovations that have been operationally proven in Gemini and Transstage spacecraft flights.

Floating Nuclear Plant Developed by Martin

Martin Company engineers and Army personnel recently achieved criticality (a self-sustaining nuclear chain reaction) with a floating nuclear powerplant.

The plant is now beginning an extensive series of nuclear physics and power generating tests to prove its capability to provide substantial electrical power to support military operations.

The floating nuclear powerplant, named *Sturgis*, is capable of producing 10 million watts of electricity for one year without refueling. A diesel powerplant producing this much electricity would require more than 160,000 barrels of fuel a year.

The reactor core of the *Sturgis* is a little larger than an oil drum and consists of 32 fuel elements containing low enriched uranium dioxide pellets.

The *Sturgis* can be towed to any port in the world to support military operations or provide electric power to communities hit by peacetime disasters.

Ryan Aeronautical Tests Precision Drop Glider

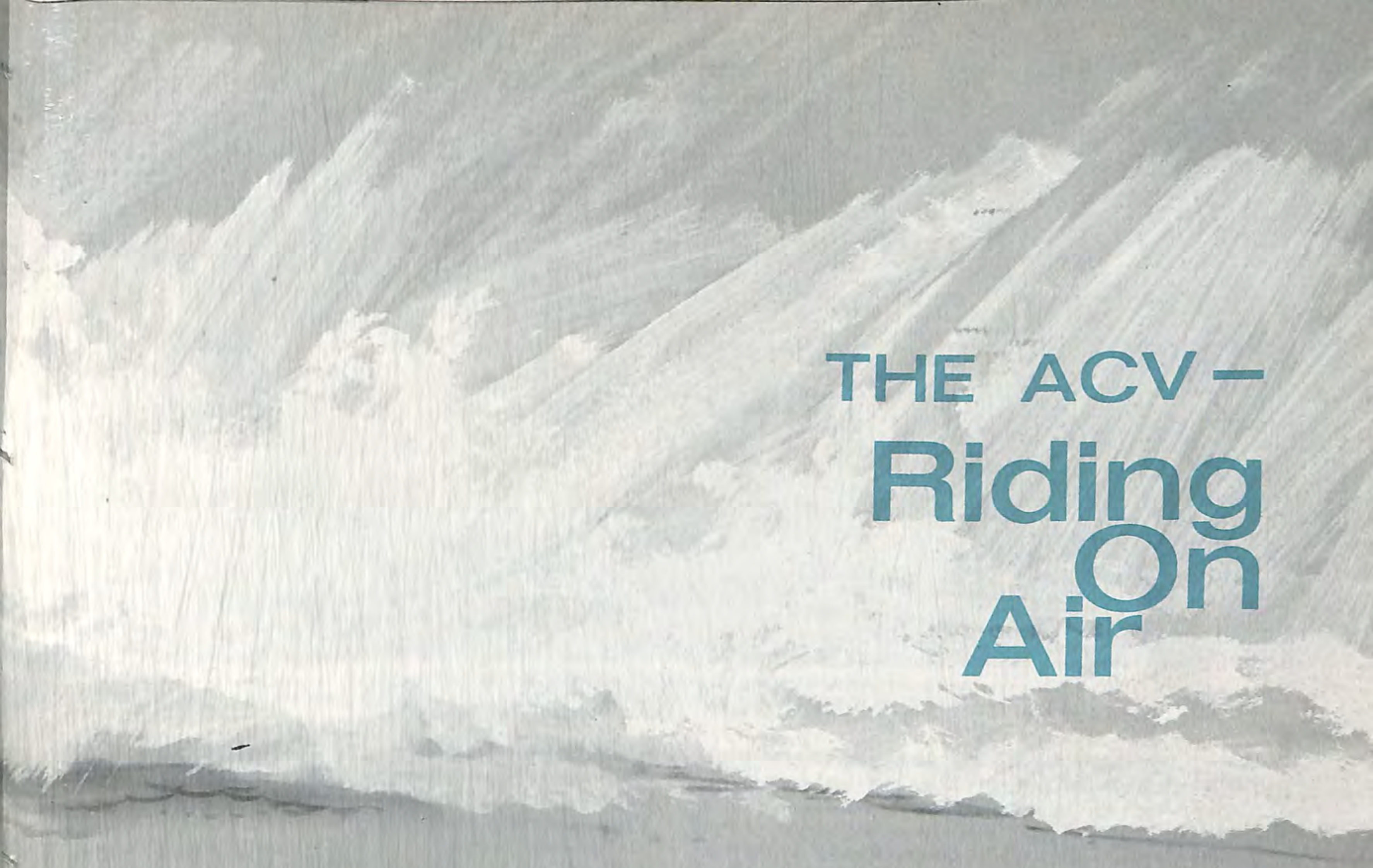
Ryan Aeronautical Co. has designed, developed and tested the Precision Drop Glider (PDG) system for use in technical assault and re-supply missions.

Working with the Advanced Research Project Agency of the Department of Defense and the Department of the Army, Ryan is currently engaged in preproduction tests of the PDG system at the U. S. Army Test Station, Yuma, Ariz.

Numerous payload weights ranging from 300 to 2,000 pounds were tested with a variety of Ryan "Flex Wing" sizes. The current model is designed for precision delivery of 500-pound, high-priority cargo.

A static line actuates the PDG's drogue chute seconds after launch. The drogue chute deploys the Flex Wing which assumes its delta-wing configuration through inflation of its non-rigid keel and outboard members.

The PDG's on-board receiver and electronic package, contained in a control platform, is energized automatically by the static line. Homing on signals transmitted by a light-weight, portable unit on the ground, the system descends in a gliding pattern to its predetermined landing site.



THE ACV — Riding On Air

The air cushion vehicle (ACV) is a new development in surface transportation which offers attractive possibilities of versatile, high-speed operations across water or rough terrain.

The ACV is one of a family of craft generally described as Surface Effect Ships which also includes vehicles called Hovercraft, Ground Effect Machines, Flexible Skirt Craft, Peripheral Jets and Captured Air Bubble Craft.

They all operate on the same principle: Support in operation by a bubble of air. The varieties in the family come principally from the manner in which the air bubble is contained under the vehicle.

The promise is substantial. The Institute for Defense Analysis, in a recent report on ACV's, stated: "The functional principle of air cushion vehicles appears to offer more potential for naval-military vehicles than any other development during the past two centuries."

Current interest in the ACVs in the United States is being spearheaded by the Navy. In the new approach, the Navy sees the possibility of improving the speed of its antisubmarine warfare craft, its amphibious landing vehicles and its patrol and rescue craft. For the future, the Navy foresees ACVs of 4000 tons capable of crossing the oceans at speeds approaching 100 knots.

The excitement about ACVs comes from a characteristic which reduces hull drag through the water upon attainment of critical speeds. This drag reduction is drastic enough to permit speed increases beyond the critical point without additional power. The critical speed appears to be between 15 and 40 knots, depending on the hull design of the craft. Calculations indicate that an ACV with a critical speed of 40 knots could operate at above 100 knots without additional power requirements; in fact, once the critical speed is reached the power requirement actually drops in the 40-100 knot range.

ACV development in the U. S. is being carried forward by companies in the aerospace industry. Among the aerospace companies engaged in ACV projects are Bell Aerosystems, Boeing Company, Douglas Aircraft Company, Fairchild Hiller Corp., General Dynamics Corp., Hughes Tool Company, Lockheed Aircraft Corp. and North American Aviation. One of

This 22-foot surface effect ship was built by the Electric Boat Division of General Dynamics Corp. Above, the craft moves across land. This vessel has achieved 60 knots over water.

the most active firms is Bell Aerosystems which has produced, with its own resources and an arrangement with a British firm, several ACVs.

In September 1966, Bell announced that it was building a production line and entering the commercial market in ACVs. The line produces versions of the ACVs which were deployed by the Navy to South Vietnam for patrol duty in the Mekong Delta area as a counter to Viet Cong smuggling as well as those tested in ferry service among the San Francisco and Oakland International Airports and downtown San Francisco during 1965 and 1966. These tests used Bell's SK-5 model. The passenger version tested on San Francisco Bay had 18 seats. The new line will produce this version as well as 30- and 90-passenger models and cargo versions of the three sizes.

Bell is offering the ACVs for use as fast passenger ferries, cargo carriers over short distances, police patrol craft, high speed ambulances, geological exploration craft and remote area transportation. Tests have shown that ACVs can move from over-water to overland transportation with ease. This makes them particularly valuable in areas where the shoreline is a fringe of marsh, sand or other base which would prove difficult for ground-borne craft. Tests have also been run over the northern wastes of Canada where roads are nonexistent and overland transportation is very difficult.

On the military side, the Navy has been active in the development of ACVs from the earliest stages. The three craft sent to Vietnam in May apparently performed very well. They were used in the Market Time Operation for control of smuggling. A Navy officer reported: "They can outrun anything on the river." The ACVs were very efficient in moving from assignment to assignment.

Because information on ACVs is limited today, the long-range applications are somewhat speculative. The Russians are aware of the potential, however. An article in the June 1966 issue of *Technology and Armament,* published in Moscow and written by an officer of the Russian Navy, notes that the ACV principle offers many advantages in antisubmarine warfare. The author points out that both surface and hydrofoil ships produce noise which is sufficient to expose them to detection by submarines. "A better vessel," the article says, "is considered to be one capable of sailing without touching the water at all, i.e., an air cushion vehicle."

Pointing out that the air cushion vehicle would have a speed advantage over a submerged submarine, the article adds, "An air cushion patrol vessel would be able to carry modern antisubmarine weapons, to seek out the submarine and to maintain contact with it by aid of variable depth sonar equipment. It would have the advantage in all stages of submarine search and kill operations."

This conclusion is supported in an article by Capt. M. J. Hanley Jr., USN, in the *"U. S. Naval Institute Proceedings."* Capt Hanley states: "Possibilities for missions . . . could include an ASW weapons system against possible missile submarines." Capt. Hanley is the Chief of Naval Operations' project officer for surface effects ships study at the Center of Naval Analysis. His article also notes that the ACVs may have applications in minesweeping and amphibious warfare.

Detailed examination of these possibilities is not required to support the medium range future of ACVs in military applications. Current surface methods of transporting troops and equipment from ships to beaches is very slow, and thus vulnerable to beach de-

Bell Aerosystems' air cushion vehicle was tested by the U. S. Navy in South Vietnam as a patrol craft. Above, the ACV inspects a sampan for possible contraband as another patrol craft, with flag flying, stands by.

fenses. The speeds possible in ACVs reduce the transit time and also the air cushion cuts vulnerability to mines or obstacles which plague surface craft.

Capability of the ACV to cross the water and land with relatively few problems in most areas also makes them ideal in amphibious warfare since they force the defender to protect much more area. Conventional craft of today are limited in their uses to areas where there is a reasonable beach over which equipment designed for land use can operate.

With ACVs, marshland would be no problem, nor would tide flats, for men and cargo could be transported over these surface craft obstacles far enough inland to reach solid ground.

Though military applications are in the forefront of ACV development today, commercial possibilities are not being ignored.

The Department of Commerce recently published a report on the possibilities of "Surface Effect Ships for Ocean Commerce." Called the SESOC report, the study concluded that huge ocean-going ACVs are a definite possibility. In general, the report indicated that development of satisfactory transoceanic ACVs must wait for additional information on stability modes; stability and control criteria; control systems; dynamic loads with respect to sea state; speed resistance, sea-keeping and structural requirements; overloading sea conditions; waves of unusual heights; damage and structural failure; collision avoidance; and the need for better knowledge on how to maintain and improve the efficiency of the supporting bubble.

Points which will affect the development of economically competitive ACVs are development of highly efficient, high powered, lightweight propulsion systems capable of operation in the marine environment without maintainence problems; additional materials research and better weather prediction, according to the Commerce Department study.

The report addresses itself to the possibility of a 5000-ton transoceanic ACV and concludes that this is not a possibility within the next ten years unless a much higher level of effort is undertaken. The Navy, however, is now working on a proposed technical approach to the problem of getting five 500-ton research craft of various types within the next five to nine years. These craft would be prototypes of a possible 4000-ton ocean-going ship, Capt. Hanley reported in his article, and he adds: "It is within the realm of possibility that an accelerated research program could produce a 4000-ton SES in ten years."

Another possibility for ACV use suggested by Capt. Hanley is for use as aircraft carriers. Such ships would radically change concepts of carrier operation in that their speed would permit downwind launches, reduce vulnerability to torpedo attack in transit and cut the requirements for ASW escort.

A measure of the aerospace industry's involvement in the program and the know-how available is available from scanning the list of participants in the SESOC study. Personnel from General Electric, Lockheed, Martin, United Aircraft, Grumman, Bell, North American, General Dynamics, Northrop, Boeing and Aerojet General all contributed papers or staff studies to the Committee.

There is considerable effort being exerted today to bring the Navy's resources and those of the Department of Commerce together in the assault on the state of the art required to produce the big transoceanic ACVs.

The program should produce a vehicle of significant value to fast, efficient transportation.

POLLUTION CONTROL-
PATTERN FOR COOPERATION

By R. G. Reichmann
Chairman, AIA Subcommittee on Pollution Control
Aerojet-General Corp.

This article describes the cooperative efforts and technical approaches of the aerospace industry in working with the Los Angeles Air Pollution Control District in the development of a rule on pollution, the enforcement of which goes into effect July 1, 1967. The affirmative action by the aerospace industry in assisting with the Los Angeles rule will serve as a guide for rule-making in other cities. At the same time, an accelerated federal program to resolve the problems of air pollution is under way. For example, in Fiscal Year 1966 federal air pollution control expenditures amounted to $21 million; for FY 1968 the government is requesting an appropriation of $64 million to combat the problem. The major portion of these funds, to be disbursed in the form of grants to states and municipalities, is intended to assist qualifying states or municipalities in meeting local air pollution problems more effectively.

Air pollution, common today to many urban areas, has been a persistent problem for many years in the Los Angeles area. Relatively new and most successful is the call to industry by local government for assistance in the formation of regulatory legislation which is effective and economically justifiable. The action has been cited as a model of government-industry cooperation.

This was the case in 1965 when the Los Angeles Air Pollution Control District presented to industry a proposed rule for the control of atmospheric emissions of organic solvents which are used in various manufacturing processes.

Previous rules had established controls on incinerators, smoke stack plumes, oil and natural gas fired equipment and sulphur content fuel oil. Local industries and associations formed an organization headed by the California Manufacturers Association to work with the APCD on a proposed workable rule. A subcommittee was formed to represent the Aerospace Industries Association.

The subcommittee was formed by the AIA because of the unique problem of the aerospace industry in the use of solvents which are specified by government in contracts, and limit the flexibility of the industry in using substitutes. As an industry, it is not permitted to

POLLUTION CONTROL —
PATTERN FOR COOPERATION

make changes in most processes, materials, or certifications without the approval of the government.

The rule would severely restrict the amount of organic solvents that may be emitted into the atmosphere from established manufacturing processes.

An investigation of four areas was begun. They included protective coatings, solvents and thinners; cleaning and degreasing; chemical milling and strippable coatings; and plastics and adhesives. As a result, the rule was investigated and suggestions made to clarify its meaning.

The principal problem was to determine which solvents are considered smog formulators and which solvents do little or nothing in the formation of smog. The smog chamber located at the Los Angeles APCD was made available by the State of California to perform new tests required to identify the solvents requiring controls. Some 11 solvents were tested and five were found to be used in sufficient volume to indicate the need for some control.

Although the solvents listed as requiring controls provide a basis for the rule, much work is being done and will be done in the future to clarify these materials. These tests are being conducted by such groups as the National Paint, Varnish and Lacquer Association, the Manufacturing Chemists Association as well as independent private research.

The data developed should establish exactly which materials in combination with each other will require controls. It is possible that two or more reactive solvents when combined would produce a solvent that could be classed as acceptable.

It appears feasible that relative reactivity numbers could be assigned to the various solvents as is the case now with toxicity levels indicated by a maximum allowable concentration. Once these lists have been developed they will provide other communities with the basis for writing good solvent smog regulations.

All areas will not require the same smog laws. The types and amounts of emissions, the geographic location, the meteorological conditions and population density will all affect the type of rules required. But the fact that intercity, intercounty and interstate problems will arise requires some uniformity in the establishment of these laws.

Where certain solvents are found to be highly contributive in the formation of smog and an adequate substitution can be found, it is reasonable to expect these communities to pass regulations requiring the substitution. For this reason the aerospace industry is working with other industrial associations, government agencies and local air pollution control districts to arrive at solutions of solvent substitution.

After the Los Angeles rule had been written and agreed to by both industry and the local Air Pollution Control District, much work still remained to be done. The primary function of the AIA subcommittee became somewhat different than that of formulating effective regulations. Investigations were started to determine what types of processes were involved; what types of materials and processes would require controls; what type of control equipment would do the job; which substitute material replaces the existing material; new equipment requirements; and the type of training required if new materials were used. Based on these questions, four areas — primers and top coatings, cleanings and degreasing, chemical milling maskants and strippable coatings, and plastics and adhesives — were selected for investigation.

Investigation into each of these areas was assigned to AIA member companies. In addition, each company appointed a member to each of the other areas under investigation. By doing this no company was denied the opportunity to contribute based on the company's current practice. It became apparent as the evaluated criteria were presented that the subcommittee's efforts should be concentrated on substitute solvent methods rather than control equipment.

There are various types of control equipment on the market today. These control equipments operate on the principles of incineration, carbon adsorption or refrigeration.

While looking into the possibility of using control equipment, the subcommittee also is investigating the possibility of substituting lower reactive solvents. The first attempts at finding the substitute materials have met with encouraging results.

In the area of chemical milling maskants, substitute materials have been developed which can replace the previously used solvents at the same cost. Several strippable coatings are currently under test and preliminary indications are that they too will be satisfactory using a substitute solvent.

Material has been developed for degreasing which operates at a lower temperature than the trichlorethylene previously used and is exempt from control under the Los Angeles rule.

Plastics and adhesives presented a different problem. Many of the adhesives in use today have been developed over a long period of time. Indiscriminate substitution of solvents could endanger the structural integrity of the bond. Additional work is required in this area.

The substitution of solvents in paints is currently being investigated by the paint manufacturers. There are three basic categories of paint affected that particularly concern the aerospace industry; architectural, proprietary and military specification coatings. Each has a different problem in its solution.

Architectural and maintenance coatings cannot be used or sold in quantities larger than one quart after July 1 in Los Angeles County. Manufacturers are currently developing new paints using exempt solvents.

The second type of paint is for those coatings developed for a specific company's process and are generally called proprietary coatings. It will be the responsibility of each company using proprietary coatings to work with its supplier in an attempt to find a suitable substitute exempt solvent.

The third class of paints which will require modifications are military specification paints. These are materials that have specific formulations and/or performance requirements set by a government agency. No substitution can be made in these materials without permission from the agency. It has taken many years to develop these materials. The subcommittee has identified those materials which affect the aerospace industry and preparations have been started with the material suppliers for the development of substitutes using solvent exempt material.

Sufficient test data should be available at the laboratory level to determine if these materials will do the intended job prior to the completion of tests.

These problems are being solved by a united effort of all the industries involved together with the help of the National Paint, Varnish and Lacquer Association, the Manufacturing Chemists Association, California Manufacturers Association and other organizations.

Industry's Stake In Clearing Our Transportation Bottlenecks

The following is from an address by William M. Allen, President, The Boeing Company, before the Society of Automotive Engineers

There have been a number of factors working together to produce the remarkable growth of traffic in recent years — the population explosion, the technology explosion and the increase in average-family earnings which in turn has resulted to a large extent from the technology gains. Combined with these has been the increasing urbanization in the United States, from 32 percent living in metropolitan areas at the beginning of the century to nearly 70 percent at present. Another one hundred million people are expected to be added to our cities by the year 2000. In the words of one appraiser, an additional one hundred million people cannot avoid creating conditions that will make city life almost unbearable. This could be the case but it is not necessarily so. The relief must come in the form of mobility of the population.

The increased emphasis on transportation is becoming clear. The automotive and aviation industries have been on the receiving end of this increase — or I might better say the doing end, with advancements that have brought about a major change in usage. At the same time, other modes have suffered. We find that while urban population has doubled over the past 35 years, the gross patronage of mass transit systems has actually decreased.

In inter-city travel the use of railroads, which played such a large role in the development of our country, has diminished rapidly while domestic air transport has been growing at an average rate of nearly 14 percent per year. Since 1940 the total amount of inter-city travel by *common carrier* has tripled, and all of the gain has been in the air. In the same period the number of automobile registrations has also nearly tripled. . . .

Just ahead of us are major new improvements with a potential additional effect on demand — the introduction of the new 400-passenger 747 super jets with their lower operating costs for both passenger and cargo carrying, and later the supersonic transports with their tremendous increase in speed and convenience of travel, taking you from New York to London in two hours, 41 minutes, New York to New Delhi in seven and a half hours. You will be able to go around the world in either direction, on regular routes including all stops, in a day. If you're going west you will always stay ahead of the sun. . . .

It is obviously timely that the President has asked the Secretary of Transportation, Alan Boyd, and CAB chairman Charles Murphy, to head a new national task force on airport planning. We are helping to overcome the problem of traffic congestion on approaches, runways, ramps and gate positions by going to these larger planes, but in turn we will incur a greatly increased problem of peak loading of terminal facilities in terms of passenger traffic, baggage logistics, parking, and transportation from airport to city center. The increase of truck traffic to airports with the growth of the air cargo business will compound the problem. . . .

The problems we have are primarily those of integrating one phase of the trip with another phase, or of integrating the capabilities of one piece of equipment with the facilities for its use which are provided by another jurisdiction. Our problems are at the interfaces. There are many different size couplings in the transportation pipeline and the smallest one controls. As we enlarge one we find another pinching. We must look at them all in order to clear the pipeline for capacity operation. Transportation is a highly integrated system of many parts, all interdependent. Our common job is to make it work as a total system rather than a collection of disjointed parts.

It is becoming increasingly necessary for us to take this "systems approach" — to view the vehicle as only a part of the larger system that demands our attention. For example, The Boeing Company just a few weeks ago hosted a major meeting of all the airport engineers of United States and foreign airlines to examine the situation as far as ground and air traffic at air terminals is concerned. Out of this session has come a call for a second meeting that is about to take place of the airport operators themselves, from all major world airports, to seek further means toward solutions of common interest. . . .

The need is clear enough. The question is, what can we do about it? I think the answer lies in several directions of effort — in the systems approach; application of new technology; a greater integration of effort between industry and government and within the many branches of government; and a greater understanding and participation on the part of the public, because the whole subject of how we live and where we live is involved.

There is a healthy interest among engineers these days in the systems analysis and systems engineering approach. Surely no problem could be more demanding of such an approach than the one we are discussing. If we are to keep up with our population and technology explosion — if we are to be their master rather than their fugitive — if we are to avoid being impelled to take hasty corrective actions on the basis of every pressure that has reached the intolerable stage, we must give transportation the best of our systems analysis and planning and management know-how. . . .

Mr. Allen

Where are we to find the authority to undertake the needed local coordination? Few communities have the answer. The public's understandable concern over big government may have helped to preserve the excessive number of small units on the local scene. It would appear that it will not be possible to solve the total transportation system problem at all unless there is a combining of these numerous units which were established when the present need did not exist. There is compelling need for larger metropolitan-type administration capable of dealing with the subject on a unified basis.

Even these administrations may lack the capability for the combined technical-economic-sociological approach that is required.

It appears necessary to have departments of transportation at the state level which can view the system in a state as a whole rather than through separate departments for highways and other elements. New Jersey and California have taken such a step. . . .

There must be greater three-way discourse among academic research institutions and government and industry, since transportation solutions cannot be studied except in close relation to the economic and social activity of society as a whole. Transportation is a servant and an implementer, not an isolated function in any respect. It is a responder to change, as well as a creator of change. I believe the new Department of Transportation can be of great help in bringing all these elements into communication. Wilfred Owen of the Brookings Institution has proposed the establishment of a National Transportation Institute and a World Transport Center at which the needed coordinated studies could take place. The immense scope and complexity of the problem justifies some such approach. . . .

We need to seek to understand better the ways in which the government-industry relationship can serve to support the interests of both industry and the public in the growth process that is mutually desired.

In seeking major new approaches to the dense-population transportation problem, there are undertakings in the public interest which industry is best equipped to perform but cannot be properly expected to accomplish with its own resources. The Supersonic Transport shows the possibilities of a new departure, with industry the doer, government the principal enabler from a financial standpoint, and the public gaining the benefit. I think there is general agreement that in any such arrangement the advantages of private enterprise must be preserved and utilized. . . .

AIA MANUFACTURING MEMBERS

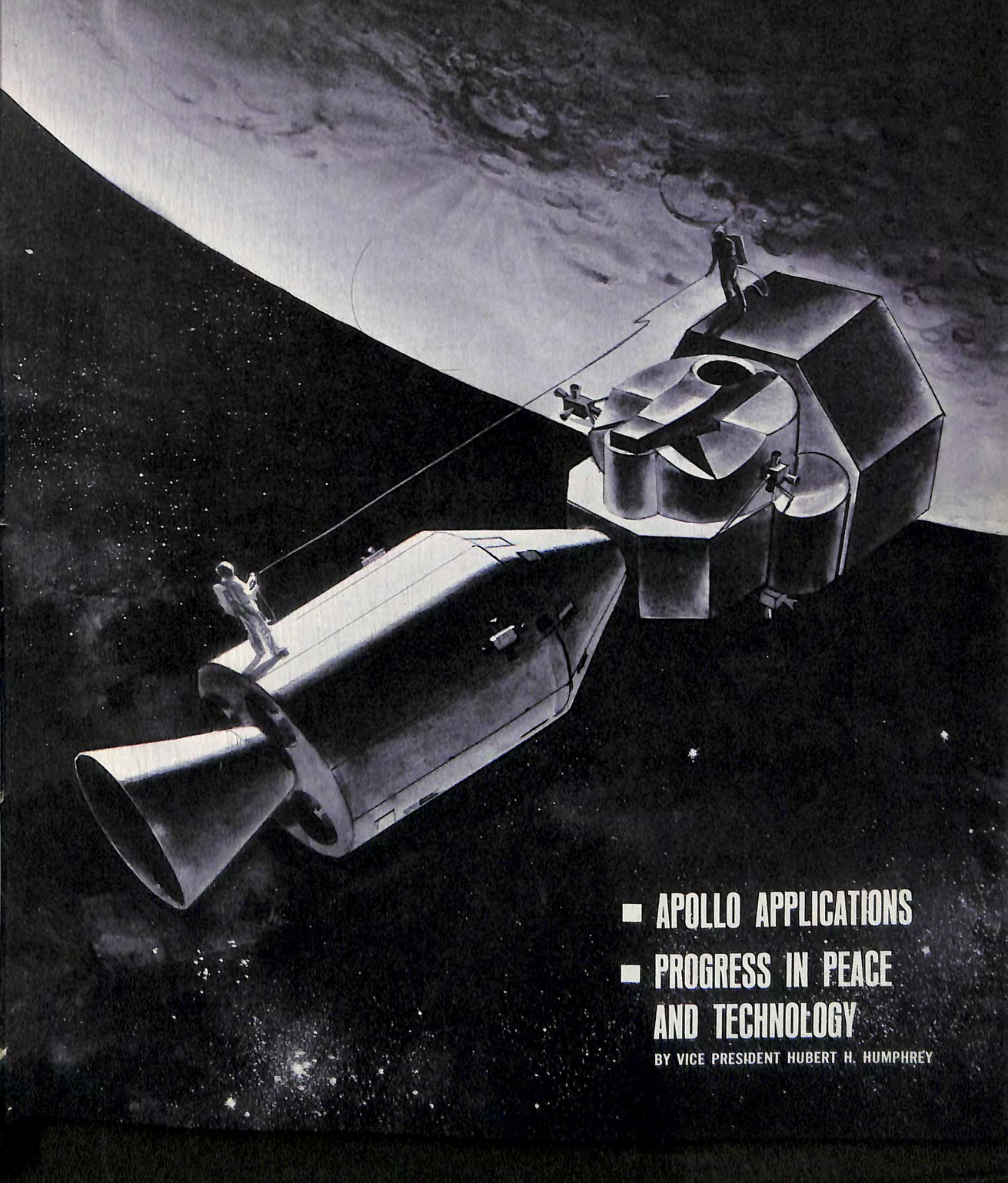
Abex Corporation
Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Aeronutronic Division, Philco-Ford Corporation
Aluminum Company of America
Avco Corporation
Beech Aircraft Corporation
Bell Aerospace Corporation
The Bendix Corporation
The Boeing Company
Cessna Aircraft Company
Chandler Evans, Inc.
  Control Systems Division of
  Colt Industries, Inc.
Continental Motors Corporation
Cook Electric Company
Curtiss-Wright Corporation
Douglas Aircraft Company, Inc.
Fairchild Hiller Corporation
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Defense Electronics Division
  Flight Propulsion Division
  Missile & Space Division
  Defense Programs Division
General Laboratory Associates, Inc.
General Motors Corporation
  Allison Division
General Precision, Inc.
The B. F. Goodrich Company
Goodyear Aerospace Corporation
Grumman Aircraft Engineering Corp.
Gyrodyne Company of America, Inc.
Harvey Aluminum, Inc.
Hercules Incorporated
Honeywell Inc.
Hughes Aircraft Company
IBM Corporation
  Federal Systems Division
International Telephone & Telegraph Corp.
  ITT Federal Laboratories
  ITT Gilfillan, Inc.
Kaiser Aerospace & Electronics Corporation
Kaman Corporation
Kollsman Instrument Corporation
Lear Jet Industries, Inc.
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Marietta Corporation
McDonnell Company
Menasco Manufacturing Company
North American Aviation, Inc.
Northrop Corporation
Pacific Airmotive Corporation
Piper Aircraft Corporation
PneumoDynamics Corporation
Radio Corporation of America
  Defense Electronic Products
Rockwell-Standard Corp.
  Aircraft Divisions
Rohr Corporation
Ryan Aeronautical Company
Solar, Division of International
  Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company
  Sperry Phoenix Company
Sundstrand Aviation, Division of
  Sundstrand Corporation
Thiokol Chemical Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory
  Marine Division

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

An air cushion vehicle is used to transport passengers across the bay between San Francisco and Oakland, Calif. This type of vehicle also has several military applications. (See *The ACV — Riding On Air*, page 8).

aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · APRIL 1967



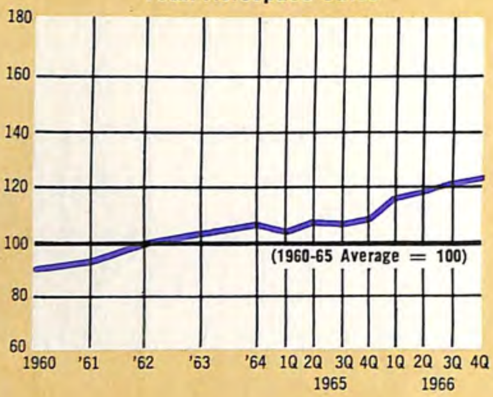
- APOLLO APPLICATIONS
- PROGRESS IN PEACE AND TECHNOLOGY

BY VICE PRESIDENT HUBERT H. HUMPHREY

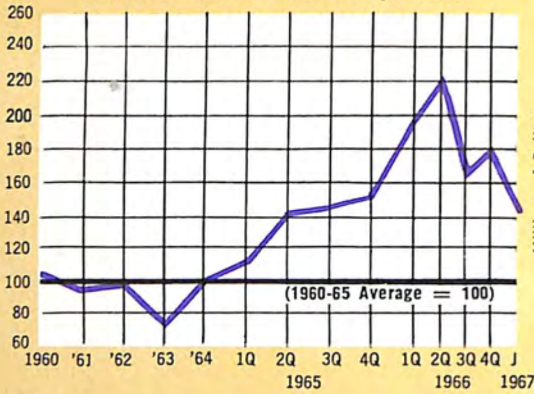
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

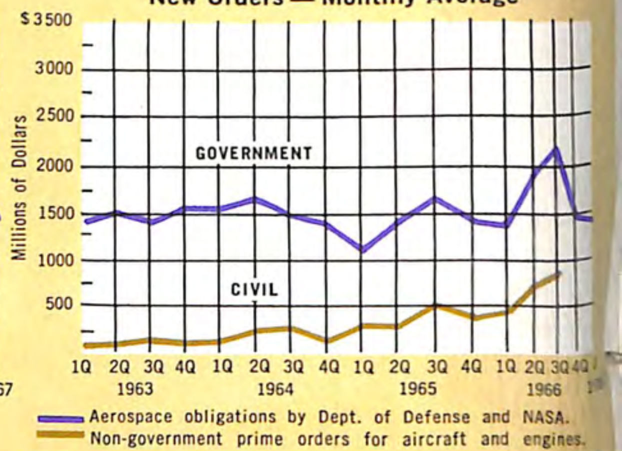


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-65 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Quarter Ending Dec. 31 1966	20.7 [R]	23.5	23.8 [E]
	Billion $	Quarterly	4.8		5.2	6.1	5.9
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	Jan. 1967	862	1,179	1,161
Aircraft	Million $	Monthly	601	Jan. 1967	527	810	767
Missiles & Space	Million $	Monthly	550	Jan. 1967	335	369	394
Aerospace expenditures: Total	Million $	Monthly	1,067	Jan. 1967	945	1,314	1,213
Aircraft	Million $	Monthly	561	Jan. 1967	546	730	885
Missiles & Space	Million $	Monthly	506	Jan. 1967	399	584	328
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	Jan. 1967	406	364	268
Expenditures	Million $	Monthly	130	Jan. 1967	378	412	387
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	692	Feb. 1967	1,173	1,161	1,019
Value	Million $	Monthly	15	Feb. 1967	31	29	28
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	Quarter Ending Dec. 31 1966	22.2	27.0	27.7 [E]
U.S. Government	Billion $	Quarterly	11.6		14.4	15.8	15.8
Nongovernment	Billion $	Quarterly	3.7		7.8	11.2	11.9
EXPORTS							
Total (Including military)	Million $	Monthly	110	Jan. 1967	103	155	148
New Commercial Transports	Million $	Monthly	24	Jan. 1967	22	47	30
New Utility Aircraft	Million $	Monthly	2	Jan. 1967	6	5	8
PROFITS				Quarter Ending Sept. 30 1966			
Aerospace — Based on Sales	Percent	Quarterly	2.3		3.6	3.2	2.7
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		5.4	5.9	5.4
EMPLOYMENT: Total	Thousands	Monthly	1,132	Dec. 1966	1,220	1,367	1,371
Aircraft	Thousands	Monthly	499	Dec. 1966	494	599	604
Missiles & Space	Thousands	Monthly	496	Dec. 1966	555	594	592
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	Jan. 1967	3.36	3.47	3.47

R Revised
E Estimate
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
# Averages for 1961-65

'A NATIONAL COMMITMENT'

The aerospace industry since the middle of this century has been called upon to overcome the most complex of technological challenges, and to force the pace of technological advance in order to meet the fast changing demands of national security and space exploration.

This capability is derived from the systems approach to complex problem solving. In the aerospace industry this involves the application of logical and sequential processes to thousands of variable elements of which complex problems are composed in order to arrive at optimum decisions.

The evolvement of alternative choices of action for the purpose of optimizing the decision making process calls for the application of a variety of disciplines, many of which are seldom considered as being classically applicable to the manufacture of aircraft, missiles or spacecraft.

These interdisciplinary processes—the integration of technological and managerial resources—have helped to create an industry of broadening outlook which is in the vanguard of capabilities needed to cope with many of the pressing social and economic issues of the day.

Congressman F. Bradford Morse recently wrote in the *Harvard Business Review:*

"There is still a considerable gap between the concern and enthusiasm of those actively pursuing systems analysis solutions to public problems and that of the highest national policy makers . . . I think we must make a major national commitment to explore fully the exciting possibilities that (the systems approach) presents for an attack on major and economic problems."

In Fiscal Year 1968, federal programs in such areas as air pollution, environmental engineering, urban planning and transportation and marine science and technology are expected to exceed $1.1 billion. If maximum benefits are to be derived, the suggestion by Congressman Morse for a "major national commitment" makes excellent sense.

In recent testimony before the special Senate Subcommittee on Scientific Manpower Utilization Karl G. Harr, Jr., President of the Aerospace Industries Association, observed that in the nation's approach to the problems that the accelerating pace of urbanization have created, the adaptability of our governmental structure — at all echelons — will be tested in a new way. If requisite resources are not to be wasted then clearly there must be a public/private mix of effort with a pinpointing of responsibility for results.

This is focal to success; experience has shown that the diffusion of responsibility in public authorities, which will be involved if national, regional or local social problems are to be properly addressed, rarely produces a sharp focus.

Today there exists a remarkable joint and cooperative capability between the federal government and aerospace companies in the defense and space sector. A public sector/industry rapport must likewise be brought to bear on community problems.

AIA

aerospace

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

PRESIDENT • Karl G. Harr, Jr.
PUBLISHER • Glen Bayless

VOL. 5, NO. 4 *APRIL 1967*

EDITOR • Gerald J. McAllister
ASSOCIATE EDITORS • Richard W. Balentine
• John J. Lee
ECONOMIST • Gerson N. Chanowitz
ART DIRECTOR • James J. Fisher

CONTENTS

The purpose of AEROSPACE is to:

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

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

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

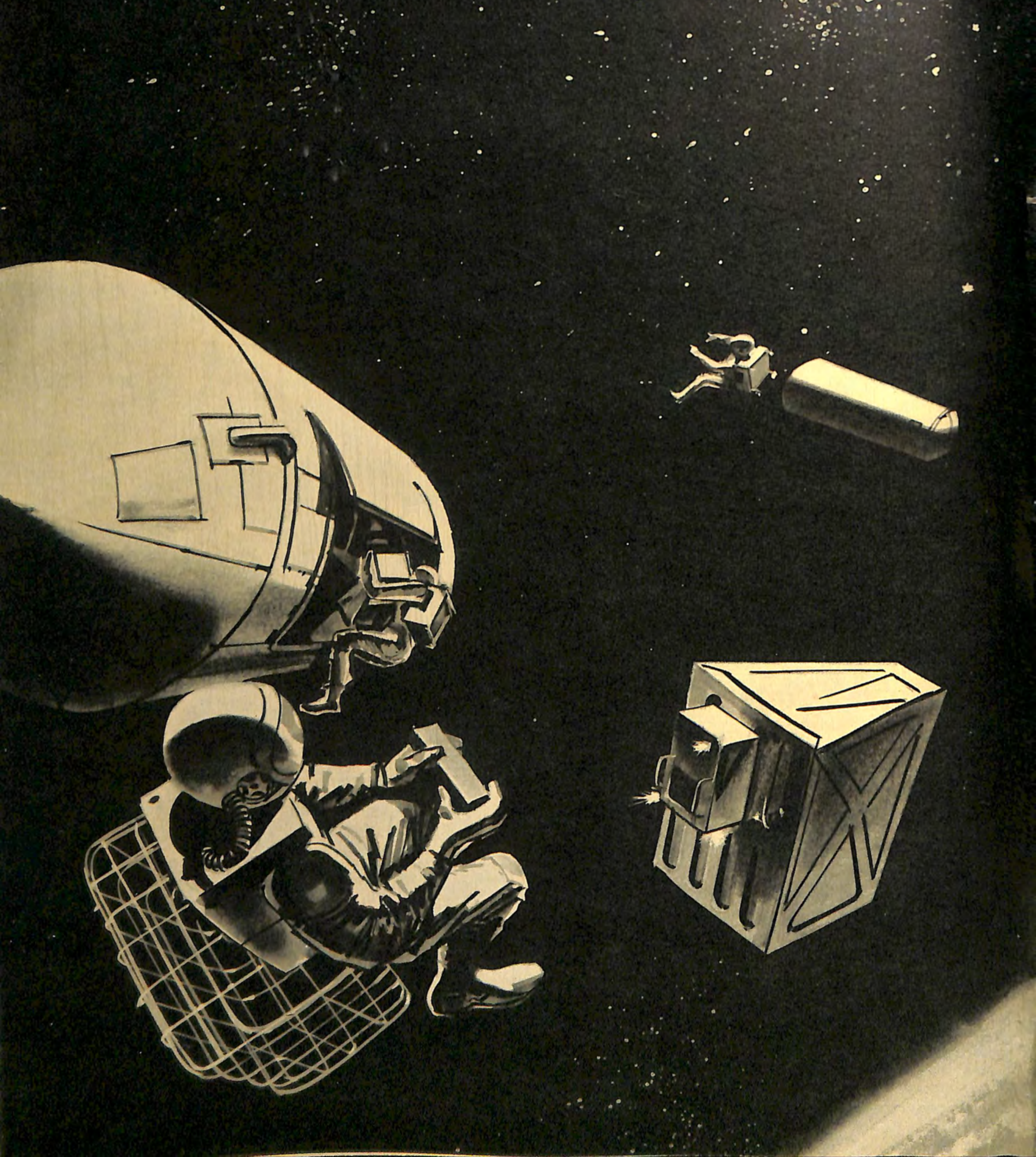
Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

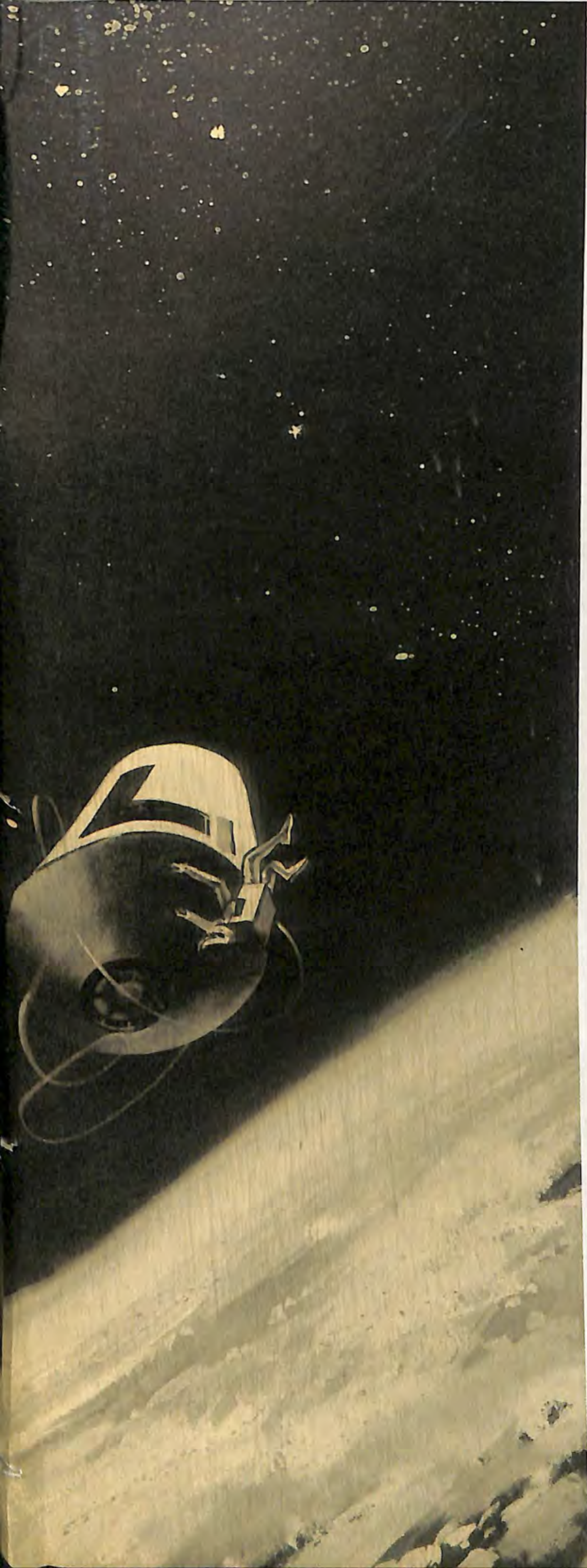
AEROSPACE is published monthly by the Aerospace Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

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

Western Office: McCulloch Building, 6151 West Century Blvd., Los Angeles, Calif. 90045

APOLLO APPLICATIONS





When U. S. astronauts land on the moon in the near future, they will have achieved another major stepping stone in the exploration of space. Following the lunar landing is an ambitious package of space programs that will rival the moon program.

Building around the hardware and technology acquired under Project Apollo and other space programs, the National Aeronautics and Space Administration plans a wide range of new projects in the near earth area, on the moon and in the distant interplanetary regions. Satellite-borne sensors will be monitoring daily activities on earth. Two-week or longer exploration of the moon will be conducted. Manned flights lasting a year or longer, and possibly manned journeys to Mars and other planets, will be attempted.

President Johnson has endorsed the new space programs, and Congress is expected to add its approval soon. Known generally as the Apollo Applications Program, \$454.7 million is due to be spent in the coming fiscal year that starts July 1. As development of the programs progresses, spending is expected to climb to the \$5 billion a year level, replacing the current Apollo costs as these taper off.

With an annual budget of around \$5 billion dollars a year — the level for the past several years — NASA says it can carry out its post-Apollo program. This will allow the agency to perfect many working space systems and tap the benefits from conquering space, plus extending scientific knowledge and technological capabilities with the more challenging lunar and planetary missions.

Nucleus of the new space programs is the three-man Apollo spacecraft, built by North American Aviation, Inc., the lunar module, a product of Grumman Aircraft Engineering Corp., and the huge Saturn boosters that launch them. These basic systems will be modified to meet the initial needs of new space programs without the necessity of immediately going into all new hardware. A launch rate of four of the uprated Saturn I and Saturn V boosters is planned each year. The uprated Saturn I can loft up to 40,000 lbs. of payload into near earth orbits and the Saturn V 285,000 lbs. around the earth or about 95,000 lbs. to the moon and lesser weights to the planets.

To get the program started, NASA has under way, or plans soon to:

- Convert the second stage of the uprated Saturn I launch vehicle into a 10,000 cubic foot orbital workshop.
- Develop a two-gas life support system that can keep men in orbit for a year or more.
- Develop a nuclear-powered rocket stage for space use.
- Modify the lunar module so that it can support men on the moon for two weeks or longer.
- Modify the Apollo spacecraft so that it can carry up to six men for short duration ferry and resupply missions, returning to earth for dry land landings and reuse.
- Develop a manned solar telscope system to study solar activity from space.
- Complete the cartography of the moon with additional lunar mapping and surveying.

- Develop a mobile lunar vehicle.
- Develop a long list of special sensors for monitoring earth and lunar activities.

The most promising area of space for providing benefits to man lies in the so-called near earth region, ranging only a few thousand miles out from the earth. Satellites placed in this part of space, both manned and unmanned, may one day perform a long list of useful tasks in the manner of the communications and meteorological satellites.

By 1970, NASA hopes to perfect a satellite system that will monitor the earth's resources. Electronic sensors carried by satellites could record crop yields on a global basis; measure water resources by checking on stream flows, snow quantities, lake water levels, and collect other similar data; forestry yields could be assessed; disease in forests and crops could be detected; and a limited knowledge of subsurface minerals could be obtained.

NASA is conducting experiments for this program by flying sensors in aircraft with highly successful results. Where costs would prohibit use of such a system using aircraft, however, satellites could perform it at only a fraction of the expense. Economists consider such a system invaluable. With it, they say, famines and surpluses in food crops could be predicted very early on a global basis and remedial steps taken before a crisis develops. Floods or droughts could be anticipated. Geologists would know where the most promising areas are for mineral deposits.

Satellites are being studied as means of monitoring the oceans, keeping tab of iceberg movements, current flows, and possibly even the movement of large schools of fish. Their use is being considered, too, to keep track of ships and aircraft in the wide ocean expanses. Satellites may even be used selectively for studying the migratory habits of wild animals. Tiny electronic devices attached to the animals would transmit signals to the satellites, which could relay them to central points.

They will almost certainly be used to expand the weather data collection system by having satellites receive and re-transmit weather information collected by literally hundreds of small weather collection devices located in the oceans and in remote areas of the world.

Satellite use in communications will be expanded. Experimental work is already under way to relay radio broadcasts directly from satellites to radio sets in the home. Eventually, television programs may be transmitted the same way, opening up large areas of the world to TV reception that now don't have it.

In the past, when a space system or experiment was to be tested, a new satellite was usually built specifically for that purpose. For the Apollo Applications Program, a new approach will be taken. It involves orbiting a huge manned space workshop that will be used to test a series of experiments. As these are perfected, then separate satellites may be developed. In some cases, too, it may be possible to combine more than one system into a single satellite.

By the end of next year, NASA hopes to have its first space workshop in orbit. Instead of building a new spacecraft, the agency is modifying a fuel tank in the uprated Saturn I launch vehicle to serve as the workshop. Built by the Douglas Aircraft Company, the tank stage, called S-IVB, measures 58.4-ft. high with a 21.7-ft. diameter. It is divided into two tanks. One contains liquid oxygen, the other liquid hydrogen.

Initially, the S-IVB will help power the uprated Saturn I to put the three-man Apollo spacecraft into an approximately 250-mile high orbit around the earth. Once its fuel has been expended and while it is still

Dr. George E. Mueller, Associate Administrator for Manned Space Flight, National Aeronautics and Space Administration, demonstrates with the model of a future spacecraft an Apollo Applications Program project.

attached to the Apollo spacecraft, the hydrogen tank on the S-IVB will be cleaned automatically to serve as the workshop. Astronauts in the spacecraft will then crawl into the tank through a special air lock entrance being developed by the McDonnell Company under an approximately $10-million contract. They will carry lightweight fabric-like materials to divide the tank into two floors or areas. Because of the weightless condition, structures in the workshop do not need to be strong. Each area will be approximately 22-ft. in diameter and 10-ft. high. One will be used as living quarters, the other for conducting experiments.

A new life support system is being developed for the workshop so that the astronauts can live and work in a "shirt sleeve" environment without being burdened by their cumbersome space suits.

The astronauts' first stay in the workshop will last about 28 days. During this time, they will conduct a long list of experiments and learn how to live in space. For example, it isn't known yet whether the astronauts will sleep lying down, or standing up because of the weightless condition. Dressing and other daily functions that pose no problem on earth must be mastered by the spacemen. Plans call for keeping the workshop in space for two to three years at a minimum. After the initial stay in the workshop, the astronauts will re-enter the Apollo spacecraft, detach from the workshop and return to earth. The workshop will remain in space.

The workshop will be revisited, with astronauts gradually increasing the length of time they remain in space to a year or longer. Additional equipment and experiments will be added to the basic workshop. Instead of installing the equipment inside the workshop, it will mainly be attached to the outside. Some equipment may also be tethered on long nylon lines, much as was demonstrated in the Gemini program.

One of the largest pieces of equipment to be added to the workshop is a big telescope mount, measuring more than 80-inches in diameter and weighing about one ton. It will be used for an intensive study of the sun, beginning by early 1969.

Other instruments to be attached to the new workshop include the earth resources sensors, a meteorological package of equipment, a photographic telescope that will be pointed manually by astronauts to take pictures of the earth and other similar equipment.

By 1969 or 1970, NASA wants to begin putting some of its experiments into synchronous orbit, 22,300 miles distant from the earth where satellites moving at the same speed as the earth appear to remain stationary. Satellites in this position can monitor the same portion of the earth continuously, noting changes as they occur. Eventually, even manned stations may be placed in these synchronous orbits.

For its lunar exploration program, NASA plans to make at least one manned trip to the moon each year for the next several years. Additional mapping of the moon similar to that provided by the Lunar Orbiter program will be conducted over almost all of the lunar surface.

The length of time that the astronauts will stay on the moon's surface is to be extended from the approximately 18 hours anticipated for the first landing to two weeks or longer. The number of astronauts, possibly including some scientists and engineers, will be increased from the two on the first landing up to four or five per trip.

In the early stages of lunar exploration, NASA wants to make a 300-ft. test drill in its surface to obtain knowledge about its geological composition. It wants to perfect a light weight vehicle to give the astronauts mobility so they can explore from 10 to 15 miles from their base camp. By comparison, astronauts on the first landing will not venture more than 1,000 feet or more from their Lunar Module.

Barring unforeseen difficulties, NASA wants to acquire the ability for men to live on and explore the moon for several weeks or even months at a time. It also wants to be able to build structures such as large antenna arrays that will be useful for scientific experiments. Eventually, the moon may become a valuable scientific laboratory for studying the universe, particularly for astronomers.

Much of the equipment and techniques NASA will perfect for the other areas of space exploration form the basis for exploring the planets. Though not an official project, it seems highly likely that a manned landing on Mars may be possible by about mid-1980. This would be a 15-month to 18-month journey.

Critical to such a trip is development of a nuclear-powered rocket to be coupled with the huge Saturn V that will send the Apollo spacecraft to the moon. By replacing one of its present chemically-fueled upper stage engines with a nuclear rocket, the weight-carrying capacity of the launch vehicle could be increased by almost 80 percent.

President Johnson recently approved development of the nuclear space rocket under Project Rover. This will cost approximately $2 billion to bring the program to the flight test stage about 1975. The bulk of the work on the rocket will be done by the Aerojet-General Corp. and the Westinghouse Electric Company.

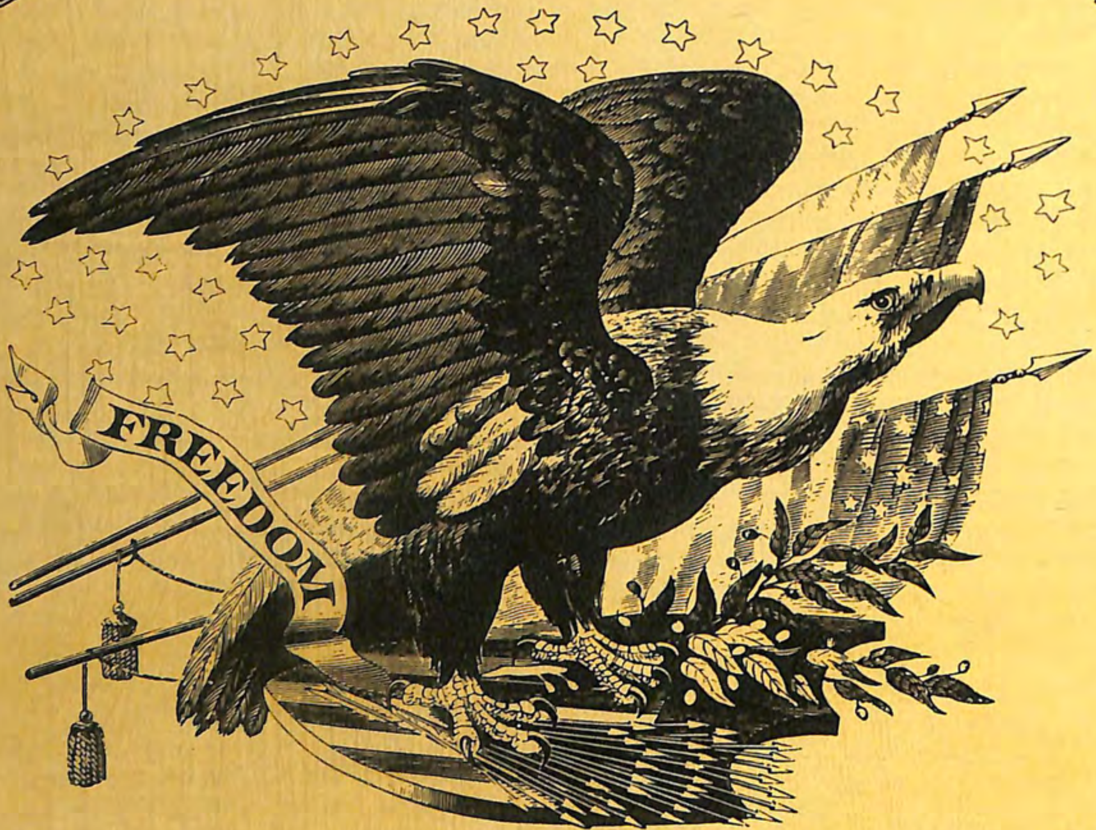
Meantime, in 1973, NASA plans to send two unmanned Project Voyager spacecraft to Mars carrying instrument packages that will be landed on the planet's surface while the mother craft orbits about it taking photographs. These will provide the preliminary information needed for a manned landing.

The long duration life support system being developed for the Apollo workshop with other technical improvements may well be combined in a new Mars spacecraft for man's first journey to the planets.

Though Mars is the immediate focal point, other planets such as Venus and Jupiter are expected to be explored.

Barely ten years old, the U. S. space program has already brought startling achievements and benefits, with the big pay-offs believed yet to come. President Johnson, in his annual report to Congress on the past year's space effort, clearly assessed its importance when he stated ". . . these accomplishments — and the promise of more to come — are the fruits of the greatest concerted effort ever undertaken by any nation to advance human knowledge and activity. Space, so recently a mystery, now affects and benefits the lives of all Americans."

PAYROLL PATRIOTS



The aerospace industry sets the pace in the purchase of U. S. Savings Bonds. The percentage of aerospace employees participating in the payroll savings plan is twice as high as that of employees of business and industry in general.

Recently, Daniel J. Haughton, president of the Lockheed Aircraft Corporation, was appointed chairman of the 1967 U. S. Industrial Payroll Savings Committee. President Lyndon B. Johnson wrote Mr. Haughton: "... Under your leadership, I know that success in this vital campaign is assured.

"You, and the distinguished members of your committee, have my personal assurance of full support and cooperation from every office and department of Government. The sale of more U. S. Savings Bonds to more Americans is essential to our Nation's economic security. I can think of no better way for any American to contribute to his country, and to his own personal future."

In a Treasury Department report on high levels of participation during 1966, there were ten aerospace companies in the top twenty of industrial firms. Lockheed Aircraft Corporation led the way with 99 percent of its employees participating in the payroll plan.

The committee headed by Mr. Haughton is composed of 48 top management leaders from business, industry and government. Nine of these members are from aerospace firms, including Don Burnham, president of Westinghouse; Dr. Elmer Engstrom, chairman of the executive committee of RCA; Robert O. Fickes, president and chairman of Philco-Ford Corporation; Harold S. Geneen, chairman and president of ITT; William P. Gwinn, president of United Aircraft Corporation; Arjay Miller, president of Ford Motor Company; Vernon R. Rawlings, vice president of Martin Marietta Corporation; Clyde Skeen, president of Ling-Temco-Vought; and Charles B. "Tex" Thornton, chairman of the board at Litton Industries. The role of U. S. Savings Bonds in safeguarding our economic future is highly important. The $50.2 billion in Series E and H Bonds now outstanding represents 23 percent of the $216.7 billion held by the public. These bonds place a solid foundation under our national economy.

In today's market, Savings Bonds represent a very wise purchase. They are an excellent investment, particularly since the rate was increased to 4.15 percent last year. This has been reinforced by the Freedom Share, bearing interest at 4.74 percent when held to its *four and a half year maturity*. The Freedom Share is sold only in combination with Series E bonds of equal face value through payroll savings or bond-a-month plans.

Karl G. Harr, Jr., president of the Aerospace Industries Association, said: "These are considerations that appeal heavily to responsible and intelligent citizens, and I like to think the heavy participation of aerospace people in bond campaigns is a consequence of the very high caliber of aerospace employees. Certainly, our people are well above the average in training and technical skill. I believe they are also above average in economic understanding and the acceptance of their responsibilities as citizens."

John Harper, president of the Aluminum Company of America, spoke recently before a meeting of the National Association of Manufacturers on the subject of "Private Enterprise's Public Responsibility." He stated: "More and more, American business is recognizing that it has a unique public responsibility . . . The real dilemma for today's businessman is not whether he should or should not accept that responsibility. His dilemma, rather, is how to identify the public areas in which he can properly and helpfully operate."

The efforts in energetically promoting the purchase of U. S. Savings Bonds represent a prime public area in which U. S. businessmen properly and helpfully operate.

PROGRESS IN PEACE AND TECHNOLOGY

MR. HUMPHREY

The following is excerpted from an address by Vice President Hubert H. Humphrey before the Goddard Memorial Dinner in Washington, D. C. This was the third consecutive time that Vice President Humphrey delivered an address before the Goddard Memorial Dinner which honors Dr. Robert Hutchings Goddard, the American pioneer in rocketry.

. . . I want to assure you that this Administration, your government, is determined that our space effort will go forward without slowdown and with a determination and with a full commitment to keeping our country first in space—preeminent in space, science, and technology.

I want to challenge the space industry. I want every one of you to become more involved in solving our problems here on earth. I know what marvelous things have already come to us as spinoffs from our efforts. . . . But there is so much more that you can do to make our society a better place in which to live. There is so much that your systems approach, your experienced management approach can bring to solving problems of transportation, air and water pollution, transit, communications, education, neighborhood development, crime control. In short, you can make this environment here on earth a better place in which to live. And I might add, you can do it at a profit.

And finally, I want to talk to you as Americans deeply concerned about our great country — not as Americans just concerned with the problems of space, but also as Americans concerned with the most crucial of international problems of the present. I refer to our deep, painful, costly, and yet vital involvement in Southeast Asia. . . .

Now let me say a word about our National Aeronautics and Space Administration team in which I have such great confidence, and I want Americans everywhere to have the same confidence I believe they have. The record justifies it. It is this team which has enabled us in just nine years to put 16 astronauts in orbit for a total of 1,996 man-hours. That's no mean accomplishment. It is this team which has made it possible for our astronauts to put in over 12 hours outside their spacecrafts. It is this team which has enabled us to map the moon and make an unmanned landing upon it. And it is this team which has probed Mars and Venus and sent spacecraft to study the sun. Above all, our entire aerospace team is insuring that we are second to none in space. I repeat — second to none — and every American ought to have that as his goal. Not second, but first in whatever we endeavor to do.

I know that we all like great drama but I think it's important that we should now note that there seems to be general agreement among the preeminent experts in the field of space science that this country no longer needs a single major dramatic goal as a spur to its space efforts such as that great commitment of 1961 to go to the moon. Rather there is the sober realization that this nation of ours has matured in its space effort and has developed the technology and the understanding to push forward in space in a balanced and selective manner. This is the recommendation of the President's Space Advisory Committee. . . . It called for a balanced space program including both the extension of earth orbiting capabilities and eventual manned planetary exploration.

I believe that most of our competent scientists, engineers, and managers in the space endeavor would agree that that outlook, that perspective, is sound. Now I said there were many space benefits over and beyond what we can readily see and one of them that is always appealing to me is this broad benefit of the improvement of our technology, our engineering capacity, and our scientific competence. I spent some time in these rceent months studying what is happening between the so-called "have" nations and the "have-not" nations between the developed nations and the developing. That has been a matter of interest for me for some 20 odd years. But in recent months I have been spending time looking into what we refer to as the "technological gap."

There may be many reasons for this gap but regardless of the reasons, the gap does exist. That gap may be somewhat exaggerated; it may be over-dramatized. But I think it is a fact that in at least two key areas, namely the computer and electronics, the United States is far out in front. And why? Because of people like yourselves and the advent of the space program. It is also because of the fantastic development or commit-

ment of this country in research and development by your Government and because of the upgrading of our great institutions of higher education. Yes, if you please, it is because of the challenge to our whole educational structure that today the American educational structure offers a broader opportunity and a great opportunity to more and more minds so that we can benefit from the exploration of the unknown.

The commitment to basic research by both our government and industry has fostered our success. I am a refugee from a classroom, a professor of sorts. I always mention it because elective office is too precarious to really depend on. I want to keep my credentials alive. And this basic research is the pool of knowledge from whence we draw, and the applied, the practical day to day research and development is dependent to a large measure upon basic research.

We have a good balance here between basic and applied research. We have moved ahead with a whole new system of education — what we call the interdisciplinary approach where departments and universities had once thought they were sovereign members of the United Nations and have now begun to understand that they are but a factor — they are but an integral part in a larger whole.

We've learned to move ahead in what I call a working partnership between government and industry and the university. And that great working partnership which has made possible our endeavors thus far in space is needed for every other thing that we tackle from here on out.

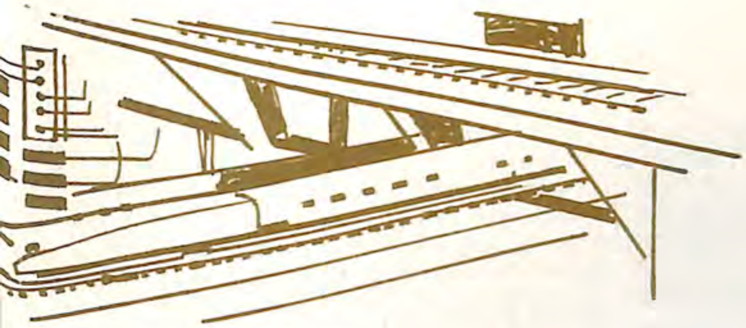
There isn't a single problem confronting this Nation today or this world that can be handled by the resources of any one group alone. The problems of our cities are too vast today for the Federal Government alone or the local government alone or private industry alone. But, together they are manageable. We have a working partnership — the theme of the last third of the 20th century where the old animosities and the cheap old demagogism are put aside — and where we have to pool our resources without the loss of identity of each. This is where we learn how to cooperate rather than to dominate; where we learn how to supplement rather than to supplant. This is the new philosophy. The new approach to the meaning of the problems of the last third and I emphasize it, the last third of the 20th century. Every one of us who is worthy of the trust of his government or his business or his university or whatever institution he is associated with ought to be thinking about Century 21 because if you are not thinking that far ahead, you're going to lose contact with reality.

The rapidity of change — the pace of change — is so rapid, so fast, that we must contemplate at least a decade — two decades — a generation, two generations — ahead in order even to be in step with what is going on. So science and technology have become two of the great arms of strength of this Republic. But science and technology must be humanized by ethics and morality. Our task is not merely to develop the scientist and the technician, but the human being per se, so as to make science and technology the servants rather than the masters.

I said there was this second challenge of putting what we have learned in this space program to work to solve other problems, and here I want to get right down to the practical day-to-day — I guess you've got to call it politics, or should I say just learning to live with each other.

From time to time in the Congress of the United States someone says that the space program ought to be cut so we can have more money for health, for cities, for roads, for airports, for water pollution control, etc. I believe they are wrong. I am going to make the same suggestion to you that I made to the mayors of the cities not long ago. I worked with the local government officials at the request of our President. I said, "Distinguished Mayors" — and I had hundreds of them before me. I said, "Instead of your spending your time and energy running down the space program or saying that the way to get some more money for your streets or your housing is to cut this program, why don't you go to Congress and fight for your own programs? Work for what's in that budget for you." And I also said, "Then put in a good word for what the space program is now, can be tomorrow, and means to this nation." In other words, join together. The budget is a well thought out political financial instrument for the advance of this nation. It is not sacrosanct, but it offers a pattern of development.

It's time that people in space made up their minds to show interest in the programs of others — in water pollution, air pollution control, cities and urban problems, communication, transportation, slum clearance.



Make them your problems too, and stand up and be counted for them, or you will get counted out. I guess that is as direct a way as I can put it, and I've been around this city for a long time. I told some friends of mine in Oklahoma City at the National Farmers Union: "I want you to remember something. You are a minority." I happen to think that they are a very important minority. I come from a rural part of this nation, but even if I didn't, I happen to think that food and fiber are important. But I said you have to present your program in a way that not only appeals to your rural neighbor but to the Congressman from Long Island as well as from San Diego. Don't be parochial or provincial. Show as much interest in the other fellow's problem as you want him to show in yours. If you are disinterested in his efforts and his goals, you can rest assured that you'll be counted out because you don't have the votes.

And it just adds up that way in our Congress, too. Moreover, I want to say the same thing to you.

I am the Chairman of the Space Council.

I'm for the space program.

I think it has given tremendous growth, power, wealth, excellence to the United States of America.

I think it is one of the greatest things that has ever happened to our educational structure.

I think it is one of the great motivating forces for efficiency in industry.

I think it has upgraded the quality of life in America.

But, I also know something about Congress. I was Majority Whip of the Senate for several years. I have lived there for 16 years. I've been in this town going on my 19th year, and it's going to be tougher this year than it ever was before because there are other demands — international and domestic.

I want the space people to show that we've learned from space how to manage some of the problems that we have right here on earth and that the experiments and the experimentation that we have had in space are invaluable for solving the great domestic, economic, social problems that confront us in rural America, in urban America, in every one of the 50 states of this Union. . . .

I also want to discuss briefly a topic that is close to my heart and of vital concern to all of you. Your nation today is involved in a very serious international confrontation. The business of this country since 1945 has been organizing the peace. We've been trying. We've had to learn a great deal. Remember, we came in as an isolationist nation and became an international nation. We became a nation of international leadership and responsibility, not by design, not by wish, but almost by accident. To the everlasting glory of this country, we fulfilled that opportunity rather well. . . .

A nation that is a world power such as ours has to have more than a half-world interest and knowledge. It is not enough to have information and understanding of other people around the whole globe. Over one-half of the population of this world is in Asia. The three wars in which this country has been involved in about the last quarter century have been in Asia — Pearl Harbor, Korea, and now Vietnam.

Last year I was in Asia in the month of February, and that was a time when things turned for the better. A year before that in February 1965, Southeast Asia faced Communist conquest. In February 1966, the line had been drawn. In March 1967, a competent, well-equipped, well-fed, well-trained, combat-experienced, highly mobile, heavy fire power, military force is winning battle after battle in the fields of South Vietnam. The tide of battle has changed, but this is not a military struggle alone. This is a military, political, economic, and diplomatic struggle. And therefore, we must succeed on all four fronts.

Our objectives are limited. Not the conquest of another country, but the protection of one. Not the securing of territorial invasion, but the stopping of infiltration and aggression and the protection of the right of self-determination. And make no mistake about it, those objectives can be achieved and are being achieved.

It is my view that the only danger to the success of our effort today in Southeast Asia in cooperation with allies would be our own indecision — indecision in our own ranks, our own lack of clear purpose.

Let our accomplishments in science and technology be for the peace of the world. No nation wants peace more than ours. No nation has more to gain from peace than ours, and no nation is willing to make a greater sacrifice for a just peace than ours. All we ask is that we have the steadfastness of purpose to attain the conditions that are conducive to that peace, and then a brighter day will come.

Hughes Delivers Portable Electronic Laboratories

Hughes Aircraft has delivered to the U.S. Army eight air transportable laboratories to service various electronics systems under combat conditions. No bigger than outdoor vacation campers, the laboratories are known technically as electronics maintenance calibration shelters.

Each of the portable labs weighs about 4,000 pounds and is designed for on-the-spot maintenance of military communication support equipment. Insulation in the walls protects the two men who can be comfortably housed within from sub-zero cold or jungle heat.

The easy maneuverability of the units, which are transportable by land, sea or air, minimizes the time required for field maintenance of vital communication equipment. Heat, moisture and dust, constant threats encountered in tropical climates such as Southeast Asia, can render the most dependable equipment useless unless field maintenance is provided.

Later models will be capable of handling more sophisticated electronics in support of avionics and weapons systems.

Supercold Storage Tank Uses 'Ping-Pong' Reflection

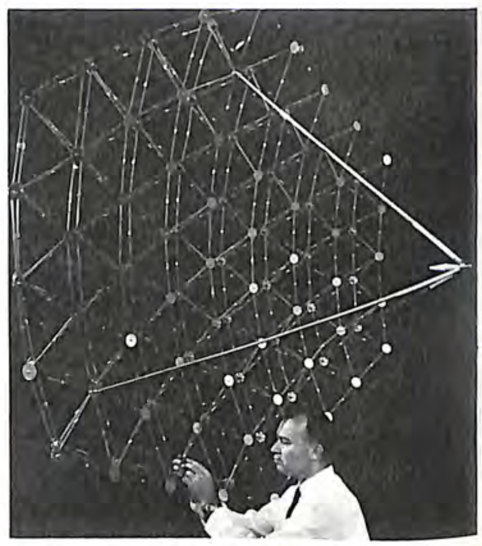
Engineers at Aerojet-General Corporation in Downey, Calif., are studying an insulation technique that uses sets of reflective coatings to bounce heat waves back and forth like a ping-pong ball as a possible key to prolonging man's ability to work and breathe in space.

Storage tanks for supercold fluids

used in spacecraft power and life-support systems are necessary parts of spacecraft in order to store great quantities of oxygen, for example, in the smallest possible areas. When chilled to 300 degrees below zero, liquid oxygen can be contained in a tank 1,000 times smaller than required if it were in its gaseous state.

A major technical problem is that heat from the sun or from other systems in the spacecraft can cause the supercold fluid to change back to gas at a rate much faster than needed. To prevent this, a thermal barrier is created by surrounding the tank with an outer shell and drawing a vacuum in the space between much like the airless space in a Thermos bottle.

Aerojet's studies are showing the advantages of installing intermediate shells or shields in the vacuum zone of the tank to create a series of vacuum barriers, then applying thin, heat-reflective coatings on all of the inside surfaces. Tests show that gold or silver coatings as thin as 100 thousandths of an inch make excellent reflectors.



Orbiting TV Antenna Developed by Convair

Orbiting large, self-erectable antennas to relay television programs directly to large sections of the earth is under company-funded study by the Convair division of General Dynamics at San Diego, Calif.

Several types of satellite antennas and power systems with payload weights ranging from 590 to 68,000 pounds are being evaluated. The study shows that they could be kept in synchronous orbit for several years on TV-relay assignments. They might carry as many as 14 television channels directly to home TV sets, to community distribution centers, or to local television stations for rebroadcast.

Entire time zones could be served by an orbiting 22 by 30-foot antenna.

The Convair antennas under study would be compact during launch and flight but would expand in space after reaching the proper orbital level.

Martin Marietta Tests Telemetry Antennas

In a four-foot plexiglass sphere, engineers at the Martin Company are able to conduct a sophisticated testing program on telemetry antennas which serve USAF's Titan III standard space launch vehicles.

To make sure they won't short out in space, the antennas are energized by alternating current inside the plexiglass sphere which duplicates the environment in which the problem occurs. Electric and magnetic fields, resulting from the current, form on the face of the antenna. Molecules of oxygen and nitrogen in the ionosphere, free to move about because of the low-density environment at this altitude, are entrapped in the fields and vibrated to a state of very high excitement by the alternating current.

Free electrons in the ionosphere enter these fields and collide with the gaseous molecules, freeing additional electrons. This triggers a progressive activity much like the buildup of an avalanche, and ever larger numbers of electrons are released.

Positively-charged particles, all lacking in electrons as a result of these collisions, accumulate on the face of the antenna and absorb the energy of the antenna's telemetry signals, resulting in the "short" and emission of visible purplish light.

DOD Evaluates Honeywell's New STATE Landing System

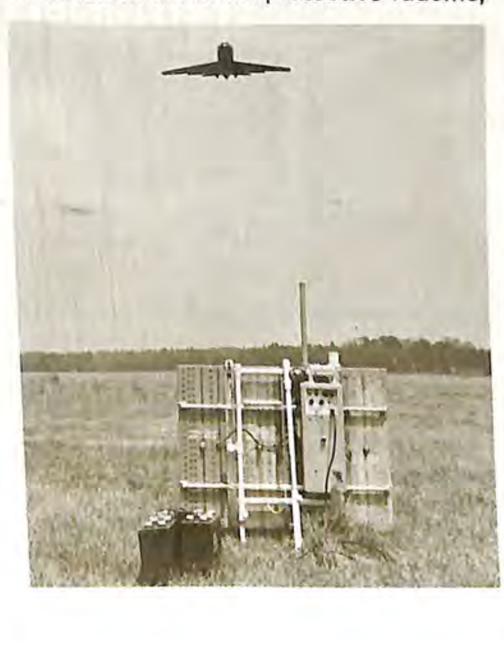
Honeywell Inc. describes its new portable aircraft landing system as the first "all-weather approach and landing system that visually informs the pilot of his approach path range and range rate to touchdown while maintaining complete control of his aircraft." It is formally known as Simplified Tactical Approach and Terminal Equipment (STATE).

Developed at the Honeywell Radiation Center in Boston, Mass., the system is undergoing technical and operational evaluation by the Defense Department as a means of providing a capability for cargo drop and extraction and low-visibility approach and landings during inclement weather.

The Federal Aviation Agency and several European countries are monitoring DoD's evaluation for possible commercial applications.

STATE is a C-band pulsed instrument landing system providing localizer and glideslope guidance information to an aircraft from a minimum acquisition range of 10 nautical miles to touchdown. Ground unit consists of four foldable flat-plate antenna arrays, omnidirectional antenna, weatherproof control box, and optical boresight, all mounted on a tripod. It can be set up and aligned by one man in five minutes. Forty-watt power is supplied by a motor generator. Present prototype weight of 55 pounds is reducible to about 30 pounds in production models.

Airborne equipment consists of a stacked cylindrical dipole antenna mounted in a vented protective radome,



a transmitter-receiver, conventional cross-pointer indicator that displays azimuth and elevation information, and new Servometric range-rate indicator developed by Honeywell's Aeronautical Division at Minneapolis, Minn.

Bell's SAILS System Lands Aircraft By Portable Beacon

Bell Aerosystems has developed a small, lightweight electronic system for landing aircraft in low visibility at remote landing sites which is known as SAILS —Simplified Aircraft Instrument Landing System.

Major feature of the system is a lightweight ground beacon which can easily be installed at a remote site. The beacon weighs 15 pounds with batteries. An aircraft flying within 40 miles can pickup the beacon, send a coded airborne signal which is returned and the airborne system locks on. The SAILS beacon will respond only to the airborne system transmitting the proper code.

Landing instruction for the aircraft, such as glide slope and heading for proper approach are entered by the pilot into the airborne system control panel. From there on the pilot flies by instruments, which provide range, range rate, elevation and azimuth error signals until about 50 feet from the landing area where he can make a visual approach.

SAILS permits aircraft to perform vital supply missions to military units operating in remote areas even when they cannot be seen. It can define temporary landing fields for conventional aircraft and low level extraction zones for dropping equipment from aircraft in tactical areas. It is also considered valuable as an inexpensive instrument landing system for future inter-city aircraft using heliports and for small landing fields for vertical and short takeoff and landing (V/STOL) aircraft.

By September, 1,384,000 men and women are expected to be on the payrolls of the nation's aerospace industry.

This increase of 3.4 percent above the 1,339,000 employed last September indicates a slower pace from recent significant gains in employment. However, the increase is above the average rate of growth for the industry between 1960 and 1965.

This forecast results from an employment survey conducted by the Aerospace Industries Association of 60 companies representing about 80 percent of the entire industry.

AEROSPACE

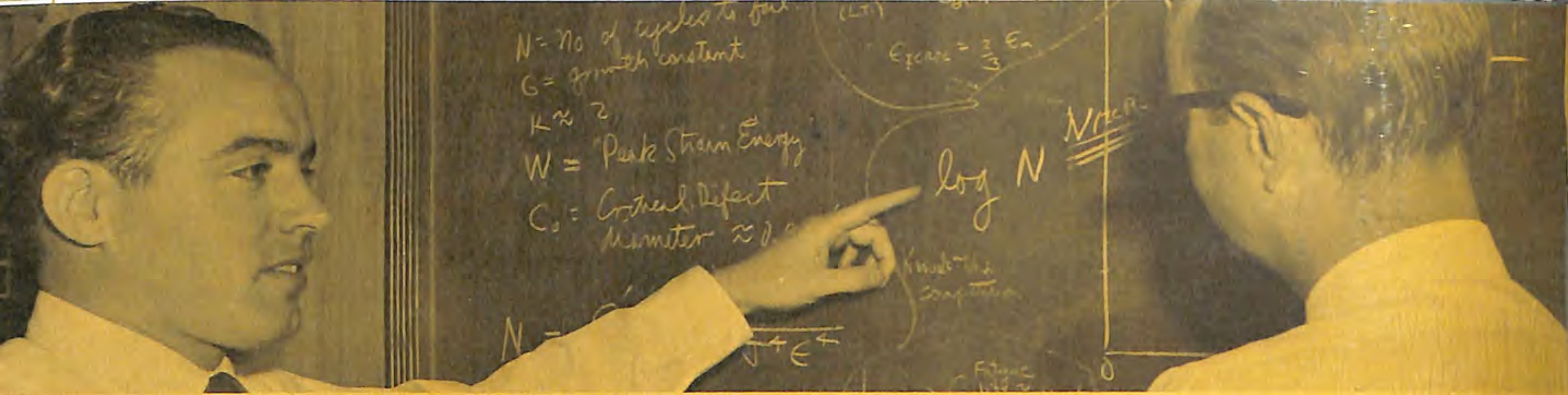
Continued rising demand for commercial transport aircraft, the backlog of which is at a record level, stable missile and space sales and increases in non-aerospace programs are chiefly responsible for the increase.

Scientists and engineers constitute more than 17 percent of the total aerospace industry employment, the AIA survey shows. Technicians total seven percent and production workers almost 55 percent.

Manufacturers of commercial and military aircraft continue to hold the lead as major growth factors in the employment pattern. The AIA survey shows a probable six percent increase from 115,605 to 122,000 during the year. Scheduled deliveries of transports such as the Boeing 707, 727 and 737, the Douglas DC-8 in its various versions, the DC-9 and the Fairchild F-227 and F-28 coupled with increase in orders for military fighters and bombers have provided an important impetus to employment rolls. The development of the larger jet transports are beginning to affect employment at plants where they are being produced.

Export demand for jet transports has also stimulated aircraft manufacturing employment. Foreign orders in-

EMPLOYMENT



EMPLOYMENT OF SCIENTISTS AND ENGINEERS IN THE AEROSPACE INDUSTRY

creased from $986 million to almost $1.9 billion between December 31, 1965 and 1966.

Helicopter manufacturers expect a four percent increase in the survey period from 35,087 to 36,447. Principal reason is the peaking of production to supply the Vietnamese effort and the steadily growing commercial sales effort to service traffic-congested cities.

Employment at firms manufacturing general aviation aircraft is expected to stabilize with a minor drop from 26,946 to 26,835 during the survey period. The tightening of credit throughout the economy in earlier months has led to a slowing in the purchase of these aircraft. The recent reinstitution of the seven percent tax credit and decline in the price of money could lead to an upturn in production of general aviation aircraft in the latter part of 1967.

Missile and space manufacturing employment is expected to increase slightly from 496,000 to 498,000.

Aerospace plants engaged in non-aerospace activities expect by September to have an increase of two percent to 57,000. Last September the total was 56,000 and in December 1965, 49,000, an indication of the

DISTRIBUTION BY PERCENTAGE OF EMPLOYMENT IN THE AEROSPACE INDUSTRY BY GEOGRAPHIC AREA

Geographic Area	September 1967	September 1966	December 1966	June 1967
NEW ENGLAND AND MIDDLE ATLANTIC	19.3	19.3	19.3	19.5
EAST NORTH CENTRAL	3.8	3.8	3.8	3.9
WEST NORTH CENTRAL	8.7	8.9	9.1	8.7
SOUTH ATLANTIC	8.9	8.9	8.8	8.8
SOUTH CENTRAL	5.8	5.8	6.1	6.3
MOUNTAIN	2.9	2.9	2.9	2.9
PACIFIC	42.8	42.6	42.4	42.2
UNDISTRIBUTED	7.8	7.8	7.6	7.7

Derived from data supplied by member companies on 245 establishments to AIA
Geographic area boundaries follow those of the U.S. Bureau of the Census.

increasing diversification and application of the industry's technology to such programs as communications systems and equipment, water desalination, air and water pollution control, waste management, submarine support equipment, oceanographic research, meteorological radar and telemetry, lasers and laser systems and nuclear reactors and reactor products.

In the survey period, the number of scientists and engineers is expected to rise by five percent from 226,000 to 237,000. Most of them will be employed in aircraft manufacturing plants where the increase from 113,000 to 121,000 represents a seven percent gain. Scientists and engineers working on transport aircraft are expected to increase in the period by almost 30 percent from 9,663 to 12,537.

Employment of scientists and engineers in missile and space plants is expected to increase from 101,000 to 103,000. Missile and space research and development and production requires the most intensive use of scientists and engineers. In September they are expected to constitute more than 20 percent of this employment.

The number of technicians employed in the aerospace industry is expected to rise from 92,000 to 94,000. Employment of technicians is now growing most rapidly in aircraft activities where they are expected to gain by nearly four percent.

The most rapidly increasing segment of aerospace employment is production workers. They are expected to increase from 713,000 to 756,000, an increase from 53 to 55 percent of total aerospace employment during the survey period.

Aircraft manufacturing plants have required the most substantial number of production workers. The increase is expected to be from 468,000 to 504,000, a rise of almost eight percent, reflecting the increasing production of new transports and military aircraft. Production workers in missile and space plants are expected to increase by more than two percent in the period.

Geographically the distribution of aerospace employment in the survey period is characterized by relative stability with no substantial shifts. The largest proportion, 42 percent, are employed in the Pacific region, primarily in California and Washington. The second largest area of aerospace employment remains the New England and Middle Atlantic regions with nearly 20 percent of the total expected in September 1967.

Ninety-seven percent of transport manufacturing employment is located in the Pacific region, a proportion which has remained stable since the survey of last year.

Seventy-one percent of the nation's helicopter manufacturing employment is located in the New England and Middle Atlantic regions, chiefly Connecticut, Pennsylvania and New York.

The current survey reveals that over 73 percent of general aviation manufacturing employment is located in the North Central area of the country, up from 66 percent in last year's survey.

With its continuing steady rate of growth, employment in the aerospace industry reflects its health and stability.

AIA MANUFACTURING MEMBERS

Abex Corporation
Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Aeronutronic Division, Philco-Ford Corporation
Aluminum Company of America
Avco Corporation
Beech Aircraft Corporation
Bell Aerospace Corporation
The Bendix Corporation
The Boeing Company
Cessna Aircraft Company
Chandler Evans, Inc.
  Control Systems Division of
  Colt Industries, Inc.
Continental Motors Corporation
Cook Electric Company
Curtiss-Wright Corporation
Douglas Aircraft Company, Inc.
Fairchild Hiller Corporation
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Defense Electronics Division
  Flight Propulsion Division
  Missile & Space Division
  Defense Programs Division
General Laboratory Associates, Inc.
General Motors Corporation
  Allison Division
General Precision, Inc.
The B. F. Goodrich Company
Goodyear Aerospace Corporation
Grumman Aircraft Engineering Corp.
Gyrodyne Company of America, Inc.
Harvey Aluminum, Inc.
Hercules Incorporated
Honeywell Inc.
Hughes Aircraft Company
IBM Corporation
  Federal Systems Division
International Telephone & Telegraph Corp.
  ITT Federal Laboratories
  ITT Gilfillan, Inc.
Kaiser Aerospace & Electronics Corporation
Kaman Corporation
Kollsman Instrument Corporation
Lear Jet Industries, Inc.
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Marietta Corporation
McDonnell Company
Menasco Manufacturing Company
North American Aviation, Inc.
Northrop Corporation
Pacific Airmotive Corporation
Piper Aircraft Corporation
PneumoDynamics Corporation
Radio Corporation of America
  Defense Electronic Products
Rockwell-Standard Corp.
  Aircraft Divisions
Rohr Corporation
Ryan Aeronautical Company
Solar, Division of International
  Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company
  Sperry Phoenix Company
Sundstrand Aviation, Division of
  Sundstrand Corporation
Thiokol Chemical Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory
  Marine Division

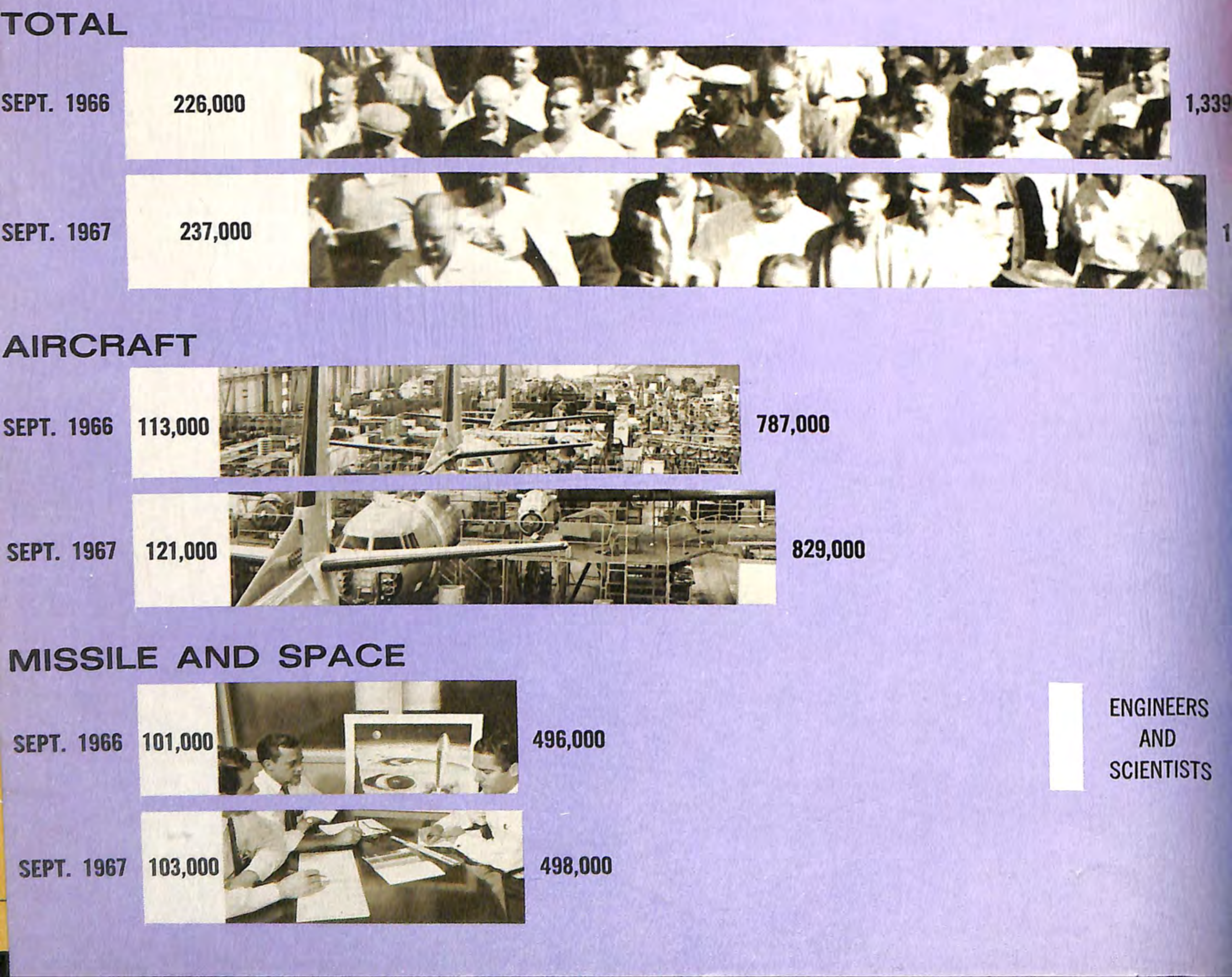
AEROSPACE INDUSTRIES ASSOCIATION
1725 De Sales St., N.W., Washington, D. C. 20036

RETURN REQUESTED

See *Aerospace Employment,* page 14

AEROSPACE EMPLOYMENT

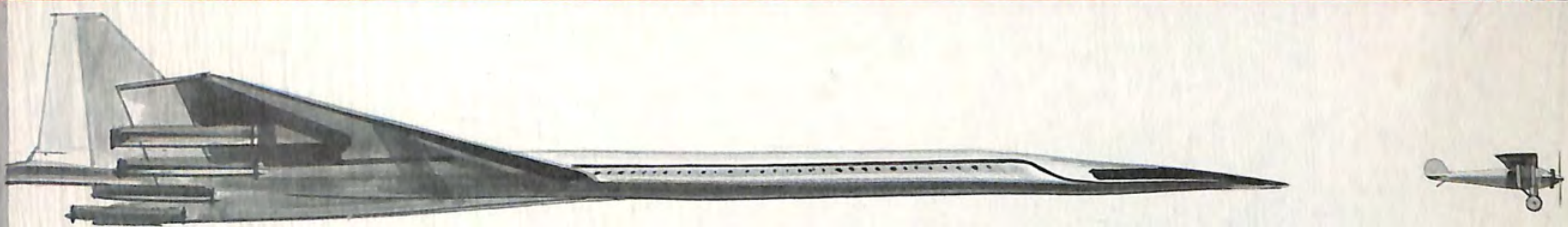
The chart indicates the changes in aerospace employment by total and type of product, comparing the employment in September 1965 and the estimated employment for September 1967. Non-aerospace employment, which is not shown on the chart, is expected to reach 57,000 by September 1967.



aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · MAY 1967

■ **Lindbergh's Flight — A Takeoff for Aviation**



Special Paris Air Show Edition

A Message from the President of the United States

THE WHITE HOUSE

WASHINGTON

Welcome to the United States Pavilion.

I extend to the people of France and to visitors from nations around the world the greetings and good wishes of the American people.

Our country's exhibition at this 27th International Aviation and Space Salon is a mutual endeavor of American private enterprise and the United States Government. It reflects the shared hope of our government and industry for international cooperation on this planet and in the exploration of outer space.

We believe that the Paris Air Show, by stimulating the exchange of technology, products, and services, advances the fulfillment of this hope. The worldwide diffusion of knowledge and products enables each country to build upon the achievements of other countries for the greater good of all.

The United States welcomes the opportunity to join with all nations in contributing to our common cause of world peace and progress.

THE PARTNERSHIP OF AEROSPACE

By KARL G. HARR, JR.
President, Aerospace Industries Association of America, Inc.

Recent developments in aircraft and space systems have played havoc with dimensions of the universe as we formerly knew them.

Since Lindbergh's historic flight from New York to Paris just 40 years ago, the world's aerospace industries have so advanced aircraft range, speed and capacity that in the very near future it will be commonplace for several hundred passengers to board a plane in New York and disembark in Paris with little more expenditure of time than it takes to serve them dinner aloft.

Shrinking the globe to such proportions creates enormous implications for the entire world. Now next door neighbors, nations long substantially isolated from one another by the oceans must reassess their concepts of geography, the interplay of their social and cultural traditions and the impact of this new proximity on their economic principles and business practices.

The peaceful exploration of outer space has also introduced radically new potential benefits for all nations. International cooperative space activities promise to provide man the knowledge and capability to harvest bigger crops, fish for larger catches and better prepare himself against such natural catastrophes as hurricanes, floods and droughts.

The United States aerospace industry has learned much about the benefits to be derived from pursuing these objectives in concert with industrial partners in other nations. We have long since engaged in such cooperation in pursuit of our mutual security, and we are now so engaged in the pursuit of mutual civil aviation and space objectives.

The International 1967 Paris Air Show clearly demonstrates the close inter-business relationships which have evolved between United States and European aerospace industries.

A wide range of such soundly based relationships, of many varieties, now exist with our European counterparts.

Our hope is that these ties may continue to grow and develop, to our mutual technological and economic benefit.

AIA

aerospace

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

PRESIDENT • Karl G. Harr, Jr.
PUBLISHER • Glen Bayless

VOL. 5, NO. 5 *MAY 1967*

EDITOR • Gerald J. McAllister
ASSOCIATE EDITORS • Richard W. Balentine
• John J. Lee
ECONOMIST • Gerson N. Chanowitz
ART DIRECTOR • James J. Fisher

CONTENTS

Because this is a special edition of Aerospace for the Paris Air Show this month, the Economic Indicators which normally appear on the opposite page are being published and mailed separately.

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

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

Western Office: McCulloch Building, 6151 West Century Blvd., Los Angeles, Calif. 90045

Lindbergh's Flight –

A TAKEOFF FOR AVIATION

By LAUREN D. LYMAN

On a bright Sunday morning, April 10, forty years ago this spring, the front page of the *New York Times* featured a story of plans for two transatlantic flights from the U. S. to Paris. Reports of both ventures had been printed earlier but the news that April morning disclosed that the *New York Times* had arranged for exclusive "wireless dispatches" from both expeditions as they flew across the ocean.

Commander Richard Evelyn Byrd and Floyd Bennett would fly a trimotored Fokker, carrying another pilot and a radio operator. This project was backed by Rodman Wanamaker. Lieutenant Commander Noel Davis and Lieutenant Stanton H. Wooster planned to fly a Keystone bomber redesigned for three engines with an estimated range of 4,000 miles. This expedition was backed by The American Legion.

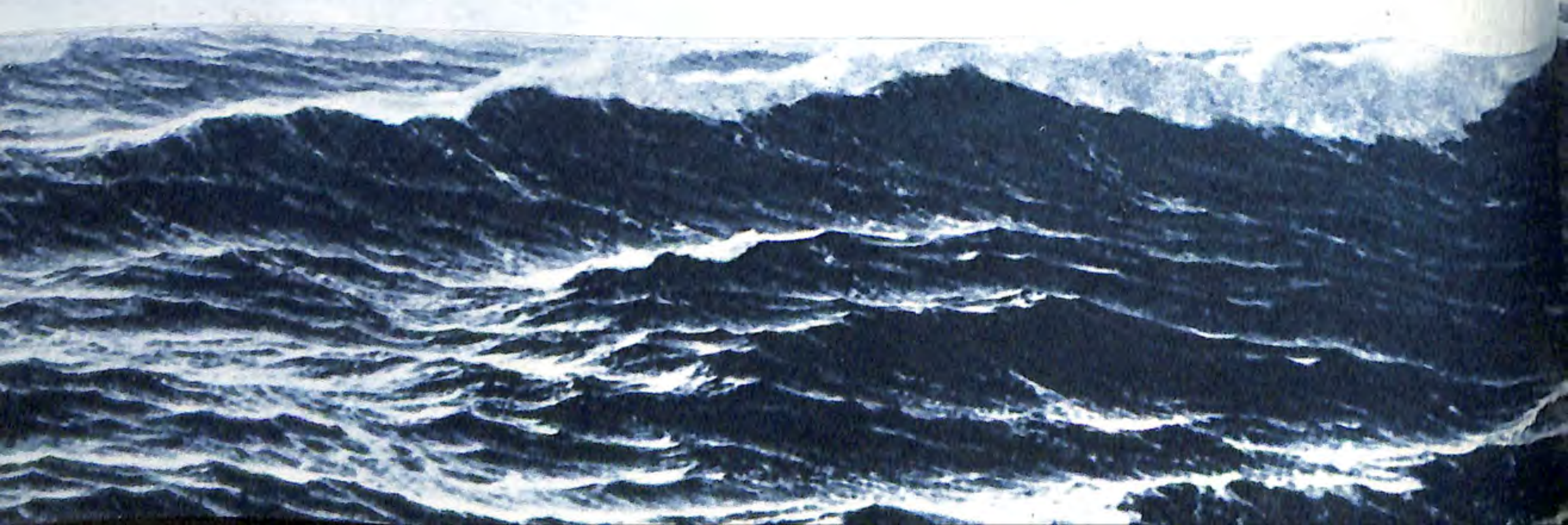
On page 24 there was an obscure box, datelined St. Louis, which reported that an air mail pilot named Charles A. Lindbergh was tuning a Ryan monoplane in San Diego for a solo flight from New York to Paris. This item was not quite new. A month earlier C. B. Allen in the *New York World* reported that Lindbergh had filed an entry for the transatlantic race with the National Aeronautic Association and that he planned "to make the flight alone."

Raymond Orteig, the French hotel man, landlord of the Brevoort and Lafayette Hotels in New York, had posted a prize of $25,000 for the first nonstop flight in either direction between Paris and New York. While eligible, neither Byrd nor Davis were interested particularly in the Orteig prize. Their programs were amply financed. Their objectives were the extension of aeronautical knowledge and international good will.

The Lindbergh venture was not regarded seriously in New York aviation circles. Veteran pilots and navigators were almost unanimous in their opinion that a navigator or co-pilot would be essential to the success of such a flight. They said one man, flying alone, no matter how skillful, could not keep awake and alert through such an ordeal. Cynics suggested that the Lindbergh flight was a Hollywood press agent's dream — a stunt to promote some future movie, not a "serious scientific expedition."

It was not until later, for some of us years later, that we learned that Lindbergh had a purpose and a vision far beyond the Orteig prize. (However, he wanted the prize money to recompense the group of visionary young men of St. Louis who had backed his venture with their dollars as well as their faith.)

On that morning in April it seemed certain that two and, if one counted this unknown mail pilot, Lindbergh, three expeditions would be starting from this side of the ocean in a thrilling race for Mr. Orteig's $25,000.



There was certainly one, and possibly two expeditions to fly west from Paris; in fact, Nungesser and Coli were almost ready.

The facts to this point have been gleaned from the record. But from here on much of this article will be from personal recollection — 40 years later.

April 11 was my day off and Tuesday, April 12, was another bright and balmy day. The phone rang as I was preparing to leave my suburban Port Washington home for New York. It was my city editor who assigned me to Roosevelt Field to cover an attempt for a world's non-refueling endurance record. It seems that the Nassau County correspondent was indisposed. I could phone my story and spend a pleasant day in the country. I was being picked for this assignment not because of my qualifications as an aviation reporter but for geographical reasons! I lived within ten miles of the story.

I went to Roosevelt Field and learned that Clarence D. Chamberlin and Bert Acosta were about to take off in a little monoplane carrying a cabin full of gasoline, the total weighing more than two tons. There also I met two of the most knowledgeable, probably the most able aviation reporters in the United States — C. B. Allen of the *New York World* and Bruce Gould of the *New York Evening Post*. They had both been pilots in World War I, and Allen was an active Air Corps reserve lieutenant. They both loved aviation and neither wanted to see a greenhorn go wrong. They introduced me to Giuseppi M. Bellanca, the creator of the little monoplane; and to Carl Schory, timer for the National Aeronautic Association, whom I watched install a barograph in the Bellanca aircraft. They told me what a barograph was (a self-registering barometer) and why.

There were others who shook their heads at the daring of these pilots. The Bellanca would probably not get off the ground, they said. It would crack up and burn as the Fonck-Sikorsky had the year before.

Chamberlin was successful. He became airborne in about 1,200 feet of the 5,000-foot dirt runway which was still in process of being rolled for the great transatlantic race. For the next two days and two long nights the crew in the Bellanca circled over Long Island to establish a new world's record of 51 hours 11 minutes and 25 seconds.

During that period, including two well-nigh sleepless nights, your reporter continued his aeronautical education. I asked the patient Mr. Allen endless questions, listened while Mr. Allen and Mr. Gould asked Mr. Bellanca more questions. No student ever had better teachers than these men, and the faculty also included Ed Mulligan and Ken Boedecker of the Wright Company, Casey Jones, of the Curtiss Company, and officers from Mitchel Field, including a stocky, pipe-smoking Colonel named Benjamin Foulois who 16 years earlier had learned to fly a Wright pusher by correspondence with Orville and Wilbur Wright.

In fact, in the next two weeks your reporter became an expert and in a month an authority, an eminence from which he has steadily descended for the last 40 years in spite of a host of patient instructors.

Two days after the Chamberlin and Acosta achievement, while people were still talking about it, came the first mishap among the aspirants for the distinction of being the first to fly between New York and Paris. At Teterboro, New Jersey, Commander Byrd's tri motored

Lauren Dwight (Deac) Lyman has been closely involved in aviation for the past 40 years, first as a reporter for 19 years with the New York Times (where he won the Pulitzer Prize in 1936) and then as an official with the United Aircraft Corporation for 21 years. Born in Massachusetts, Mr. Lyman attended Williston Academy and Yale University. During World War I he drove an ambulance with the French army. Mr. Lyman's earliest recollection of matters aeronautical is his grandfather quoting from the 139th Psalm at morning prayers: "If I take the wings of the morning and dwell in the uttermost parts of the sea. . . ." Mr. Lyman's recollections of the memorable spring of 1927 are equally eloquent.

Fokker with Anthony H. Fokker at the controls turned over on landing from its first test flight.

Ten days later real tragedy struck. Noel Davis and Stanton Wooster, making their final heavy load tests at Langley Field, Virginia, crashed on takeoff. Both were killed. It was to have been their last load test before the flight to Paris.

In San Diego on that day, April 28, Lindbergh was about to begin test flights of his Ryan monoplane. This item stirred little interest at Curtiss and Roosevelt Fields and at Teterboro where rapid progress was reported on the repairs on Byrd's *America*.

The Bellanca monoplane and Chamberlin were the center of interest there. The duration record had made this aircraft famous and daily the number of visitors increased. And how they asked questions! One stands out in my memory. An elderly lady asked Chamberlin what happened if an airplane ran out of fuel while up there in the sky. The pilot looked at her for a moment and then replied, "Ma'am, that is one of the tragedies of aviation. The good Lord only knows how many pilots are up there, out of gas and unable to get back to land!"

One record begets another and the press was alert. One wire service, in a widely published dispatch from somewhere in the west, disclosed that a versatile pilot had established a new "world's record for consecutive ground loops." I asked Chamberlin about that one and he said it was not hard to do provided the landing gear held up.

In Paris, interest in the race was building up. Pilots Nungesser and Coli and their "White Bird" were ready for the east to west attempt, waiting only for favorable weather. Plans for the Bellanca flight were uncertain. Charles A. Levine, who had purchased the plane from the Wright Company, disclosed that he had not decided on a pilot. It might be either Chamberlin or Acosta or maybe someone else! When Acosta joined the Byrd expedition, Levine retained Lloyd Bertaud, a veteran air mail pilot, with whom he quickly reached a disagreement resulting in a legal action which tied the Bellanca to the ground — a sadly frustrating delay.

The April days slipped by. At Teterboro, the *America* was nearly ready. May arrived. In addition to the flying fields, New York reporters began to cover the weather bureau atop the Whitehall building near the Battery where Dr. James H. Kimball made weather maps, explained about isobars and millibars and fronts and prevailing winds along the great circle course over the Atlantic.

On May 8, the gallant Frenchmen, Nungesser and Coli, took off in their "White Bird," climbing slowly and heavily into the west.

"Due in New York tomorrow" the headlines of May 9 proclaimed; but tomorrow brought no sign of the "White Bird," only wishful and scattered rumors. Two more brave men had sought a path into the unknown and had paid with their lives.

But others were moving to find the path. At Curtiss Field on the morning of May 10 litigation still held the Bellanca to its hangar. A steam roller chugged slowly back and forth to smooth and harden the makeshift runway at Roosevelt Field adjoining Curtiss. At Teterboro mechanics were completing final details on Commander Byrd's *America*.

In San Diego there was more significant activity. News flashed across the country in time for the late evening editions that Lindbergh, a captain in the Missouri National Guard, was in the air on his way non-stop to St. Louis, en route to Roosevelt Field! His Ryan monoplane had become the *Spirit of St. Louis*, a name symbolic of the city where the flight was conceived; the name has been beloved and revered in France for six centuries. In fourteen and a half hours, his wheels touched at Lambert Field, St. Louis. The next afternoon sightseers and newsmen gathered at Roosevelt and Curtiss Fields to welcome Byrd's *America* were startled to see the silver-grey *Spirit of St. Louis* circling for a landing.

Under Casey Jones' supervision, the plane was wheeled into a hangar and the tall boyish pilot was ready for questions. Within an hour those of us close enough realized that this was no foolhardy stunt with a Hollywood background. Here was an airplane constructed for one purpose: To fly the ocean. It was blind; the big gas tank obscured all straight ahead vision. A simple wicker porch-type chair, cushioned for greater comfort, finally convinced us all that Lindbergh planned to fly alone. His only forward view was through two small windows in the fabric covered doors on each side of the cockpit. A small portable periscope, constructed by the Ryan people, helped to protect the pilot's eyes and face from weather and slip stream.

In an interview, Lindbergh said he would navigate by dead reckoning. His fuel consumption, indicated by his record-breaking flight across the country, would be less than 15 gallons an hour. Yes, he felt he had plenty of range. Yes, he was confident he would keep awake.

There was no uncertainty about Lindbergh's plans and actions. The next morning, May 13, he walked across to Roosevelt Field, paced off and studied the runway. He visited Dr. Kimball at the weather bureau. He thanked Commander Byrd for his quick offer of the runway.

That rainy evening of May 19, there were lights in the hangar around the *Spirit of St. Louis;* men were putting fuel in the big tank. A few doors away there were lights in the Bellanca hangar where Ed Mulligan of the Wright Company was making final adjustments to the Whirlwind engine. A check of the Garden City Hotel disclosed that Lindbergh had gone to bed. Clouds were low and there was still a drizzle which was slacking off a bit. Johnnie Frogge, Long Island correspondent for the *New York Times,* kept his vigil at the hotel while others, including this reporter, moved restlessly between Curtiss Field and the hotel.

It was still raining long before daylight when Lindbergh came down the stairs into the lobby and walked onto the stone porch. He looked up at the forbidding clouds and the dripping trees.

"Are you going this morning, Captain?" Frogge asked him. He did not answer immediately, but finally said, "I don't know."

There was a chance of catching the last edition and Frogge asked, "When will you know?" The pilot answered again with more emphasis, "I don't know."

The weary and exciting night turned grey. There was no sunlight in the east, just grey and white low clouds. A truck towed the *Spirit of St. Louis* across Curtiss Field, up the muddy slope to adjacent Roosevelt Field. The slight wind had shifted from east to west, an augury for fair weather but an added hazard for the west to east takeoff. More fuel, a lot more, was added, strained slowly through chamois.

The growing crowds spread along the field, kept well back from the runway. A small group pressed about the plane: Veteran pilots who were flying men when Lindbergh was in grade school; officers from Mitchel Field who had been his classmates in cadet days in Texas; Chamberlin and Giuseppi Bellanca, their own plane still immobilized by an injunction although loaded and ready to fly. All were tense and silent. Commander Byrd ran from his hangar with a last minute weather forecast to thrust into Lindbergh's hand. Clad in his air mail flying suit Lindbergh climbed in, fastened the door. Ken Boedecker spun the propeller slowly against the cold Whirlwind's compression. The engine caught and for a few minutes Lindbergh alternately opened and closed the throttle, his head almost out the window as he studied the wet heavy runway. At its far end stood the steam roller.

C. B. Allen had started walking swiftly down the field along side the flier's intended path and I ran to join him. We stopped near the steam roller close to the end of the runway. If the *Spirit of St. Louis* failed to get off it would be at this point or near it that help would be needed, if there could be any help. But the silver monoplane did get off, starting slowly, gaining speed with men pushing on the struts, bouncing once and then twice through puddles, then holding the air and climbing sluggishly a few feet off the ground. It appeared to clear the steam roller — and the two tense reporters crouched behind it — by five or ten feet, roared just above the low telephone wires at the end of the field, dropped perceptibly as the pilot sought more flying speed and disappeared behind the rolling wooded slopes to the east.

As the flight progressed, excitement increased both

here and abroad. That evening in New York at Yankee Stadium where 40,000 noisy fans were watching the Sharkey-Mahoney heavyweight fight, it was announced between rounds that the *Spirit of St. Louis* had appeared over St. Johns, Newfoundland, and was "now 300 miles at sea" and going strong; and the 40,000 stood with bared heads in silent prayer for Lindbergh's safe arrival.

There were about a thousand people at Roosevelt Field that morning for the takeoff. A hundred thousand broke down fences, pushed aside the police and a regiment of soldiers the next night at Le Bourget in France. The French were conscious of a proud tradition as they cheered Lindbergh's arrival and honored him in the hectic days that followed. France, after all, is the birthplace of man's flight. Pilatre de Rozier rose 84 feet at Paris in a Montgolfier hot air balloon 144 years before the *Spirit of St. Louis* crossed the Atlantic.

The Wright brothers had been cordially received and appreciated in France before this country had awakened to the significance of their achievement, and Wilbur was setting world's records at Le Mans in front of cheering thousands while Orville was still trying to sell the U. S. government his first airplane.

Those Le Mans days were less than two decades before the flights of 1927 and only five years after the Wrights made their first flight from Kitty Hawk. There has never been anything static about this industry.

The extraordinary achievement of Lindbergh and the *Spirit of St. Louis,* followed within a fortnight by Chamberlin's brilliant flight to Germany with a passenger aboard his Bellanca, provided dramatic illustrations of how dynamic this industry already had become. Now millions instead of a thousand or so realized that aviation had become a force, not a promise.

In the preface to his vivid story, "The Spirit of St. Louis," Lindbergh in a single sentence defined aviation as it appeared to him forty years ago:

"When the *Spirit of St. Louis* flew to Paris, aviation was shouldering its way from the stage of invention onto the stage of usefulness."

Today that "stage of usefulness" is deeper and wider and continues to find places for broad shoulders.

Air Travel –

Going Your Way

Spectacular as was the first flight of the Wright brothers, its full significance was both lost to and largely ignored by the world. Interest in aviation grew slowly in the years immediately following. The exploits of Louis Blériot as he flew across the English Channel in 1909, the 1911 transcontinental flight of Cal Rodgers in "84 days and 15 crashes," and the World War I heroics of Rickenbacker, René Fonck and von Richthofen, all contributed to the growing realization that man had indeed mastered the mysteries of flight.

All remaining doubts were finally dispelled with the electrifying exploit of Charles Lindbergh. The result was a loosening by investors of their pocketbooks, causing such an unprecedented boom that aviation was catapulted into a new era.

In the year following Lindbergh's epochal flight, 4,500 airplanes, an astonishing number, were in commercial use. Airlines doubled their flying mileage, trebled the amount of mail carried and hauled four times as many passengers. Individual airplane registration jumped from hundreds to thousands. New manufacturing companies were formed with the quick influx of capital. Established manufacturers added new divisions. Cities that maintained airports rose from a hundred or so to about a thousand.

By the end of 1928 the Department of Commerce reported the existence of 15,128 miles of airways, two-thirds of them employing beacon light night navigational aids. There were no less than 32 airlines operating, but because carrying mail brought in so much more revenue than did the transport of passengers, few of the contractors bothered to install seats in their planes. In fact, most of the planes were inadequate for passenger service, and it was only with the prodding of the government that most airlines became, in time, capable of handling people as well as mail bags.

In 1934 President Roosevelt canceled all the contracts and ordered the Army Air Corps to haul the mail. The outcome was chaos for the airlines. Most continued to fly passengers and express on curtailed schedules, but without air mail pay, flights were ruinously expensive. The administration relented and threw open the old routes for bid. When the new contracts had been awarded the nation had an air transportation system with a new look.

The basic route pattern established in the U. S. in

1934 has changed little; the airline map drawn in 1934 remains the skeleton of the broader service available today. But the new look derived as much from the nature of new and available aircraft as it did from the new route structure.

The first of the modern transport aircraft began to appear on the nation's airways in 1933 and within a few years the domestic airlines were standardizing their flight equipment. In comparison with the lumbering grace of their forerunners, they looked compact, racy and powerful. The Boeing 247, the Lockheed Electra, the Douglas DC-2 and the phenomenally popular follow-on Douglas DC-3, were all low-wing monoplanes, completely equipped for instrument flying, and powered with two radial engines faired into the wing leading edge. They brought to air transportation speed and durability as well as new standards of safety and comfort for passengers and crews.

These developments and many more that were to follow to the outset of World War II had a cumulative effect on airplane design and airline operating practices. Each new model brought not only greater safety and speed to the nation's airways but a high degree of efficiency and, therefore, of economy to the airlines.

With the cessation of hostilities in 1945, the number of planes in daily use by domestic airlines soon reached a total of 411, as compared with the pre-Pearl Harbor peak of 359, with scores more in process of reconversion and other new models coming off the production lines. The U. S. overseas fleet totalled an additional 107 planes. But the aircraft were still insufficient to handle the steadily increasing demand for seats.

The immediate post-war years of commercial aviation can be described as "explosive." The pent-up demands of people to travel could now be realized and they took advantage of the opportunities for mobility that airlines offered. Air travel had entered the important era of mass transportation.

Before the war, only five four-engine commercial planes had been flown over domestic routes, and these were purchased by the Army in 1941 as a preparedness measure. War's end threw wide open two major sources of transport airplanes: the airplane manufacturing industry and the pool of war surplus aircraft. By 1946 most trunk airlines, though still dependent on the DC-3, began modernizing their fleets with larger capacity and speedier DC-4s. Meanwhile, the manufacturers were turning out the four-engine Douglas DC-6s and Lockheed Constellations, and the twin-engine Martins and Convairs, significant advancements over the DC-3. In standard airline service they carried almost three times the number of passengers and in non-scheduled airlines and air coach services they could hold more. They cruised in the vicinity of 250-300 miles an hour as opposed to 180 for the DC-3. But most importantly they offered operating economies far in excess of the pre-war transports.

The net result was that the entire character of America's domestic and international travel habits underwent a drastic change.

With the DC-3 as their standard airliner, pre-war airlines accounted for only three percent of intercity passenger traffic handled by common carrier. Following the introduction of the larger and more efficient post-World War II aircraft, domestic airlines accounted for 17 percent of intercity passenger miles — for the first time exceeding first-class rail travel.

Airline traffic in the U. S. passed the total for intercity buses in 1955, all railroad travel in 1957 and the total for railroads and intercity buses combined in 1963.

But speed and decreasing travel costs were not the only things that attracted the air traveller. There were creature comforts and safety features which the traveller, long accustomed to the pre-war slow and spartan air travel, found inviting. For overnight hops, he could choose varying combinations of staterooms, berths, and reclining seats. These were pressurized cabins to maintain ground level conditions at "over-the-weather" heights. Windows were larger and better arranged for panoramic viewing. Some of the larger planes had double decks, speeding loading and unloading of express, mail and baggage.

Safety and reliability were enhanced by scientific advances such as radar, the radio altimeter, the gyro synchronized compass, long range navigation systems, a vastly improved system of weather reporting, and an advanced, radio-aided airway traffic control.

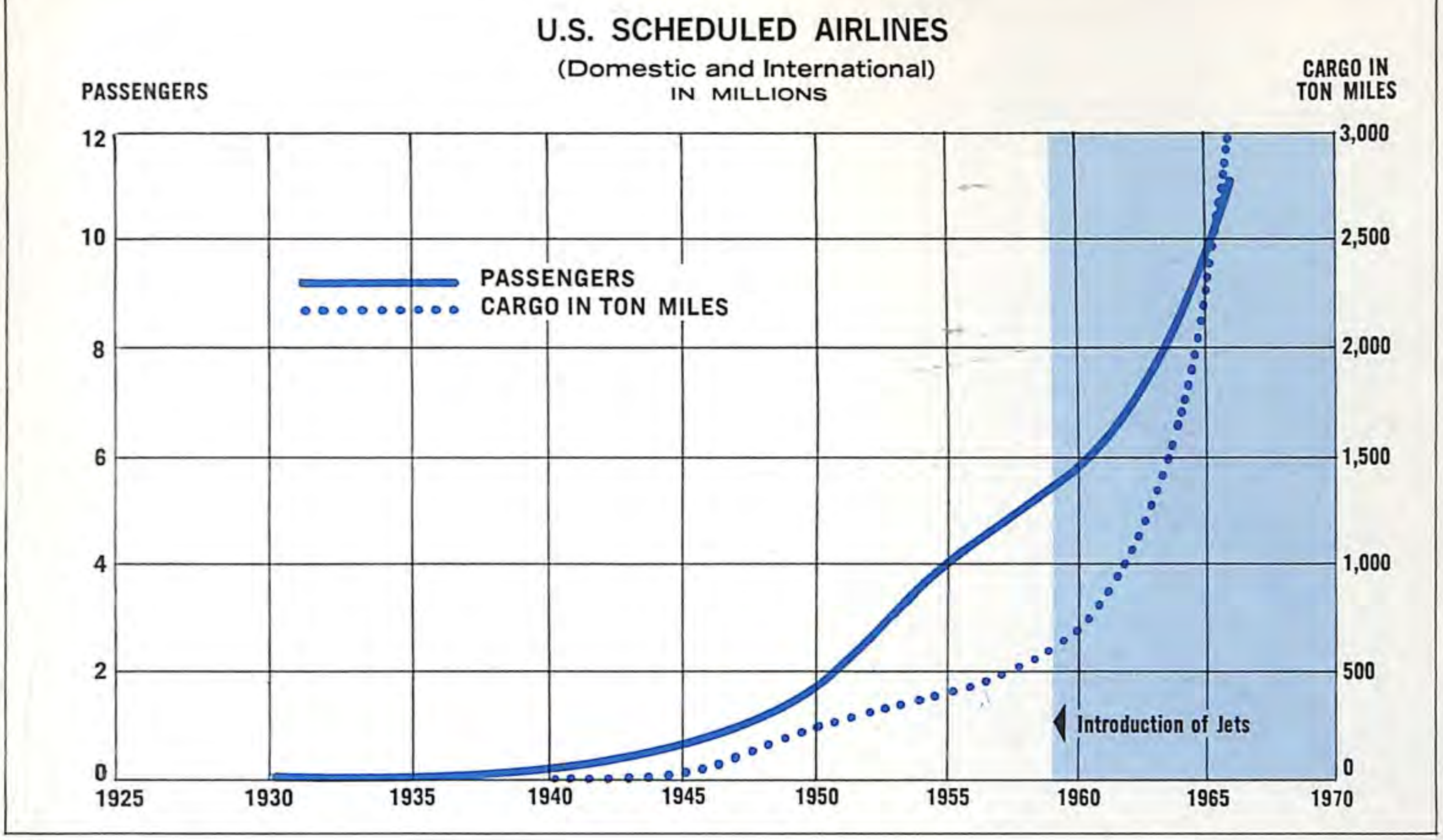
Beginning in 1945, the feeder airlines were developing to serve the smaller communities of the country. They linked, by the early 1950s, more than 350 localities with major U. S. and foreign centers.

So ended the first 50 years of powered flight. American aviation spent little time looking at the past; airline operators and manufacturers were already planning for the "jet-age." Enormous amounts of aeronautical research in high-speed flight technology had been carried out. Not only had the plane itself, and the power plants, been placed under the most detailed scrutiny, but so too were examined all of the supporting facilities that were to be needed when the speedier craft went into regular service.

Several times in U. S. history new technology has precipitated extraordinary periods of change, dramatically changing the life of the nation.

In 1810, only one million people lived west of the Allegheny Mountains, but by mid-century, this population had multiplied 15 times. The development of the river steamboat is largely credited with this upsurge. Westward migration started by the steamboats was greatly expanded by the railroads, which, between 1850 and 1870, quintupled their mileage. By the 1920s the automobile had made a major impact, enlarging the family's cruising range from four miles to 50. In that decade, surfaced mileage of highways in the nation doubled. Since then the automobile has vastly changed the entire economy, not only in the U. S., but throughout the world.

The dramatic upsurge in air travel suggests still further and far reaching changes in American life. Jet travel — a few hours to anywhere — further stimulates the age old human drive for the new and the different. For a New Yorker, a week-end in Paris or London or Mexico City is now no more difficult than a week-end in Chicago or New Orleans. On a typical day more than



300,000 persons board commercial airliners in the U. S.

The age of jet travel on U. S. airlines started late in 1958 with the first transatlantic flight in Boeing 707s. Douglas DC-8s entered service the following year. Improved and specialized versions of these four-engined aircraft have since been developed. Meanwhile, smaller jet planes designed for shorter trips have come into service in increasing numbers. These aircraft, with their greater speed and convenience, have generated a travel demand undreamed of a few years ago. Today the U. S. airline industry ranks among the fastest growing sectors of the world economy.

In the United States, domestic scheduled airlines carried 110 million passengers in 1966 with more than 90 percent being flown in jet-powered aircraft. This was 16 percent more than the previous year and well over double the number in 1958, the last year before jet service cut transcontinental flying time by almost one-half.

Scarcely a month goes by without news of a U. S. or foreign airline contracting for more jet planes. The flow of orders shows no sign of diminishing. On the contrary, it is likely to accelerate in the decade ahead as the "jumbo" and supersonic jets, for which orders are beginning to pile up, come on the scene.

As in the case of passenger traffic, it was the arrival of the jet aircraft that has provided the greatest stimulus to air cargo. Since November 7, 1910, with the first air express shipment (70 pounds of silk air-shipped for a distance of 58.3 miles), improvements in capacity and quality of service have continued to provide a major stimulation for the growth of air cargo traffic.

In 1960, U. S. airlines operated one turboprop and 179 piston-powered cargo aircraft with a total capacity for about 2.5 million ton-miles of cargo service a day at home and abroad.

By the end of 1966 this fleet consisted of 96 jets capable of all-cargo service in addition to 25 turboprops and 89 piston-powered aircraft. Assuming maximum loads and average utilization, this fleet was able to increase its cargo service capability six-fold. On the basis of current orders for an additional 163 jet cargo aircraft, America's daily domestic and international air cargo capacity in 1970 will be almost tripled.

A substantial portion of air freight business still comes from high priority and perishable commodities. But, more and more, manufacturers, wholesalers and retailers find that expensive warehousing and large inventories can be greatly reduced or entirely eliminated by use of air freight.

Air transport is going to have an increasing impact upon both the individual as well as the pattern of location of new production facilities. The availability of rapid transit by air to any part of the nation or globe will enable business firms to expand their market areas more readily. Distances will be measured more meaningfully in the future in air time rather than miles.

Tri-motors carried passengers coast to coast in 28 hours in 1929. In the late '30s this trip took 16 hours, compared with at least 60 hours by train. The first nonstop transcontinental flights in DC-7s, starting in 1953, took eight hours. With the introduction of the jets, this time was cut to five hours. Supersonic transports (SSTs) will halve this schedule a decade or so hence.

It is frequently said that the first doubling of man's scientific knowledge occurred in 1750, the second in 1900, the third in 1950 and the fourth ten years later. These dates roughly correspond to new advances in transportation — the steam engine and trains and boats, the internal combustion engine for autos, the airplane and jet power. The worth of travel consistently shows up in the long story of human adventure and as the catalyst of human progress.

General and VTOL Aircraft – HIGH AND RISING

The routine acceptance of trans-ocean travel in general aviation airplanes tells the story of growth since that May morning 40 years ago when *The Spirit of St. Louis* slowly moved into the murky sky over Long Island. Today, general aviation — non-airline — aircraft cross the North Atlantic an average of a flight a day.

Lindbergh's departure was one year to the day after President Calvin Coolidge signed the first Air Commerce Act into law. This Act instructed the Secretary of Commerce to foster air commerce; designate and establish airways; establish, operate and maintain aids to air navigation; license pilots; and certificate airplanes and investigate accidents.

With 234 people and a budget of $550,000, the Aeronautics Branch of the Department of Commerce began the establishment of facilities on which the promising infant industry could strengthen and grow.

Lindbergh's dramatic flight triggered the first wave of broad public enthusiasm for private flight. But the need for swift, distant travel did not exist, and the frail aircraft were more conducive to daredevil antics than to dependable transportation.

There were a few hardy individuals who persisted. But as long as twelve years after Lindbergh took his general aviation airplane to Paris, the first official count of civil airplanes in the United States showed only 13,000.

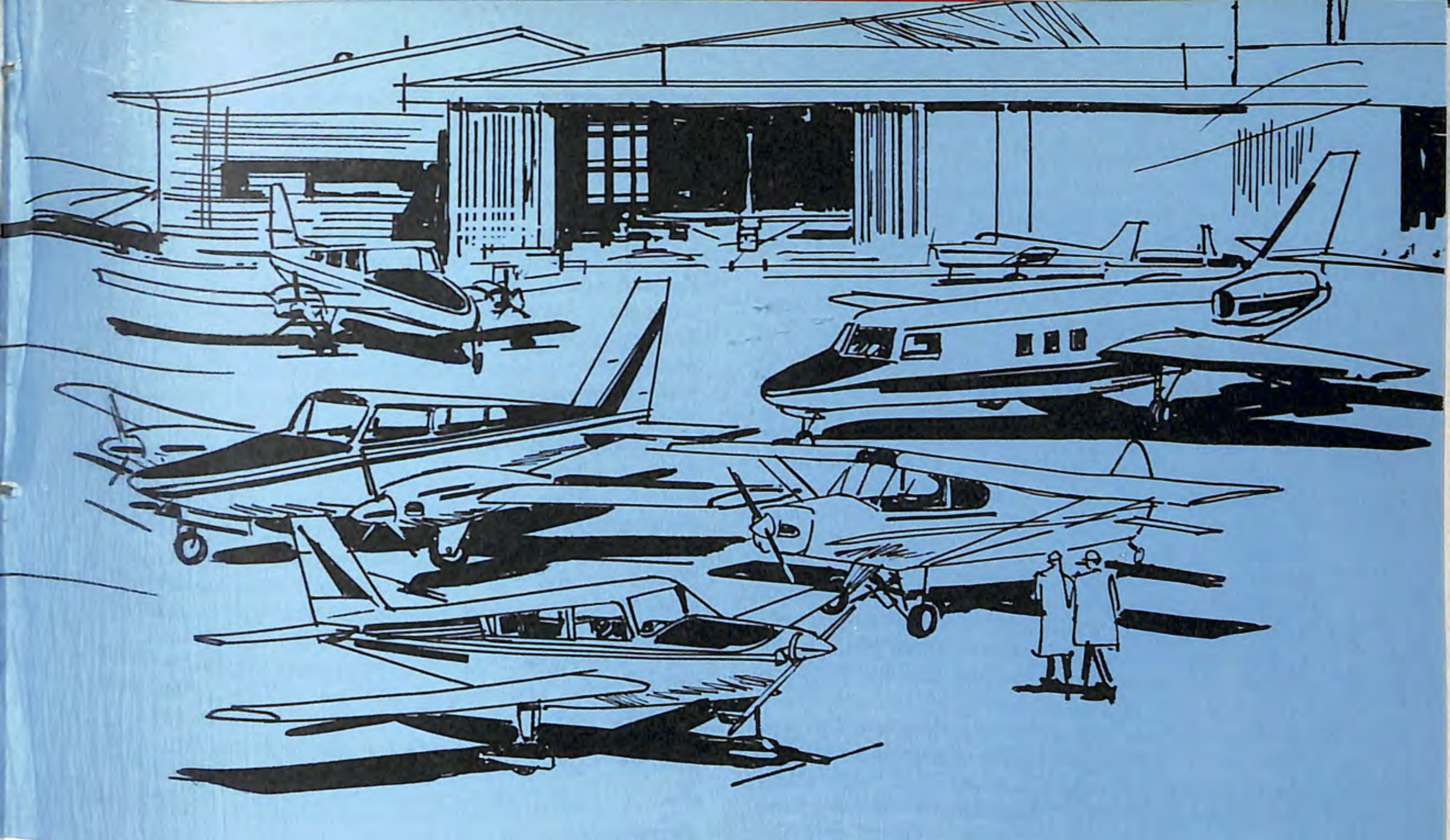
It was in this same year — 1939 — that the Civilian Pilot Training program began with the ambitious goal of training 11,000 new pilots a year. (Today, without this artificial stimulus of government assistance, new civilian pilots are being trained at the rate of nearly 11,000 every *month.*)

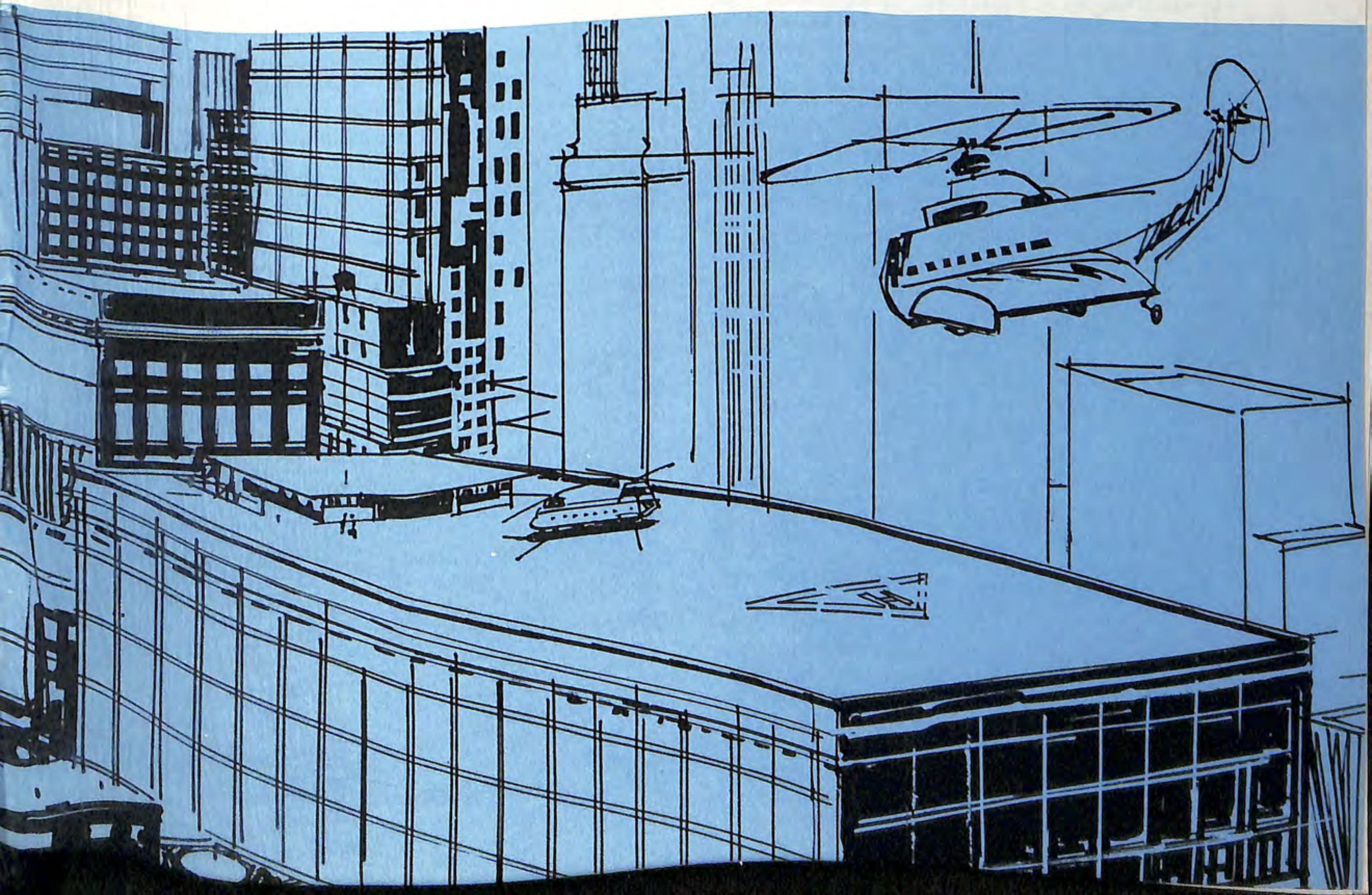
After World War II, general aviation in the United States experienced its second wave of growth. With thousands of young men discharged as experienced pilots, some prophets again predicted a fantastic growth in air travel. These predictions, however, ignored the fact that most of these young pilots would return home, finish their educations, find jobs and raise families. It also ignored the hard fact that to many of these pilots, flying an airplane carried with it the memory of combat.

But there were those who persisted. They built small airports. They eked out a livelihood by giving sightseeing rides and instructing the handfuls of students.

While these men and women with the love of flying nurtured general aviation, there were two other influences that were destined to come together in the 1960s. Manufacturers were designing, engineering and building improved products, and economic and social advances were demanding swifter, more flexible transportation methods.

General aviation today is in its third wave of growth. These airplanes have become more than just vehicles





that fly. They compress the time of businessmen, they spread the talents of teachers, and multiply the mercies of doctors.

In the United States today, there are more than 9,500 airports used by 100,000 general aviation airplanes. At 302 of these airports, where traffic control towers are maintained, general aviation airplanes last year made more than 35,000,000 takeoffs and landings. There is no way to measure the millions of flights made at the airports without towers. Three out of every four flights at the 302 airports with towers are made by general aviation airplanes. The remaining one-fourth are made by the airlines and the military.

Every week the general aviation industry of the United States delivers about 300 new airplanes. These are not only going into service in the United States, but are also bringing the benefits of air travel to people throughout the world. Last year, 2,903 U.S.-made general aviation airplanes were exported to 70 nations. Exports of general aviation aircraft in the last two years have numbered almost as many airplanes as the total fleets operated by all the scheduled airlines of the world, except the U.S.S.R. and the Peoples Republic of China, for which figures are not available.

These airplanes are used for everything from spraying cotton in the Sudan to rushing medical aid to the outback country of Australia.

One two-hour flight in Africa surveyed water sources and irrigation opportunities over 180 miles of river-bed, a job which would have required one month of ground tracking.

In South America, a plantation operator moves his freshly picked coffee beans from mountain top grove to city market in 45 minutes by air instead of three days by burro.

A single-engine airplane in Brazil carries 7,000 baby chicks per load from hatchery to outlying farms.

These practical applications of the airplane as a working vehicle as well as a swift transport vehicle are found wherever general aviation airplanes fly.

Aviation in the United States is growing so rapidly that its very success is the fountainhead of its problems. Airports are acutely crowded. All levels of workers are in short supply. But the problems of growth are the result of solving bigger, more serious problems of living. The general aviation airplane has become important not for what it is but for what it does.

Seven years ago, a test stand of timber was fertilized by air. This experimental plot grew 30 percent faster than unfertilized trees nearby. The airplane could in this way shave 20 years off the normal 60-year harvest time for Douglas fir trees and help to fulfill the constantly increasing demand for lumber.

While time is important to growing trees, it is equally important to the businessman who realizes that going slow can mean going broke. One U. S. business firm, before committing itself to the purchase of its own airplane, analyzed its business travel and found that in the case of one city frequently visited by its executives, the company's airplane could save 29 hours and 30 minutes over a comparable round trip by commercial airline. In this day of excellent scheduled air transportation — when continents and oceans are crossed in five to eight hours — such an advantage of private air travel seems incredible. But in this example, use of regular airline service required an overnight stay because of the scarcity of schedules.

The economic facts of scheduled airline transportation dictate concentration of service where the bulk of the passengers are found. General aviation fills the gap so that today's businessman can schedule his own time to full advantage. The whole nation, and in fact large parts of the world, can now be reached by the businessman or the vacationer on his own schedule in his own airplane.

As important as general aviation is today, and promises to be tomorrow to the economic and social development of the United States, it doesn't approach the dramatic effects it can still have on other parts of the world. Those developing nations now emerging particularly find the general aviation airplane the pioneer vehicle in developing resources and advancing growth.

A single airplane suddenly opens many remote areas to commerce and brings many cultures into frequent contact.

In short, the general aviation airplane has become a powerful force for progress and peace.

VTOL Aircraft

Twenty-one years ago — March 8, 1946 — the Bell model 47B was granted the world's first commercial helicopter license. Today more than 10,000 military and civil helicopters are operating in more than 80 countries around the world. U. S.-built helicopters are being operated from the DEW line in Canada to the jungles of Borneo, and in temperatures ranging from 50 degrees below zero to 120 degrees Fahrenheit, from sea level to the high altitudes of the Andes and the Alps.

Early in its career the helicopter proved reliable in such routine jobs as power line patrol, crop dusting and spraying, air taxi and rescue. Now the helicopter is demonstrating its unique ability to overcome the age-old barrier of terrain, opening up formerly inaccessible areas. In all parts of the globe, helicopters are penetrating dense jungles, flying over mountains, across rivers and swamps, as well as above the teeming traffic of metropolitan centers.

The Aerospace Industries Association of America's 1966 Directory of Helicopter Operators lists 933 operators flying 2,318 helicopters and 183 helicopter flight schools in the United States and Canada alone.

Thirty-nine models are in current production in the United States ranging from the Gyrodyne QH-50D pilotless drone helicopter to the Sikorsky S-64A flying crane which can carry 67 passengers in the pod slung beneath the crane, and five crew members.

The first helicopter capable of lifting itself and its pilot was built in France by Louis Breguet just over 60 years ago which proved that vertical flight was possible. Spain's Juan de la Cierva, with his development of the autogyro, made an important contribution to vertical flight in the mid-1920s.

In 1909 and 1910, the young engineer Igor Sikorsky experimented with a helicopter but the available engine lacked sufficient power. Thirty years later, Igor Sikorsky, then famed for his multi-engine airplanes and ocean-spanning Flying Clippers, turned once more to the helicopter. By then adequate power plants were available and he developed the VS-300, the first practical helicopter built in the Western Hemisphere, and the first to go into production for the military services.

In 1951, the Kaman Aircraft Corporation pioneered with the first turbine-powered helicopter. Subsequent development of the turbine proved a major breakthrough for the rotary-wing industry. Turbine power has reduced maintenance costs, improved performance and increased speeds and range. For example, speeds now exceed 200 miles per hour and helicopters have flown at more than 36,000 feet.

The scheduled helicopter airlines in Greenland, the United Kingdom and the United States now operate U.S.-built turbine-powered helicopters. In Greenland the helicopter is providing scheduled service to remote and heretofore inaccessible areas. In the United Kingdom the helicopter is providing fast scheduled service from the mainland to the Scilly Isles — formerly a trip of several hours by ship.

Smaller five-place U.S.-built turbine helicopters are now available commercially as executive and company transports.

In 1966, 1,116,000 passengers used the three U. S. scheduled helicopter airlines (Los Angeles Airways, Inc., New York Airways, Inc., and San Francisco & Oakland Helicopter Airlines, Inc.). This 1966 total represents an increase of more than 55 percent over 1965 and testifies to the growing public acceptance of rotary-wing transportation and the increasing demand for airport-to-city-center service. For example, today's travellers to New York City can now go all the way by air. New York Airways offers helicopter service from the three area airports to a heliport on a pier at the foot of Wall Street and to the roof of the Pan Am building in downtown Manhattan. Similar service is available in Los Angeles and San Francisco.

The helicopter has not only proved to be the most versatile aircraft ever developed, it has also proved indispensable as a rescue vehicle. It first had the chance to demonstrate this capability during the Korean conflict where it rescued more than 2,300 United Nations personnel and is credited with reducing substantially the mortality rate among the wounded.

It has been estimated that U.S. helicopters have saved more than 100,000 lives. Military and civilian helicopters combined to rescue more than 2,229 persons stranded by Hurricane Betsy in New Orleans, La., in 1965. During the serious floods in Tampico, Mexico, in 1955, helicopters airlifted 9,262 persons to safety. Thousands more were saved by delivery of medical aid and food to otherwise inaccessible areas.

The helicopter can be used in a variety of ways. It can help to save highway accident victims by flying them from the scene of the accident to hospital heliports. More and more hospitals are now providing either ground or roof areas as heliports. In the United States today there are more than 65 hospital heliports. In the future, helicopters may also lift the crashed car off the highway to prevent traffic tie-ups.

The movie industry uses the helicopter as an ideal flying camera platform for aerial action shots. Geologists use it in oil field exploration both on land and sea. The U. S. Forest Service uses the helicopter to fight forest fires. On the airport, the helicopter is used as a crash truck or fire engine. Construction companies use the helicopter to lift heavy equipment, install television towers and telephone poles. Cargo can be airlifted by helicopter from ship to shore and banks now use helicopters to speed the delivery and processing of checks and drafts. More than 350 corporations in the U. S. and Canada use the helicopter to transport executives between plants and airports. Police in more than 40 U. S. cities use it to direct traffic, track down escaped criminals and for general patrol.

Every year more and more men and women are employed in the research, development, fabrication and operation of the helicopter. In 1966, U. S. helicopter manufacturers employed more than 44,000 in their factories across the country. Production approximated 2,500 vehicles, nearly double the number produced in 1965.

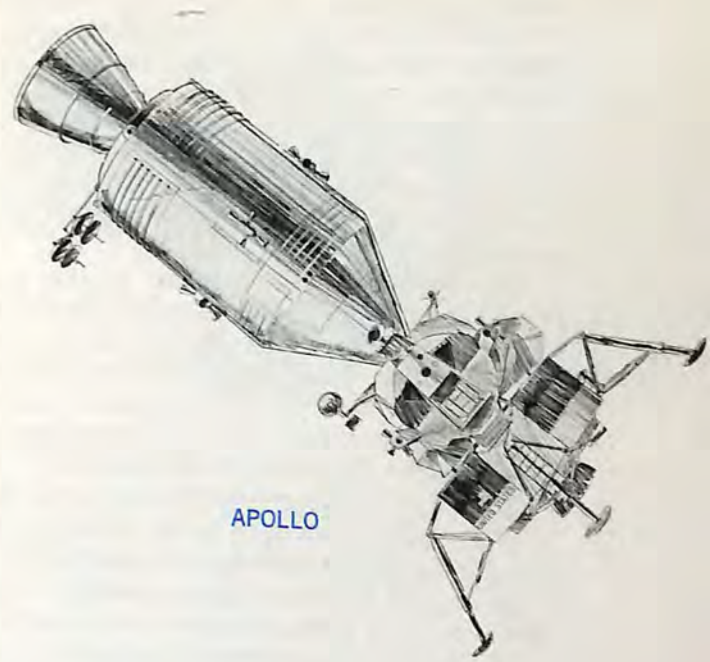
In addition to the turbine helicopters now in operation and production, new designs for helicopters and other types of VTOLs (vertical takeoff and landing) aircraft are being developed. Among these are the rigid rotor, the hot cycle rotor, turbojet, the fan-in-wing, ducted fan, stopped and stowed rotor. These varying concepts are designed to provide extra lift, increased speed and range at lower operating costs. Future transport VTOLs with possible speeds of 350 to 400 miles per hour with significantly more passenger capacity than those helicopters flying today will serve as the short-haul transport serving city-center to city-center.

Space Exploration

Just a summer away is the 10th anniversary of the Space Age, and the approach of such a milestone calls up the question, "What has man accomplished in his first decade of space research and what does it mean to the peoples of the earth?"

The answer is that man has accomplished a succession of scientific and technological miracles that qualify these initial years of the Space Age as the decade most productive in history from the standpoint of elevating the human mode of existence. Technology, spurred from a canter to a gallop by the dictates of space policy, has been able to translate many of the advances into practical benefits for mankind: Systems that operate in space, such as weather and communications satellites, and hundreds of less spectacular but cumulatively important innovations ranging from improved surgical techniques to smoother-shaving razor blades.

These applications of space hardware, together with the corollary products that have emerged from space research, are in themselves partial justification for the effort and funding that have gone into the first decade



APOLLO

THE FUTURE BECKONS

of extraterrestrial exploration. Yet they represent only the visible portion of the iceberg that is the overall benefit to man. In the sub-surface nine-tenths of the berg lies the greatest gain: A new wealth of information about the universe we inhabit and a more rapidly advancing ability to put it to practical use. It is intangible benefit, promise rather than reality, but promise of inevitable fulfillment. From these new volumes in the library of man's accumulated knowledge will come great advances in human life, as surely as earlier volumes brought forth every convenience from the wheel to the telephone.

The United States, which has put up about 70 percent of all the spacecraft launched to date, has naturally borne the greatest expenditures. By the anniversary date of October 4, 1967, the various non-military U.S. space programs will have cost close to $35 billion.

What return has the investment produced? Restoration of prestige to the United States as a technological leader in the world, a prestige which suffered a setback in the early days of the Space Age. The events since have clearly demonstrated that American technology is second to none. Technological capability is a vital factor in the maintenance of free world leadership. No dollar value can be placed on prestige, but since leadership demands the confidence of those who are led, its importance is indisputable.

For the hard-headed realist who seeks more concrete evidence of return on his investment, there are the "applications" spacecraft, those employed for practical rather than purely scientific purposes. It is in this area that the international aspects of space benefit are most apparent.

Geodetic satellites are mapping the earth with a precision never before attainable. Investigations are under way toward employment of navigational satellites as artificial stars for highly accurate position fixing of aircraft plying long, overwater international routes. More than 50 nations have banded together in the International Telecommunications Satellite Consortium to exploit the potential of space-relayed global telephone, telegraph and television transmission.

On the horizon is a new type of "applications" spacecraft, the "earth resources satellite," a tool for cataloging the earth's food, fuel, minerals, timber and water in order that such resources may be more effectively managed to support all the world's people in the face of a continuing population explosion.

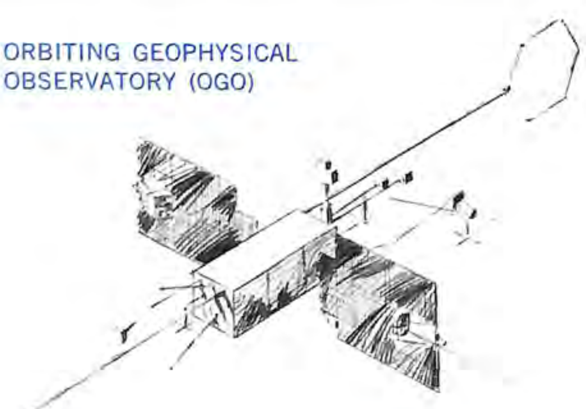
Perhaps the best example of what applied spacecraft can do to improve human life is the weather satellite, pioneered by the National Aeronautics and Space Administration and now employed by the Environmental Science Services Administration of the U.S. Department of Commerce in a global system being utilized by more than 40 nations.

There is no one who cannot benefit in some manner by foreknowledge of the weather. But to many, highly accurate forecasts are vitally important; for instance, those engaged in air transportation or agriculture, sponsors of outdoor events or homeowners in the paths of destructive storms. In the seven years of their existence, weather satellites have clicked off nearly 1,000,000 pictures of the earth's cloud cover and relayed them to meteorologists on earth for preparation of "nephanalyses," graphic weather charts which are sent all over the world. On a great many occasions, they have performed sentinel service of inestimable value. In the Caribbean, the Gulf of Mexico, the Atlantic and Pacific Oceans, they have warned of the approach of hurricanes and typhoons, permitting mass evacuations from the paths of the storms and saving countless lives. Weather satellites have provided monetary savings by reporting ice conditions in the seas and inland waterways; they have foretold the arrival of the monsoon rains which have such far-reaching impact on the food crop of Asia; and in North Africa and Arabia they have alerted the populace to the onset of destructive sandstorms.

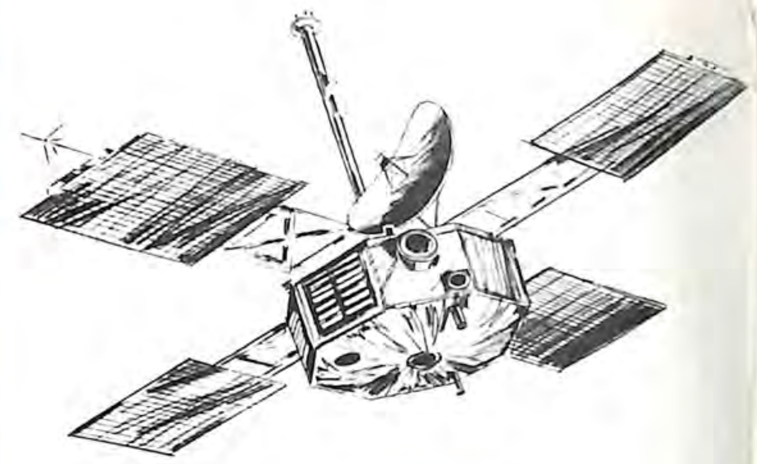
Valuable as it has proved, the weather satellite is still in its infancy. Today it makes possible accurate forecasts up to three, on occasion five days. But in the near-term future there are coming far more advanced spacecraft that together with computers should permit accurate long-range forecasts of one to two weeks. It has been estimated that weather satellites offer a potential savings of $2.5 billion annually in agriculture alone, but with the rapid advances of space technology the estimate is beginning to appear more conservative.

The weather satellite is also an example of how the benefits of U.S. space research are spreading to the rest of the world, in line with the American policy of sharing technology. The early weather satellites required complex, expensive equipment on the ground for the reception of satellite signals and the translation of them into usable cloud-cover photographs. Recognizing this as an obstacle to global usage of the system, the National Aeronautics and Space Administration and its aerospace contractors went to work to simplify the weather reporting network. The result was a system known as Automatic Picture Transmission. Where the early satellites sent television-like pictures, one line at a time, APT sends an entire cloud-cover photo by a process similar to that used to transmit radio photographs. The complete picture appears on a facsimile machine. These pictures can be picked up by ground stations anywhere in the world when a satellite is in range, and the requisite equipment can be purchased for about $5,000, an expenditure well within the means of a developing nation.

The realist can also understand the benefits afforded by the products of "fall-out" or "spin-off," the non-space items that have emerged as bonuses from space



ORBITING GEOPHYSICAL OBSERVATORY (OGO)



MARINER

research. There are not many, however, who realize the magnitude of this fall-out; only a few of the more newsworthy products reach the public view through the news or television media. The bulk of them are too humdrum for public attention. Every month of space research brings a new group of fall-out applications; NASA's latest list numbers more than 1,200 products or techniques that did not exist a decade ago. In the aggregate, they represent a substantial contribution to man's economy and his way of life.

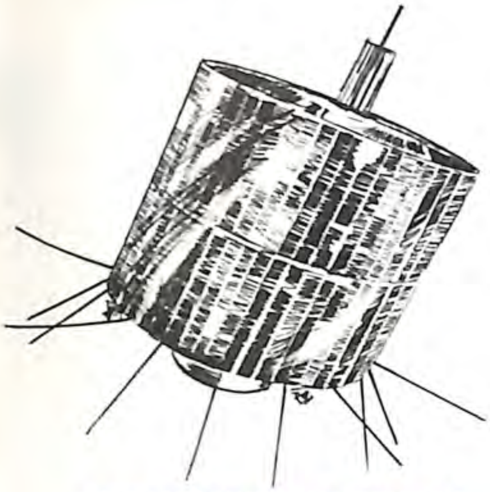
The greatest benefit evolving from a decade of space research, the tremendous new store of scientific knowledge and technological know-how, is not yet widely appreciated because its significance is not readily apparent to those of a pragmatic turn of mind. Of what use, one might ask, is knowledge of the surface of the moon or the atmosphere of Venus, or the know-how that permits man to leave his planet and return to it?

By way of answer, NASA's Deputy Associate Administrator for Sciences, Dr. John E. Naugle, tells the story of electricity. It is difficult if not impossible to imagine anything that has had a more dramatic, sweeping impact on man's way of life than electric power, yet from the standpoint of its practical application it is a relatively recent development, one which came about only after hundreds of years of thought, experiment and compilation of apparently useless information.

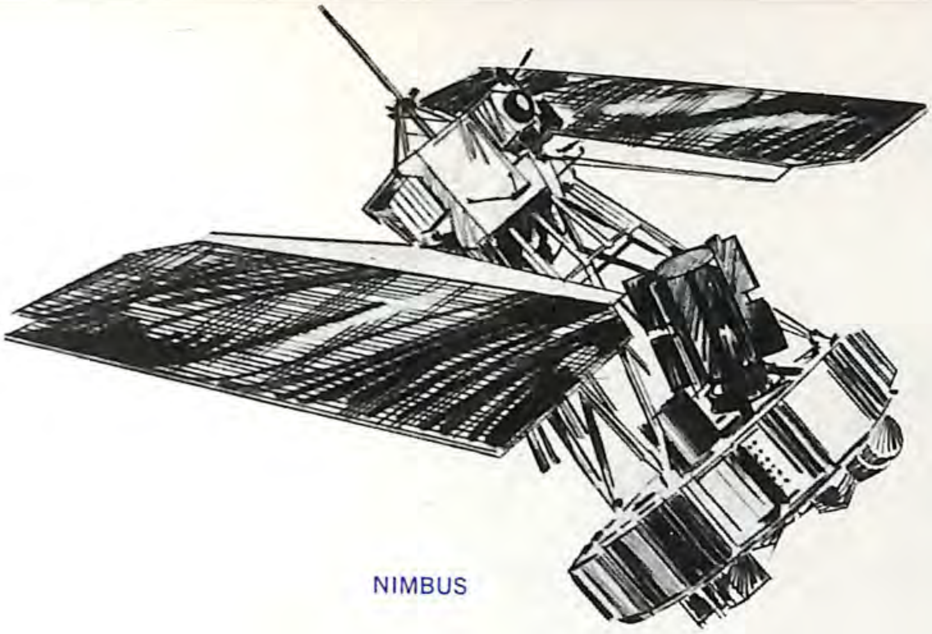
The first recorded experiment on electricity, Dr. Naugle tells us, came some 600 years before Christ, when a Greek philosopher named Thales observed that rubbing a piece of amber over cloth caused it to attract particles.

Over the centuries, hundreds of experimenters contributed bits of information to the growing storehouse of electrical knowledge. About 1830, British scientist Michael Faraday proved that mechanical energy could be converted into electrical energy. Asked in Parliament of what use was his research, Faraday replied, "Some day you will tax it."

But, until the late years of the 19th century, most scientists were not thinking in terms of practical potential; electricity was largely a subject of academic interest. For two and a half millenia man had been



APPLICATIONS TECHNOLOGY
SATELLITE (ATS)



NIMBUS

building a tower of knowledge like an inverted pyramid, each level broader than the one below. Then technology, which had been progressing at an ever-increasing rate, came of age.

Thomas Alva Edison produced the incandescent light bulb, he and Lane Fox in England developed the first public supplies of electricity, Alexander Graham Bell applied it to voice transmission, and Guglielmo Marconi brought forth the telegraph. In the years since, the catalog of electrical applications has grown to telephone-book dimensions, everything from the bevatron to that hyperconvenience of modern existence, the electric can opener.

Space research is building a new pyramid of knowledge, not in one area but in hundreds, not at the leisurely pace of an earlier civilization but at a rate that is incredible even to those most intimately connected with man's greatest endeavor. Each tiny scrap of information about the universe is a minute tile in the vast mosaic of man's knowledge.

The rate at which scientific knowledge is translated into concrete benefit is dependent upon advancing technology. Therein lies the extremely important but little understood contribution of space research: it is *forcing* technology, accelerating it at an ever-more rapid pace.

Before the Space Age, the aerospace industry of the United States had already been forced to a position of world technological preeminence by responding to the extraordinary demands of national defense and modern air transportation. But space introduced a challenge of an entirely new order of magnitude, compounded by a national dictate which required tremendous technological advances within a compressed time span. Some idea of the scope of these advances may be gleaned from this thumbnail resume of space progress:

The first American scientific satellite, Explorer 1, measured six inches in diameter, weighed 31 pounds and carried three experiments. The most advanced, the Orbiting Geophysical Observatory, measures 50 feet with its telescoping booms extended, weighs more than half a ton, carries 200 pounds of experiments, including more than a score of complex instrument systems.

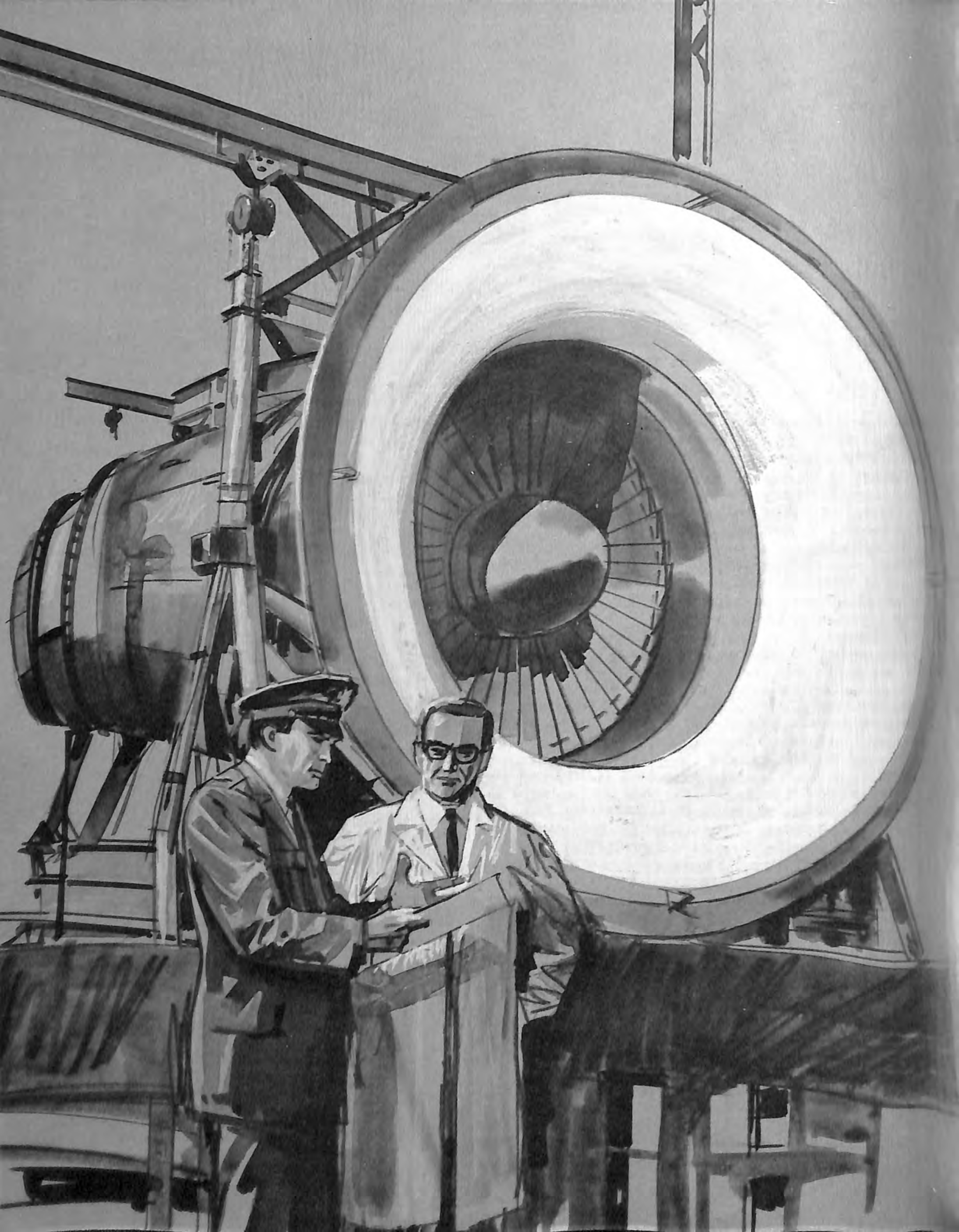
The first U.S. lunar planetary probe, Pioneer 1 of 1958, reached an altitude of 70,000 miles, less than a third of the distance to its target, the moon. Contrast it with last year's Surveyor 1, which not only scored a bull's-eye on the moon but backed down gently to a soft landing, or with Mariner 4, which flew 325,000,000 miles to Mars and returned 21 historic photos of the red planet.

The launch vehicle which sent the first American into space developed 75,000 pounds of thrust. The Saturn V moon booster, six stories taller than the Statue of Liberty, produces exactly 100 times as much power.

After an initial flight of 15 minutes duration, the United States amassed a total of nearly 2,000 man hours of space flight experience in less than six years. The first manned spacecraft, Mercury, carried one man, weighed less than 3,000 pounds, afforded environmental protection for a maximum of three days. Apollo, in its lunar version, weighs some 90,000 pounds; the smallest of its three modules is four times the size of Mercury. The environmental control system can support three men for 14 days, up to 45 days in later versions. One of the most complex inventions of mankind, the spacecraft is capable of flying to the moon under control, orbiting the moon, detaching an excursion "bus" to land two men on the lunar surface, docking with the bus on its return and delivering the crew safely back to earth.

Each of these broad progressions represents not one but several increments of technological advance. For a picture of the scope of technological advance they must be multiplied thousands of times, to include all the other spacecraft, launch vehicles, systems, subsystems, laboratories and test facilities, fabrication tools and techniques and an infinite variety of equipment needed on the ground to keep man in space. It adds up to far more than the ability to build better spacecraft, for the program involves virtually every scientific and technological discipline. The Space Age has advanced American technology on a thousand fronts.

The real achievement of this decade of incredible progress has been the concerted thrust of science and technology into new frontiers.



Military Aviation – PACING PROGRESS

Aviation never has had a reliable prophet. No one ever has been able to forecast accurately just what advances aviation can make in the future.

Mostly the predictions have erred on the conservative side. Even the great aeronautical pioneers, the technical experts, have been unable to judge just how rapid progress will be.

No part of aviation illustrates this inability to forecast better than military aviation. The world of military aviation today is vastly different from what most people thought it would be even a decade ago. The best case in point is the airplane versus missile controversy. At one time it was widely believed that missiles had made airplanes obsolete for military use.

Experience has proven much different. The durability and ruggedness and its capacity to perform a wide variety of missions has made it an integral part of major military forces. Helicopters have joined the airplane as first line equipment, and their usefulness should grow since their speed, range and load carrying ability are rapidly improving.

Certainly no one in 1927 foresaw the wide variety of military aircraft that would be flying 40 years later, the excellence of their performance, or the extent to which they are today employed.

Expectations of a productive future for aviation rose to a new height in 1927, but none of the hopes matched the reality. In that year, European aviation was exceptionally vigorous. U.S. response to this competition produced nine major long distance flights in addition to Lindbergh's epic Atlantic crossing. These 1927 flights to Europe and Asia were unprecedented both in their number and the distance covered.

Technical progress during the decade after World War I was astonishing. Industry in the U.S. and Europe was mastering the vital techniques of lightweight construction by the use of sheet aluminum. The power of piston engines was rising rapidly while their weight was falling. Military and civil transport planes capable of carrying about 20 people for several hundred miles were establishing new records for reliability in daily service. The top speed of fighters had been pushed above 150 mph, more than 50 percent higher than the best of the World War I models. Startling progress in contests such as the Schneider Cup Races, were the speed was close to 250 mph., left no doubt that aviation was rapidly advancing.

In 1927, the expansion program for the U.S. Army Air Corps called for a total of 1,892 airplanes to be in service by 1932, with 59 of these transports capable of moving about 1,000 soldiers at a time. While many aviators did not agree, this was widely considered at the time to be more than an adequate number of military aircraft.

The purchase of these transports started a long term trend in the United States toward an air-mobile army. The trend has not slackened, and has continued to acquire momentum. During World War II and afterwards thousands of light and heavy transports were produced. They have performed vital services in both war and peace.

The first major demonstration of their peacetime effectiveness came during the Berlin Airlift in 1948 when more than 300 four-engined propeller-driven transports from the U.S., Great Britain and other nations supplied the city for months.

Even then, 20 years after Lindbergh's flight, most people failed to realize that air transport was in its infancy. The jet engine, born in Europe, was just coming into use. Many technical experts were pessimistic concerning its prospects of replacing the piston engine in military or commercial service. The jet engine had a very short life between overhauls and consumed prodigious amounts of fuel.

Few technical forecasts have ever been so wrong. The overhaul life of a commercial jet engine has risen to 10,000 hours, about five times that of the best piston engine. Fuel consumption of the new turbofan powerplants is approaching that of the most efficient gasoline engines. Jet transports, beginning in the late-1950s, formed the backbone of the U.S. military airlift.

Now a new, revolutionary era in the long range movement of troops and materiel is beginning. The world's largest transport, the C-5A, is under development for the U.S. Air Force by Lockheed Aircraft Corp. This airplane will weigh more than 700,000 pounds and carry more than 500 troops across the Atlantic at speeds above 500 mph. General Electric Company is developing the very large turbofan engines, of 41,000 pounds thrust, which will power the C-5A.

The work capacity of these new airplanes is prodigious. One can do the job of 20 or more of the four-engined airplanes used in the Berlin Airlift. In other words, about 15 C-5As could have supplied the city in place of the 300 or more aircraft that were employed. Militarily, the C-5A capacity is very important because it can move heavy infantry divisions, including their biggest tanks, by air. Previously only light infantry could be airlifted.

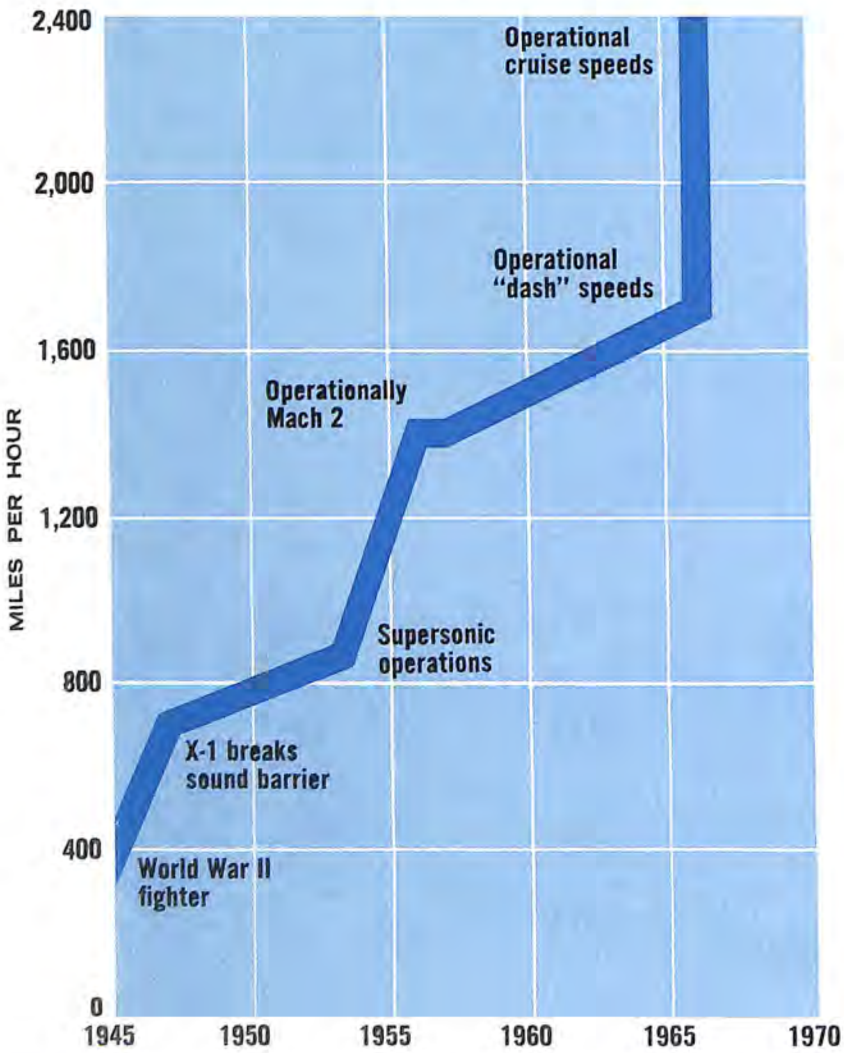
Great strides also are being made in tactical transport of troops, with both helicopters and small wing transports. In some units, trucks and other ground vehicles have all but been eliminated for troop transport in combat operations.

The rotary wing craft range from small two-man models, through heavy transports that carry more men than the Douglas DC-3 principal troop carrier of World War II, on up to Sikorsky S-64A flying cranes that can lift 25,000 lbs. or more. Cruise speeds of more than 200 mph have been achieved by experimental helicopters and the next generation of operational vehicles will perform at this speed — nearly 100 percent faster than most helicopters today.

The performance of fighter and bomber aircraft jumped dramatically at the end of World War II, from about 400 mph or less to around 600 mph, as the jet engine was introduced. Still, there was little understanding of the speed increases that were to take place in the next two decades. A large and respected segment of the aeronautical engineering community in all nations believed a "sound barrier" would prevent manned aircraft from flying faster than about 770 mph.

Capt. Charles Yeager, USAF, by flying supersonically in the Bell X-1 research aircraft in 1947, proved conclusively that the "sound barrier" did not exist.

SPEED INCREASES OF MILITARY AIRCRAFT



Steady technical improvements for the next 20 years have produced fighter and bomber models in several countries that cruise at high subsonic speeds and can "dash" at twice the speed of sound (about 1300 mph) or faster for brief periods. Range and payload of fighters and bombers also have increased rapidly as improved jet engines were brought into service. The most modern fighter-bombers, such as the McDonnell F-4 and the Republic F-105, can carry heavier loads over longer ranges than some World War II heavy bombers.

Several years ago another important aviation milestone was reached. An airplane that doesn't "dash," but *cruises* at supersonic speeds over intercontinental distances was built in the United States by Lockheed. Several new and very difficult problems had to be solved in the development of this airplane, the SR-71, because it cruises above Mach 3 (over 2,000 mph). At such a speed the whole airplane heats up to unprecedented temperatures. The forward portions of its wings, fuselage and empennage glow furnace red at more than 450 degrees Fahrenheit. Conventional aluminum airframe could not withstand such heat. It was necessary to pioneer by using titanium as the primary structural material in an airplane for the first time.

Severe high temperature problems also had to be solved in development of the SR-71's powerplant, the Pratt & Whitney J58. This large turbojet engine was a technical pacesetter in several areas of design.

The SR-71 was followed in flight by the North American XB-70, which also cruises at Mach 3. Both airplanes are important proving grounds for the high temperature technology needed for developing commercial supersonic transports, such as the Concorde now under development by England and France, and the Boeing SST which will be developed in the U.S.

Despite a growing mastery of technology and a record of rapid progress for 40 years, prediction of aviation's future is still risky. Many difficult problems must be solved before operational speeds can be pushed above Mach 3, or supersonic transports become as economical as present subsonic jets, or vertical takeoff and landing airplanes can be brought into wide use, or any of a dozen other goals of modern aviation can be achieved.

Some technical experts are pessimistic about future progress being as rapid as it has been for the past four decades. Other experts feel that this pace can be maintained in the future, and are optimistic.

The air races of the 1920s and 1930s, which pushed speeds up and spawned new technology in Europe and North America, are now out of style. But, experimental flying has taken their place and there still is much room for improvement in operational aviation. The North American X-15, for example, has flown faster than Mach 6 (more than 4000 mph). Aeronautical research is still vigorous in Europe, Japan and North America. Unless the pattern changes completely, the aviation world 40 years from now, in 2007, will be as different from today, as the aviation world of young Charles Lindbergh was in 1927.

'IN THE SPIRIT OF LINDBERGH'

United States participation in the Paris Aeronautical and Space Show this year reaffirms American recognition of French and other European pioneers who influenced U.S. efforts in the early days of aviation.

Since its inauguration, the event has been a central force in international cooperation in aviation and the United States is making a special effort to continue that tradition in the advancement of flight technology.

The United States has been a contributor to the Paris exhibition since the first show in the Grand Palais in 1909, when the star attraction was the aircraft flown that year by Louis Blériot across the English Channel from Calais to Dover — the first overwater flight in history.

Theme of the U.S. exhibition, "In the Spirit of Lindbergh," commemorates Charles A. Lindbergh's historic non-stop flight from New York to Le Bourget Airport on May 20-21, 1927, and salutes the contributions of the French and other nationalities in aviation and aerospace history.

The replica of Lindbergh's plane, "The Spirit of St. Louis," was specially built in Santa Ana, California, for this homecoming to Paris and for its display in the scale model of the 640-foot "Gateway to the West" arch in St. Louis, Missouri.

The objective of the U.S. exhibition is to portray United States posture in aerospace by presenting:

- Achievements in the field of aerospace from the time of Lindbergh's flight to the present, with a projection of things to come in the next 40 years.
- U.S. contributions to international cooperation in aerospace developments and activities, including: Reciprocal flight privileges and services; exchange of flight research, development and testing data; and joint use of communications and environmental satellites and launching facilities.

The U.S. Pavilion represents the joint efforts of the aerospace industry of the United States and U.S. government agencies, under the sponsorship and coordination of the U.S. Department of Commerce, which first became concerned with the development of civil aviation one year before the Lindbergh flight.

The U.S. Pavilion dramatizes worldwide achievements in the air over the 40-year period through the individual exhibits of U.S. companies and agencies.

The United States exhibition provides the aerospace industry of other nations an opportunity to use the latest U.S. equipment, and nearly three-quarters of the U.S. Pavilion directly recognizes the rapidly increasing public interest in the civilian uses of aerospace technology.

The smaller commercial section of the U.S. Pavilion shows products by U.S. manufacturers of aerospace components and ground support equipment. (Admission to the commercial section is limited to viewers with business interests.)

AIA MANUFACTURING MEMBERS

Abex Corporation
Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Aeronutronic Division, Philco-Ford Corporation
Aluminum Company of America
Avco Corporation
Beech Aircraft Corporation
Bell Aerospace Corporation
The Bendix Corporation
The Boeing Company
Cessna Aircraft Company
Chandler Evans, Inc.
  Control Systems Division of
  Colt Industries, Inc.
Continental Motors Corporation
Cook Electric Company
Curtiss-Wright Corporation
Douglas Aircraft Company, Inc.
Fairchild Hiller Corporation
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Defense Electronics Division
  Flight Propulsion Division
  Missile & Space Division
  Defense Programs Division
General Laboratory Associates, Inc.
General Motors Corporation
  Allison Division
General Precision, Inc.
The B. F. Goodrich Company
Goodyear Aerospace Corporation
Grumman Aircraft Engineering Corp.
Gyrodyne Company of America, Inc.
Harvey Aluminum, Inc.
Hercules Incorporated
Honeywell Inc.
Hughes Aircraft Company
IBM Corporation
  Federal Systems Division
International Telephone & Telegraph Corp.
  ITT Federal Laboratories
  ITT Gilfillan, Inc.
Kaiser Aerospace & Electronics Corporation
Kaman Corporation
Kollsman Instrument Corporation
Lear Jet Industries, Inc.
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Marietta Corporation
McDonnell Company
Menasco Manufacturing Company
North American Aviation, Inc.
Northrop Corporation
Pacific Airmotive Corporation
Piper Aircraft Corporation
PneumoDynamics Corporation
Radio Corporation of America
  Defense Electronic Products
Rockwell-Standard Corp.
  Aircraft Divisions
Rohr Corporation
Ryan Aeronautical Company
Solar, Division of International
  Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company
  Sperry Phoenix Company
Sundstrand Aviation, Division of
  Sundstrand Corporation
Thiokol Chemical Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory
  Marine Division

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

RETURN REQUESTED

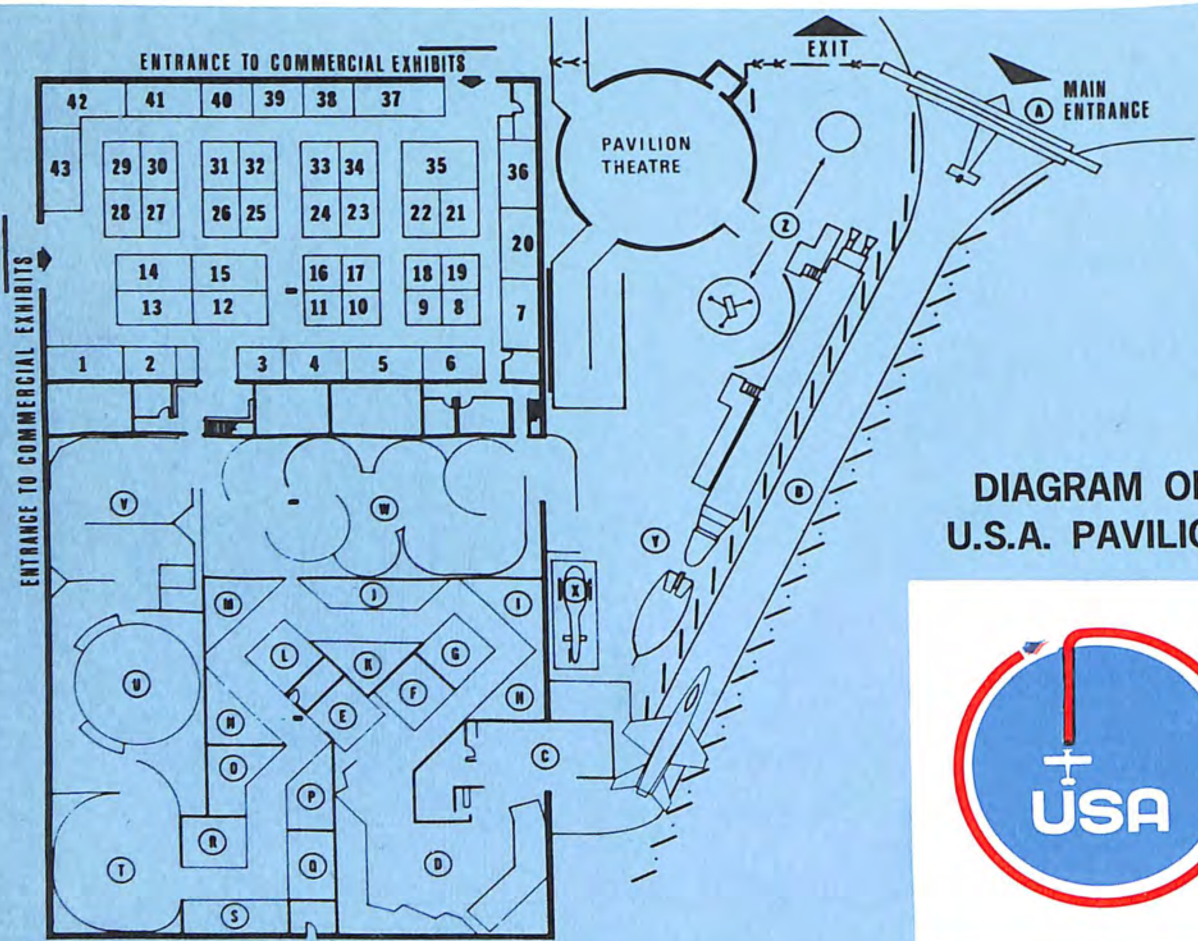


DIAGRAM OF U.S.A. PAVILION

U.S. EXHIBITORS

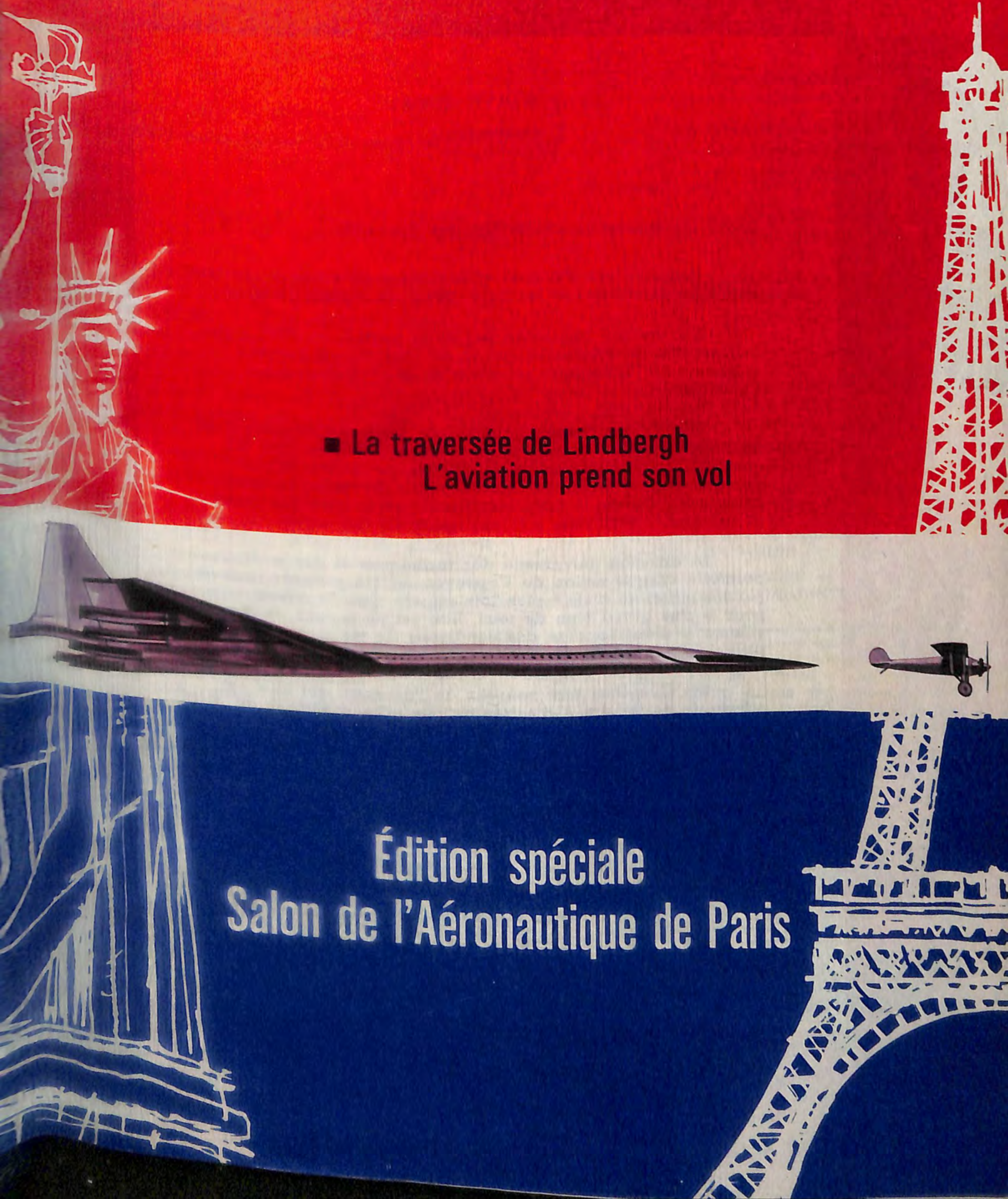
A. Entrance
B. Lindbergh Walk
C. Pavilion Entrance
D. Federal Aviation Agency
E. General Electric Company
F. United Aircraft Corporation
G. The Garrett Corporation
H. North American Aviation
I. Wyman-Gordon Company
J. Litton Industries
K. Northrop Corporation
L. Beech Aircraft Corporation
M. McDonnell Company
N. Trans World Airlines
O. Lockheed Aircraft Corporation
P. Pan American World Airways
Q. The Boeing Company
R. Ling-Temco-Vought
S. General Dynamics Corporation
T. Environmental Science Services Administration
U. Communications Satellite Corporation
V. Atomic Energy Commission
W. National Aeronautics & Space Administration
X. Bell Helicopter Company
Y. Outdoor Exhibits — Department of Defense
Z. Outdoor Exhibits — N.A.S.A.

1. Astra Aircraft Corporation
2. RCA Aviation Equipment Department
3. Inflight Motion Pictures
4. Latrobe Steel Company
5. Wyman-Gordon Company
6. Eastern Stainless Steel Corporation
7. Honeywell Inc.
8. Gray Company
9. Bild Industries
10. Zep Aero
11. Voltron Products
12. Conductron Corporation
13. General Connectors Corporation
14. United Control Corporation
15. Ampex Great Britain
16. Standard Pressed Steel Company
17. Schick Products
18. Brodsky, Hopf & Adler
19. Hazeltine Corporation
20. Atlantic Research
21. Borg-Warner International
22. General Precision
23. Baird-Atomic, Inc.
24. Airco Supply Company
25. Allen Aircraft Radio, Inc.
26. Abex Corporation
27. Lawrence Electronics
28. Dorne & Margolin
29. Motorola
30. Stratoflex, Inc.
31. Chicago Aerial Industries
32. Northeast Aircraft Corporation
33. Laboratory for Electronics
34. Anglo-American Aviation
35. Link Group (General Precision)
36. Aeroquip Corporation
37. Westinghouse Electric International
38. Ryan Aeronautical Company
39. Del Mar Engineering Laboratories
40. Lockheed-California Company
41. Hardman Tool & Engineering Company
42. Aeromaritime, Inc.
43. REA International Corporation

Other U.S. aerospace firms exhibiting outside the U.S. Pavilion are The Bendix Corporation, Cessna Aircraft Company, Grumman Aircraft Engineering Corp., Hughes Aircraft Company, IBM Corporation, International Telephone & Telegraph Corp., Kollsman Instrument Corp., Martin Company, Piper Aircraft Corp., and Rockwell-Standard Corporation's Aircraft Divisions.

aerospace

PUBLICATION OFFICIELLE DE L'AEROSPACE INDUSTRIES ASSOCIATION • MAI 1967



■ La traversée de Lindbergh
L'aviation prend son vol

Édition spéciale
Salon de l'Aéronautique de Paris

UN MESSAGE DU PRÉSIDENT DES ÉTATS-UNIS

THE WHITE HOUSE

WASHINGTON

Soyez les bienvenus au Pavillon des États-Unis.

J'adresse aux Français et aux visiteurs venus du monde entier les salutations et les bons vœux du peuple américain.

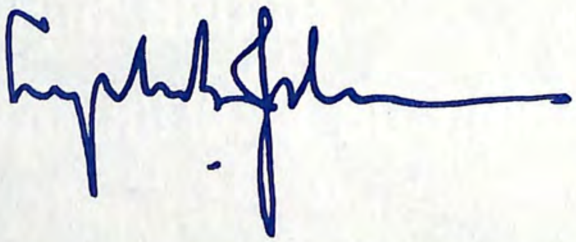
L'exposition présentée par notre pays à ce 27ème Salon International de l'Aéronautique et de l'Espace est l'œuvre commune de l'entreprise privée et du gouvernement des États-Unis.

Elle illustre l'espoir commun de notre gouvernement et de notre industrie de voir se développer et s'épanouir la coopération internationale et le progrès pacifiques. Nous pensons que le Salon de l'Aéronautique de Paris, en encourageant les échanges internationaux de techniques, de biens et services, contribuera à la réalisation de cet espoir.

La diffusion universelle des techniques et des produits permet à chaque nation de s'appuyer sur les progrès réalisés par les autres et d'aller plus loin encore dans la même voie, pour le plus grand bien de tous. Elle est un facteur de bonne volonté et d'amélioration des conditions de vie dans tous les pays.

Les États-Unis sont heureux de l'occasion qui leur est offerte de se joindre à d'autres nations pour participer au salon de l'aéronautique le plus important du monde, et de contribuer ainsi à la cause de la paix et du progrès mondial, que nous défendons tous.

Puisse cette visite au Pavillon des États-Unis vous être agréable et profitable.



L'INDUSTRIE AÉROSPATIALE :
une œuvre de coopération.

par KARL G. HARR, JR.

Président de l'Aerospace Industries Association of America, Inc.

Les progrès accomplis par l'avion et les engins spatiaux ont bouleversé les dimensions de l'univers qui nous étaient familières.

Depuis le vol historique de Lindbergh, qui relia New York à Paris il y a juste quarante ans, l'industrie aérospatiale a augmenté dans de telles proportions le rayon d'action, la vitesse et la capacité des appareils que, dans un très proche avenir, il sera courant de voir plusieurs centaines de passagers embarquer à bord d'un avion à New York et en descendre à Paris en un temps à peine supérieur à celui qu'il faut pour leur servir leur dîner en vol.

Un rétrécissement aussi marqué de notre planète entraîne des conséquences prodigieuses pour le monde entier. Des pays pratiquement isolés les uns des autres par des océans sont maintenant devenus de proches voisins et doivent réviser leurs notions de géographie, examiner l'interaction de leurs traditions sociales et culturelles respectives et évaluer l'effet de cette nouvelle proximité sur leurs conceptions économiques et leurs usages commerciaux.

L'exploration pacifique de l'espace extra-atmosphérique a également ouvert à toutes les nations la perspective d'avantages radicalement nouveaux. La coopération internationale dans le domaine des activités spatiales promet de doter les hommes de connaissances et de compétences qui leur permettront d'obtenir des récoltes plus riches, de prendre des poissons plus nombreux et de se prémunir avec plus d'efficacité contre les catastrophes naturelles telles que les cyclones, les inondations et la sécheresse.

L'industrie aérospatiale américaine a bien compris les avantages que comporterait la coopération dans ce domaine avec les industries des autres nations. Voici longtemps qu'elle s'y est engagée pour assurer la sécurité de tous, et elle s'y adonne maintenant pour ce qui est de l'aviation civile et de l'exploration spatiale.

Le Salon International de l'Aéronautique de Paris 1967 illustre avec éclat les étroites relations d'entreprise à entreprise qui se sont nouées entre les industries aérospatiales des États-Unis et de l'Europe.

Nous espérons qu'elles continueront de se développer et de se renforcer, à notre mutuel avantage technique et économique.

AIA

Publication officielle de l'Aerospace Industries Association of America, Inc.

PRÉSIDENT : Karl G. Harr, Jr.

Éditeur : Glen Bayless

VOLUME 5, n° 5 *MAI 1967*

RÉDACTEUR EN CHEF : Gerald J. McAllister

ADJOINTS : Richard W. Balentine

John J. Lee

SERVICE ÉCONOMIQUE : Gerson N. Chanowitz

DIRECTEUR ARTISTIQUE : James J. Fisher

SOMMAIRE *PAGES*

Ce numéro spécial a été réalisé par l'Aerospace Industries Association of America, Inc., avec la collaboration de l'United States Information Agency et du Bureau des échanges internationaux au département américain du Commerce.

Les objectifs de la revue AEROSPACE :

Faire mieux comprendre la contribution que l'industrie aérospatiale apporte à la sécurité nationale des États-Unis en concevant, mettant au point et produisant des systèmes d'armes de type avancé ;

Faire mieux comprendre les responsabilités de l'industrie aérospatiale dans le domaine de l'exploration spatiale ;

Faire mieux comprendre le rôle primordial que joue l'aviation civile sur le plan intérieur comme sur le plan international, pour promouvoir le tourisme et les échanges.

Faire mieux comprendre que les techniques d'analyse et de gestion administrative utilisées par l'industrie aérospatiale peuvent s'appliquer, dans le domaine économique et social, aux problèmes d'ordre local ou national.

AEROSPACE est une publication mensuelle de l'Aerospace Industries Association of America, Inc. Cette association commerciale groupe à l'échelon national les sociétés qui conçoivent, mettent au point et fabriquent les avions, missiles et véhicules spatiaux, les systèmes de propulsion, de navigation et de guidage et autres, ainsi que leurs différents éléments.

Administration - Rédaction : 1725 De Sales Street, N.Y., Washington, D.C. 20036

Bureau de Californie : McCulloch Building, 6151 West Century Blvd, Los Angeles, California, 90045

La traversée de Lindbergh

L'AVIATION PREND SON VOL

Par LAUREN D. LYMAN

Il y a quarante ans, par une belle matinée de printemps, le dimanche 10 avril, le *New York Times* publiait en première page un article consacré à deux projets de vol transatlantique des États-Unis vers Paris.

Le commandant Richard Evelyn Byrd et Floyd Bennett devaient piloter un trimoteur Fokker, en compagnie d'un autre pilote et d'un opérateur radio. Ce projet était patronné par Rodman Wanamaker. Le capitaine de corvette Noel Davis et le lieutenant de vaisseau Stanton H. Wooster, pour leur part, se proposaient d'utiliser un bombardier Keystone modifié pour être équipé de trois moteurs, et dont le rayon d'action était évalué à 6 450 kilomètres. L'American Legion soutenait cette expédition.

A la page 24 figurait une discrète information en provenance de Saint-Louis, annonçant qu'un pilote de l'aéropostale nommé Charles A. Lindbergh mettait au point à San Diego un monoplan en vue d'un vol solitaire de New York à Paris.

Raymond Orteig, un Français possédant les hôtels Brevoort et La Fayette à New York, avait fondé un prix de 25 000 dollars destiné à récompenser le premier vol sans escale Paris-New York ou vice-versa. Tout en pouvant y prétendre, ni Byrd ni Davis ne s'intéressaient particulièrement au prix Orteig. Leurs projets bénéficiaient d'un soutien financier suffisant. Ils n'avaient pour autre objectif que d'assurer les progrès de l'aéronautique et de promouvoir l'amitié internationale.

Le projet de Lindbergh n'était pas pris au sérieux dans les milieux de l'aviation de New York. Les pilotes et les navigateurs confirmés étaient presque unanimement d'avis qu'un navigateur ou un copilote était indispensable au succès d'un vol transatlantique. Ils déclaraient qu'un homme seul à bord, quelles que soient ses qualités, ne pourrait rester éveillé et garder l'esprit vif tout au long d'une telle épreuve. Des cyniques insinuaient que le vol de Lindbergh n'était que le rêve d'un chargé de presse d'Hollywood, une affaire publicitaire montée pour lancer quelque film et non pas une « expédition scientifique sérieuse ».

Plus tard seulement – plusieurs années après, pour certains d'entre nous – nous avons appris que Lindbergh voyait beaucoup plus loin que le prix Orteig.

En ce matin d'avril, il semblait certain que deux expéditions – trois, si l'on comptait ce pilote de l'aéropostale totalement inconnu, Lindbergh – allaient prendre le départ de la côte américaine et s'engager dans une course passionnante pour tenter de s'assurer les 25 000 dollars de M. Orteig. Une, et peut-être deux équipes se préparaient de leur côté à s'envoler de Paris vers les États-Unis. En fait, Nungesser et Coli étaient presque prêts.

Les faits relatés jusqu'ici ont été puisés dans les archives. Mais les pages qui vont suivre sont basées en grande partie sur des souvenirs personnels, évoqués quarante ans plus tard.

Le 11 avril était mon jour de repos. Le lendemain 12 avril, le temps demeurait clair et doux. Le téléphone sonna alors que je me préparais à quitter mon domicile banlieusard de Port Washington pour New York.

C'était mon rédacteur en chef qui me chargeait de me rendre au terrain d'aviation Roosevelt pour assurer un reportage sur une tentative de record mondial de vol sans ravitaillement. Notre correspondant local était souffrant, semblait-il. Je pouvais téléphoner mon article et passer une agréable journée à la campagne. J'étais choisi pour ce reportage non pas en raison de mes connaissances en matière d'aviation, mais pour des motifs d'ordre géographique : j'habitais à une quinzaine de kilomètres du lieu de la tentative.

Je gagnai le terrain Roosevelt et appris que Clarence D. Chamberlin et Bert Acosta étaient sur le point de prendre l'air à bord d'un petit monoplan lourdement chargé d'essence, ce qui portait son poids à près de deux tonnes. J'y rencontrai aussi deux des reporters d'aviation les plus compétents et probablement les plus qualifiés des États-Unis : C.B. Allen, du *New York World* et Bruce Gould, du *New York Evening Post*. Ils avaient été tous deux pilotes pendant la Première Guerre Mondiale, et Allen était lieutenant de réserve de l'Armée de l'Air. Tous deux aimaient l'aviation et ni l'un ni l'autre ne désirait voir un novice se fourvoyer. Ils me présentèrent à Giuseppi M. Bellanca, le constructeur du petit monoplan, ainsi qu'à Carl Schory, chronométreur de la National Aeronautic Association, que je vis installer un barographe dans l'avion. Ils m'expliquèrent ce qu'était un barographe (un baromètre auto-enregistreur) et à quoi il servait.

D'autres étaient là, qui hochaient la tête devant l'audace de ces pilotes. Le Bellanca, disaient-ils, ne pourrait probablement pas quitter le sol. Il se briserait et brûlerait comme l'avait fait un Fonck-Sikorsky l'année précédente.

Chamberlin réussit dans son entreprise. Il décolla après un parcours de 400 mètres sur la piste longue de 1 500 mètres qui était encore en cours de surfaçage en vue de la grande course transatlantique. Durant les deux jours et les deux longues nuits qui suivirent, l'équipage du Bellanca tourna au-dessus de Long Island pour établir un nouveau record du monde de durée en 51 heures, 11 minutes, 25 secondes.

Durant ce laps de temps, dont deux nuits presque blanches, votre serviteur poursuivit son éducation aéronautique. Je posais au patient M. Allen des questions qui n'en finissaient pas et prêtais l'oreille quand M. Allen et M. Gould en posaient d'autres à M. Bellanca. Nul élève n'eut jamais meilleurs maîtres que ces hommes, auxquels venaient s'ajouter des professeurs tels que Ed Mulligan et Ken Boedecker, de la Wright Company, Casey Jones, de la Curtiss Company, et des officiers de la base aérienne Mitchell, y compris un certain colonel Benjamin Foulois, un trapu fumeur de pipe qui, seize ans plus tôt, avait appris par correspondance à piloter un Wright à hélice arrière, en se conformant aux instructions écrites qu'il recevait d'Orville et Wilbur Wright.

Deux jours après la performance de Chamberlin et Acosta, alors qu'on en parlait encore, deux des hommes qui aspiraient à la distinction d'être les premiers à voler de New York à Paris connaissaient un contretemps. A Teterboro, dans le New Jersey, le trimoteur Fokker du commandant Byrd, avec Anthony H. Fokker aux commandes, capotait à l'atterrissage, après un premier vol d'essai.

Dix jours plus tard, une véritable tragédie survenait. Noel Davis et Stanton Wooster, qui effectuaient au terrain de Langley, en Virginie, leur essai final à pleine charge – le dernier avant l'envol vers Paris – s'écrasaient au décollage. Tous deux étaient tués.

Ce même 28 avril, à San Diego, Lindbergh était sur le point d'entamer la série d'essais de son monoplan Ryan. Ce détail n'éveillait guère d'intérêt sur les aérodromes Curtiss et Roosevelt, non plus qu'à Teterboro où l'on annonçait en revanche que la remise en état

Depuis une quarantaine d'années, Lauren Dwight (Deac) Lyman s'intéresse à l'aviation. Reporter au *New York Times* pendant dix-neuf ans (il remporte le prix Pulitzer en 1936), il entre ensuite à l'United Aircraft Corp. où il assume depuis d'importantes fonctions. Pendant la Première Guerre mondiale, M. Lyman a conduit une ambulance sur le front français. Son premier contact avec le monde de l'aviation : ce verset du 139e Psaume que récitait son grand-père pour les prières du matin : « Je prends les ailes de l'aurore, je me loge au plus loin de la mer... » Les souvenirs du mémorable printemps 1927 qu'évoque M. Lyman sont tout aussi éloquents.

de l'*America* de Byrd progressait très rapidement.

C'était le monoplan Bellanca et Chamberlin qui soulevaient le plus vif intérêt. Le record de durée avait rendu l'avion célèbre, et le nombre de visiteurs augmentait tous les jours. Et que de questions posaient-ils ! L'une d'elles me revient à la mémoire. Une vieille dame demanda à Chamberlin ce qui arriverait si un avion tombait en panne d'essence en plein ciel. Le pilote la regarda un instant, puis répondit : « Madame, c'est l'un des drames de l'aviation. Dieu seul sait combien de pilotes sont là-haut, sans essence, et incapables de regagner la terre ! »

A Paris, la course soulevait un intérêt croissant. Les pilotes Nungesser et Coli et leur « Oiseau-Blanc » étaient prêts à tenter la traversée Est-Ouest, n'attendant plus qu'un temps favorable. Les plans concernant le vol du Bellanca étaient imprécis. Charles A. Levine, qui avait acheté l'avion à la Wright Company, révéla qu'il n'avait pas encore fait choix d'un pilote. Ce pourrait être soit Chamberlin, soit Acosta, ou peut-être quelqu'un d'autre ! Lorsque Acosta se joignit à l'expédition Byrd, Levine se décida pour Lloyd Bertaud, un pilote chevronné de l'aéropostale avec lequel il fut bientôt en désaccord. L'action judiciaire qui s'ensuivit immobilisa le Bellanca au sol, imposant ainsi un délai fort regrettable et fort décevant.

Le mois d'avril s'écoulait. A Teterboro, l'*America* était presque prêt. Mai arriva. Outre les terrains d'aviation, les journalistes de New York commencèrent à envahir le bureau météorologique installé au sommet du building de Whitehall, près de la Battery, où le Dr James H. Kimball dressait les cartes météo, discourant sur les isobars et les millibars, les fronts et les vents dominant le long de l'arc de cercle figurant la route de l'Atlantique.

Le 8 mai, les vaillants Français Nungesser et Coli décollaient à bord de leur « Oiseau-Blanc », prenant lentement et péniblement de l'altitude en direction de l'Ouest.

« Attendus demain à New York », proclamaient les manchettes des journaux du 9 mai. Mais le lendemain, l' « Oiseau-Blanc » n'était signalé nulle part; seules circulaient quelques rumeurs encore pleines d'espoir. Deux héros de plus, qui avaient voulu se frayer un chemin dans l'inconnu, avaient payé de leur vie leur témérité.

Mais ce chemin, d'autres s'efforçaient de le trouver. A l'aérodrome Curtiss, le matin du 10 mai, le procès immobilisait toujours le Bellanca dans son hangar. Un rouleau compresseur sillonnait lentement, pour l'aplanir et la raffermir, la piste de fortune du terrain d'aviation Roosevelt, jouxtant l'aérodrome Curtiss. A Teterboro, des mécaniciens mettaient la dernière main à l'*America* du commandant Byrd.

A San Diego, en Californie, des événements plus importants se déroulaient. Tous les journaux du pays annonçaient dans leur dernière édition du soir que Lindbergh, capitaine de la Garde Nationale du Missouri, avait pris l'air pour gagner sans escale Saint-Louis, et, de là, l'aérodrome Roosevelt. Son monoplan Ryan avait été baptisé *Spirit of St. Louis* en l'honneur de la ville où son aventure aérienne avait pris naissance; *Saint-Louis,* c'était un nom que la France révérait et chérissait depuis six siècles. Quatorze heures et demie plus tard, ses roues touchaient l'aérodrome de Saint-Louis. L'après-midi suivant, les spectateurs et les journalistes qui s'étaient massés sur les aérodromes Roosevelt et Curtiss pour applaudir l'*America* de Byrd voyaient avec stupeur le *Spirit of St. Louis,* au fuselage argenté, décrire un cercle pour atterrir.

Sous la surveillance de Casey Jones, l'avion était amené dans un hangar et le pilote efflanqué au visage juvénile était prêt à répondre aux questions. Dans l'espace d'une heure, ceux d'entre nous qui étaient assez près de lui s'étaient rendu compte qu'il ne s'agissait pas d'une affaire de publicité, dénuée de tout sérieux et inspirée par Hollywood. Cet avion était construit en vue d'un seul objectif : survoler l'Océan. Il était aveugle : un énorme réservoir d'essence bouchait la vue vers l'avant. Un simple siège en rotin, rembourré pour assurer plus de confort, nous convainquit tous finalement que Lindbergh avait bien l'intention de voler seul. Il ne pouvait voir devant lui qu'à travers deux étroites fenêtres ménagées dans les portes entoilées, de chaque côté de l'habitacle. Un petit périscope portatif, construit par les gens de Ryan, contribuait à protéger les yeux et le visage du pilote des intempéries et du vent de sillage.

Interviewé, Lindbergh déclara qu'il naviguerait à l'estime. La consommation d'essence, telle que l'indiquait son vol record transcontinental, serait inférieure à 68 litres à l'heure. Oui, il était certain d'avoir un rayon d'action largement suffisant. Oui, il était certain de demeurer éveillé.

Les plans de Lindbergh et leur mise en œuvre ne laissaient place à aucune incertitude. Le matin suivant, le 13 mai, il parcourut à pied l'aérodrome Roosevelt, l'arpenta et étudia la piste. Il rendit visite au Dr Kimball, au bureau météorologique. Il remercia le commandant Byrd d'avoir spontanément mis la piste à sa disposition.

Dans la soirée pluvieuse du 19 mai, des lumières brillaient dans le hangar du *Spirit of St. Louis* : des hommes faisaient le plein du gros réservoir. A quelques portes de là, d'autres lumières éclairaient le hangar Bellanca où Ed Mulligan, de la Wright Company, achevait la dernière mise au point du moteur Whirlwind. On apprit qu'à l'Hôtel Garden City, Lindbergh venait de se coucher. Les nuages étaient bas, mais la bruine tenace commençait pourtant à s'atténuer un peu. Johnny Frogge, le correspondant du *New York Times* à Long Island, montait la garde à l'hôtel, tandis que les autres, y compris votre serviteur, faisaient une navette incessante entre l'aérodrome Curtiss et l'hôtel.

Il pleuvait toujours quand, bien avant l'aube, Lindbergh descendit dans le hall et se dirigea vers le porche de pierre. Il jeta un coup d'œil sur les nuages hostiles et les arbres ruisselants d'eau.

« Partez-vous ce matin, Capitaine? » lui demanda Frogge. Il ne répondit pas immédiatement, mais dit finalement : « Je ne sais pas. »

Il y avait encore une chance de ne pas rater la dernière édition, aussi Frogge demanda-t-il : « Quand le saurez-vous? » Une fois de plus, le pilote répondit avec plus de force encore : « Je ne sais pas. »

Épuisante et exaltante, la nuit s'éclaircissait. Vers l'est, aucun rayon de soleil, rien que des nuages bas, gris et blancs. Un tracteur remorqua le *Spirit of St. Louis* par l'aérodrome Curtiss, le long de la piste boueuse, jusqu'au terrain Roosevelt adjacent. Le vent léger avait tourné d'Est en Ouest, augurant un beau temps, mais ajoutant un risque au décollage Ouest-Est. On remit encore beaucoup d'essence dans les réservoirs, en la filtrant lentement à travers une peau de chamois.

La foule s'amassait le long du terrain, tenue à bonne distance de la piste. Un petit groupe se pressait autour de l'avion : de vieux pilotes qui volaient déjà alors que Lindbergh était encore au lycée, des officiers de la base Mitchell qui avaient été ses condisciples au temps où il faisait ses classes d'aspirant au Texas, Chamberlin et Giuseppi Bellanca, leur propre avion toujours immobilisé par une saisie, bien que chargé et prêt à s'envoler. Tous étaient tendus et silencieux. Le commandant Byrd sortit en courant de son hangar, brandissant un bulletin météo de dernière minute qu'il glissa dans la main de Lindbergh. Revêtu de sa combinaison de pilote de l'aéropostale, Lindbergh monta à bord et ferma la porte. Ken Boedecker balança l'hélice lentement pour passer les compressions du Whirlwind, qui était froid. Le moteur démarra. Pendant quelques minutes, Lindbergh ouvrit et ferma les gaz à plusieurs reprises, la tête presque hors de la fenêtre pour étudier la piste fortement mouillée, à l'extrémité de laquelle stationnait le rouleau compresseur.

C.B. Allen était parti. Il marchait rapidement le long du chemin que l'aviateur allait parcourir, et je courus le rejoindre. Nous nous arrêtâmes près du rouleau compresseur, presque à l'extrémité de la piste. Si le *Spirit of St. Louis* ne réussissait pas à décoller, ce serait en ce point, ou à proximité, qu'une aide serait nécessaire, pour autant qu'il pourrait être possible de l'apporter. Mais le monoplan d'argent prit sa course, poussé à main d'homme, lentement d'abord, puis gagnant de la vitesse. Il rebondit une fois, deux fois dans les flaques d'eau, décolla enfin et s'éleva lourdement à quelques mètres du sol. Il survola de 1,50 mètre à 3 mètres le rouleau compresseur, derrière lequel les reporters anxieux s'étaient tapis, rugit juste au-dessus des fils téléphoniques à l'extrémité du terrain, puis redescendit nettement pour permettre au pilote de prendre de la vitesse et disparut vers l'est, derrière les pentes boisées.

A mesure que le vol progressait, l'agitation augmentait tant aux États-Unis qu'à l'étranger. Ce soir-là à New York, au Yankee Stadium où 40 000 « fans » bruyants suivaient le combat de poids lourds Sharkey-Mahoney, on annonça entre deux rounds que le *Spirit of St. Louis* avait survolé Saint-Jean de Terre-Neuve, qu'il « se trouvait maintenant à 500 kilomètres en mer » et que tout allait très bien. Les 40 000 spectateurs se levèrent, se découvrirent et prièrent en silence pour l'heureuse arrivée de Lindbergh en France.

Le matin du départ, à l'aérodrome Roosevelt, un millier de personnes avaient assisté au décollage. La nuit suivante, au Bourget cent mille autres démolissaient les barrières et bousculaient la police et un régiment de l'armée. Au cours des journées agitées qui suivirent, les Français avaient le sentiment d'honorer une tradition dont ils étaient fiers en acclamant Lindbergh et en lui rendant hommage. La France, après tout, n'était-elle pas le berceau du vol humain? A Paris, Pilâtre de Rozier ne s'était-il pas élevé dans les airs jusqu'à 25 mètres de haut dans une montgolfière de papier et de toile 144 ans avant que le *Spirit of St. Louis* ne traversât l'Atlantique?

Les frères Wright avaient été cordialement reçus et admirés en France avant que les États-Unis ne comprennent la portée de leurs hauts faits, et Wilbur Wright établissait au Mans des records du monde en présence de milliers de spectateurs enthousiastes alors qu'Orville Wright cherchait encore à vendre son premier aéroplane au gouvernement des États-Unis.

Ces journées du Mans s'étaient déroulées moins de vingt ans avant les vols de 1927 et cinq ans seulement après le premier décollage des Wright sur les sables de Kitty Hawk. L'aviation ignore l'immobilisme.

L'exploit extraordinaire de Lindbergh et du *Spirit of St. Louis*, suivi dans la quinzaine par le remarquable vol de Chamberlin vers l'Allemagne, avec un passager à bord de son Bellanca, démontrait d'éclatante façon le dynamisme qui marquait déjà l'aviation. L'aéronautique ne se contentait plus d'être une promesse.

Dans la préface de son récit plein de vie : « 33 heures pour Paris », Lindbergh a défini en une seule phrase l'aviation telle qu'elle lui apparaissait voici quarante ans : « Tandis que le *Spirit of St. Louis* volait vers Paris, l'aviation se frayait un chemin, passant de la phase de l'invention à la phase de l'utilisation. »

De nos jours, la « phase de l'utilisation » est plus vaste et plus solidement établie, et l'aviation continue à trouver partout des occasions de se frayer dans le monde entier un chemin de plus en plus large.

Le transport aérien

Dans tous les cieux

Tout spectaculaire qu'ait été le premier vol des frères Wright, sa pleine signification fut largement ignorée dans le monde. L'intérêt suscité par l'aviation se développa lentement au cours des années qui suivirent. Les exploits de Louis Blériot, traversant le Pas de Calais en 1909, de Cal Rodgers, réalisant en 1911 son vol transcontinental en « 84 jours et 15 atterrissages forcés », les hauts faits de Rickenbacker, de René Fonck et de von Richthofen pendant la Première Guerre mondiale, tout cela contribua cependant à faire comprendre de plus en plus nettement que l'homme s'était rendu maître des mystères du vol.

Tous les doutes qui subsistaient furent finalement effacés par l'exploit sensationnel de Charles Lindbergh ; si bien que les capitalistes délièrent les cordons de leurs bourses, provoquant un boom sans précédent qui catapulta littéralement l'aviation dans une ère nouvelle.

Dans l'année qui suivit le vol historique de Lindbergh, 4 500 avions – un nombre stupéfiant – prirent du service. Les lignes aériennes doublèrent le nombre des kilomètres couverts par leurs vols, triplèrent le volume du courrier transporté et acheminèrent quatre fois plus de passagers. Les immatriculations d'avions privés ne se comptèrent plus par centaines, mais par milliers. De nouvelles sociétés de construction aéronautiques furent constituées, grâce à des apports massifs de capitaux. Les constructeurs déjà à l'œuvre ouvrirent de nouveaux ateliers. Le nombre des villes qui exploitaient des aéroports passa d'une centaine à près d'un millier.

A la fin de 1928, le département du Commerce mentionnait l'existence de 24 350 kilomètres de routes aériennes, dont les deux tiers balisées, c'est-à-dire aptes à la navigation de nuit. Il n'y avait pas moins de 32 compagnies aériennes en activité, mais, comme les transports postaux assuraient des recettes beaucoup plus importantes que le transport des passagers, bien peu d'exploitants prenaient la peine d'installer des sièges dans leurs avions. En fait, la plupart des appareils étaient inadaptés au transport de voyageurs, et il fallut toute l'insistance du gouvernement pour que la plupart des compagnies aériennes se décident enfin à prendre en charge des passagers aussi bien que des sacs postaux.

En 1934, le président Roosevelt annula tous les contrats et prescrivit à l'aviation militaire de transporter le courrier. Cette décision se traduisit par un véritable chaos au sein des compagnies aériennes. La plupart continuèrent à transporter des passagers et des messageries en comprimant leurs horaires, mais sans les

recettes de la poste aérienne, l'exploitation des lignes était ruineuse. L'administration revint sur sa décision et mit en adjudication les anciennes routes aériennes. Quand furent signés les nouveaux contrats, le pays se trouva doté d'un système original de transports aériens.

La trame des lignes aériennes établie aux États-Unis en 1934 a peu changé; le réseau dessiné alors demeure l'ossature des services plus développés d'aujourd'hui.

Le premier avion moderne de transport fit son apparition sur les lignes aériennes américaines en 1933, et, en quelques années, les compagnies standardisèrent leurs matériels volants. Comparés à leurs prédécesseurs à la grâce pataude, les nouveaux appareils semblaient compacts, racés et puissants. Le Boeing 247, le Lockheed Electra, le Douglas DC 2 et son successeur au succès populaire phénoménal, le Douglas DC 3, étaient tous des monoplans à aile basse, entièrement équipés pour le vol aux instruments et actionnés par deux moteurs en étoile carénés et placés dans le bord d'attaque de la voilure. Ils apportaient aux transports aériens la vitesse et l'endurance, aussi bien que de nouveaux standards de sécurité et de confort.

Avec la cessation des hostilités en 1945, le nombre d'avions en service quotidien dans les compagnies de transport intérieur atteignit bientôt un total de 411, contre un chiffre maximum de 359 avant Pearl Harbor, non compris tous les appareils en cours de reconversion et les nouveaux modèles sortant des chaînes de production. La flotte utilisée pour les services aériens internationaux comptait de son côté 107 unités. Mais les avions étaient toujours en nombre insuffisant pour faire face aux demandes croissantes de passages.

Au cours des premières années de l'après-guerre, la situation de l'aviation commerciale pourrait être décrite comme « explosive ». La demande qui s'était accumulée pouvait enfin être satisfaite, et les Américains profitaient des possibilités de déplacement que leur offraient les lignes aériennes. Les voyages par avion entraient dans l'ère des transports de masse.

Avant la guerre, les lignes intérieures américaines comptaient en tout et pour tout cinq quadrimoteurs en service; ils furent achetés en 1941 par l'Armée, qui se préparait à toute éventualité. La fin des hostilités donna libre accès à deux sources principales d'avions de transport : l'industrie de la construction aéronautique et le stock des avions de guerre en surplus. En 1946, la plupart des compagnies de transport aérien, tout en continuant à utiliser des DC 3, commencèrent à moderniser leurs flottes en y adjoignant sur les grands itinéraires des DC 4 plus rapides et plus spacieux. Entre-temps, les constructeurs sortaient les quadrimoteurs Douglas DC 6 et Lockheed Constellation, ainsi que les bimoteurs Martin et Convair, en net progrès sur le DC 3. En service aérien courant, ils transportaient près de trois fois plus de passagers, davantage encore quand les appareils étaient affectés à un service non régulier ou ne comportaient que des secondes classes. Ils avaient une vitesse de croisière de l'ordre de 400 à 480 kilomètres-heure, contre 290 kilomètres-heure pour le DC 3. Mais, élément plus important encore, leur exploitation était beaucoup plus économique que celle des transports d'avant-guerre.

Le mode de déplacement des Américains qui voyageaient tant à l'intérieur de leur pays qu'à l'étranger s'en trouva radicalement modifié.

Avec le DC 3 comme avion de ligne standard, le trafic aérien d'avant-guerre ne représentait que 3% environ des transports en commun interurbains de voyageurs. Après la mise en service des avions d'après-guerre, plus vastes et d'un meilleur rendement, les lignes intérieures s'adjugèrent 17% des passagers-kilomètres du trafic interurbain, excédant pour la première fois les passages ferroviaires de première classe.

Le trafic aérien des États-Unis dépassa celui des autocars interurbains en 1955, le total du trafic ferroviaire en 1957 et celui du trafic par chemin de fer et autocar en 1963.

Mais la rapidité et la baisse des prix ne furent pas les seuls éléments qui attirèrent le voyageur de l'air. Le passager, accoutumé depuis longtemps à la lenteur et à la rudesse spartiate des transports aériens d'avant-guerre, était séduit par le confort et la sécurité que lui assuraient les nouveaux avions. Pour les parcours de nuit, il pouvait choisir entre la cabine de luxe, la couchette ou le fauteuil inclinable. La climatisation maintenait dans les cabines, à des altitudes supérieures à celles des perturbations atmosphériques, les conditions de pression régnant au niveau du sol. Les fenêtres furent agrandies et mieux disposées, afin d'offrir une vue panoramique.

La sécurité et la régularité de vol furent renforcées par des progrès scientifiques tels que le radar, le radio-altimètre, le compas gyroscopique synchronisé, les procédés de navigation au long cours, l'amélioration du système de prévisions météorologiques, ainsi que par des dispositifs perfectionnés de contrôle par radio de la circulation sur les routes aériennes.

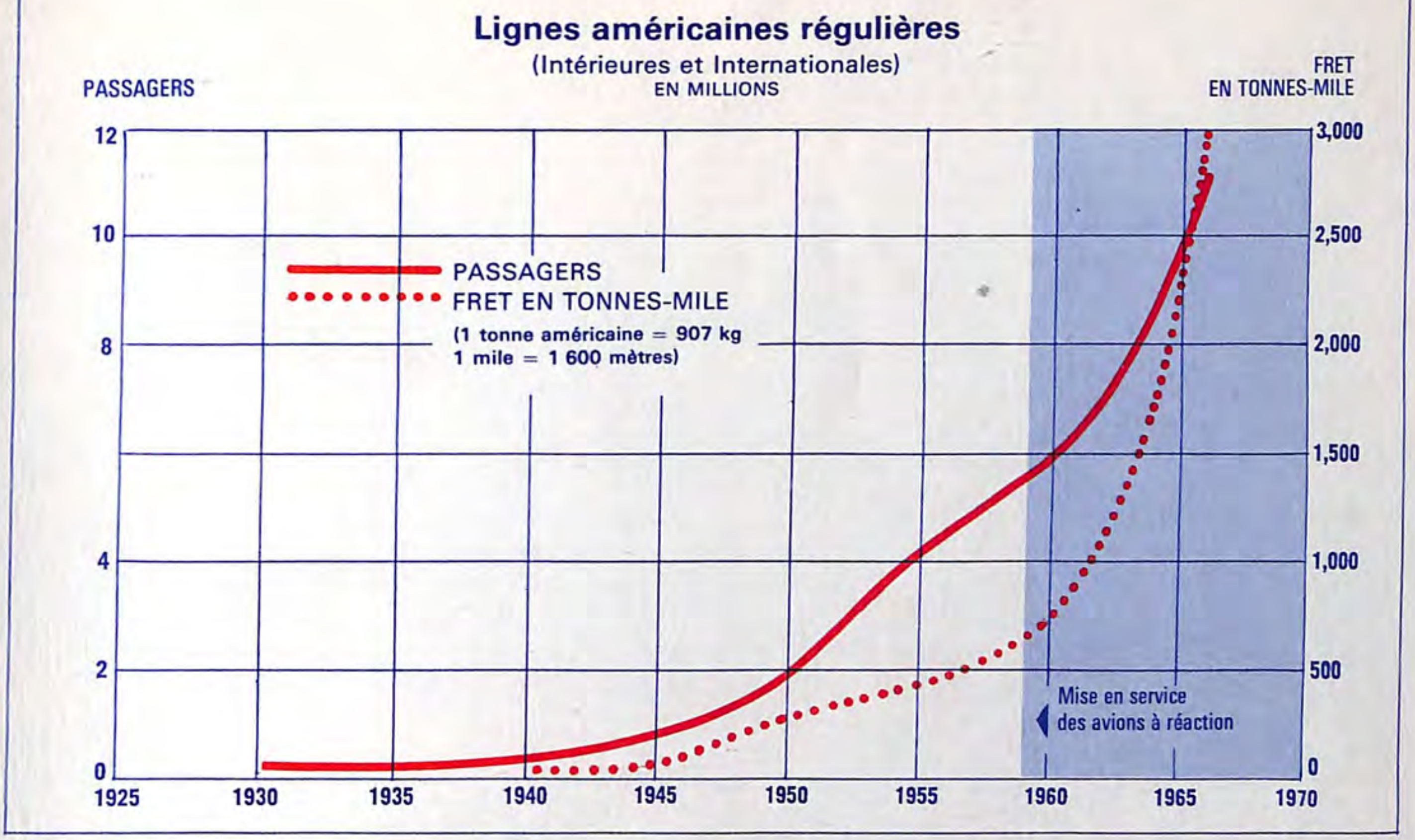
A partir de 1945, les lignes aériennes auxiliaires se développèrent pour la desserte des agglomérations secondaires. Au début de 1950, elles reliaient plus de 350 localités aux principaux centres urbains.

C'est ainsi que s'achevèrent les 50 premières années du vol à moteur. L'aviation américaine ne s'attardait pas sur le passé et déjà les exploitants de services aériens et les constructeurs élaboraient des plans pour « l'âge de la réaction ». Une énorme masse de recherches aéronautiques portant sur la technique du vol à grande vitesse avait été effectuée. Non seulement les cellules et les groupes motopropulseurs avaient fait l'objet des études les plus minutieuses, mais toute l'infrastructure qui deviendrait nécessaire lorsque les appareils plus rapides seraient mis en service régulier était également étudiée.

A plusieurs reprises dans l'histoire des États-Unis, une technique nouvelle a donné naissance à d'extraordinaires périodes de changements, qui ont modifié de façon spectaculaire la vie du pays.

En 1810, un million d'habitants seulement vivaient à l'ouest des Appalaches, mais au milieu du siècle cette population s'était multipliée par 15. Cet accroissement doit être attribué pour une large part au développement des transports fluviaux motorisés. Les migrations vers l'ouest, qui commencèrent avec les bateaux à vapeur, se développèrent considérablement grâce aux chemins de fer qui quintuplèrent leur kilométrage entre 1850 et 1870. Dans les années 20, l'automobile exerça une influence de première importance, en portant le rayon des déplacements familiaux de 6 à 80 kilomètres. Durant cette décennie, le kilométrage des routes à grande circulation recouvertes d'un revêtement passa du simple au double. Depuis lors, l'automobile a profondément modifié la vie économique, non seulement aux États-Unis, mais à travers le monde entier.

Le développement spectaculaire des voyages aériens



a profondément modifié la vie des Américains. Le transport par avion à réaction – qui ne demande que quelques heures pour toute destination – renforce la tendance naturelle de l'homme à toujours chercher quelque chose de nouveau et de différent. Pour un habitant de New York, un week-end à Paris, à Londres ou à Mexico n'est aujourd'hui pas plus malaisé qu'un court voyage à Chicago ou à La Nouvelle-Orléans. Chaque jour, aux États-Unis, plus de 300 000 personnes s'embarquent à bord d'avions commerciaux.

L'ère des avions à réaction sur les lignes américaines a commencé à la fin de 1958, avec le premier vol transatlantique des Boeing 707. Les Douglas DC 8 ont été mis en service l'année suivante. Des versions améliorées et spécialisées de ces avions quadriréacteurs sont depuis lors sorties des usines. Entre-temps, des avions à réaction plus petits, conçus pour des liaisons plus courtes, sont entrés en service. Ces appareils, plus rapides et plus pratiques, ont créé dans le domaine des transports une demande qu'on n'aurait osé imaginer quelques années auparavant.

Aux États-Unis, en 1966, les services aériens réguliers intérieurs ont transporté 110 millions de passagers, dont plus de 90 % ont voyagé à bord d'avions à réaction. Ce chiffre est supérieur de 16 % à celui de 1965 et de plus du double à celui de 1958, dernière année avant la mise en service des avions à réaction (qui ont réduit de près de moitié la durée du parcours transcontinental).

Il est rare qu'un mois se passe sans qu'on apprenne qu'une compagnie américaine ou autre a commandé d'autres avions à réaction. La cadence des ordres d'achat ne montre aucun signe de ralentissement. Au contraire, elle est susceptible de s'accélérer dans les dix ans qui viennent avec l'entrée en scène des avions à réaction géants – appareils supersoniques –, pour lesquels les commandes commencent à s'accumuler.

Comme tel a été le cas pour le transport des passagers, c'est l'apparition des avions à réaction qui a fourni le stimulant le plus puissant au transport par air des marchandises. Depuis le 7 novembre 1910, date de la première messagerie aérienne (32 kilos de soieries), l'amélioration de la capacité et de la qualité des services n'a cessé de stimuler fortement le développement du trafic aérien de marchandises.

En 1960, les compagnies aériennes américaines exploitaient un appareil cargo à turbopropulseurs et 179 autres équipés de moteurs à pistons ; leur capacité totale était d'environ 3,5 millions de tonnes-kilomètres par jour.

Fin 1966, cette flotte comprenait 96 avions à réaction pour transport exclusif de fret, s'ajoutant à 25 appareils turbopropulsés et 89 dotés de moteurs à pistons. Étant donné les commandes en cours portant sur 163 avions cargo à réaction, la capacité américaine de transport quotidien de marchandises, intérieur et international, aura presque triplé en 1970.

En 1929, les trimoteurs transportaient les passagers de l'Atlantique au Pacifique en 28 heures. A la fin des années 30, ce parcours demandait 16 heures, contre au moins 60 heures par chemin de fer. Les premiers vols transcontinentaux sans escale par DC-7C, qui ont débuté en 1953, s'effectuaient en huit heures. Avec la mise en service des avions à réaction, cette durée a été réduite à cinq heures. Les avions supersoniques la diminueront de moitié dans une dizaine d'années.

On dit souvent que le premier accroissement du simple au double des connaissances scientifiques de l'homme eut lieu en 1750, le deuxième en 1900, le troisième en 1950 et le quatrième dix ans plus tard. Ces dates correspondent à peu près à de nouveaux progrès sur le plan des transports – le moteur à vapeur pour les trains et les bateaux, le moteur à combustion interne pour les autos, l'avion, et la propulsion par réaction. La portée économique et sociale des voyages se manifeste tout au long de l'histoire de l'aventure humaine et se révèle comme le meilleur catalyseur du progrès.

Hélicoptères et avions privés

LES APPAREILS A TOUT FAIRE

Les vols transocéaniques à bord d'avions privés sont devenus aujourd'hui chose courante. Ce simple fait illustre bien le développement de l'aéronautique depuis ce matin de mai où, il y a quarante ans, le *Spirit of St. Louis* s'envolait dans le ciel sombre de Long Island. Aujourd'hui, les appareils privés – en excluant les transports des compagnies de navigation aérienne – traversent l'Atlantique Nord à la cadence moyenne d'un vol par jour.

Le départ de Lindbergh eut lieu un an jour pour jour après la signature par le président Calvin Coolidge de la première loi sur l'aviation commerciale. Cette loi chargeait le Secrétaire au Commerce de développer l'aviation de transport, de désigner et aménager les routes aériennes, d'établir, exploiter et entretenir les aides à la navigation, de délivrer les brevets de pilotes, d'attribuer aux avions le certificat de navigabilité et d'enquêter sur les accidents éventuels.

Avec un personnel de 234 fonctionnaires et un budget de 550 000 dollars, le service aéronautique du Département du Commerce entreprit de mettre en place les installations qui permettraient à une activité encore dans son enfance, mais déjà pleine de promesses, de se consolider et de se développer.

Le vol sensationnel de Lindbergh déclencha dans le public une première vague d'enthousiasme pour l'aviation privée. Mais la nécessité de voyages rapides et à longue distance ne se faisait pas encore sentir et les frêles avions se prêtaient plus à des fantaisies de casse-cou qu'à des transports dignes de confiance.

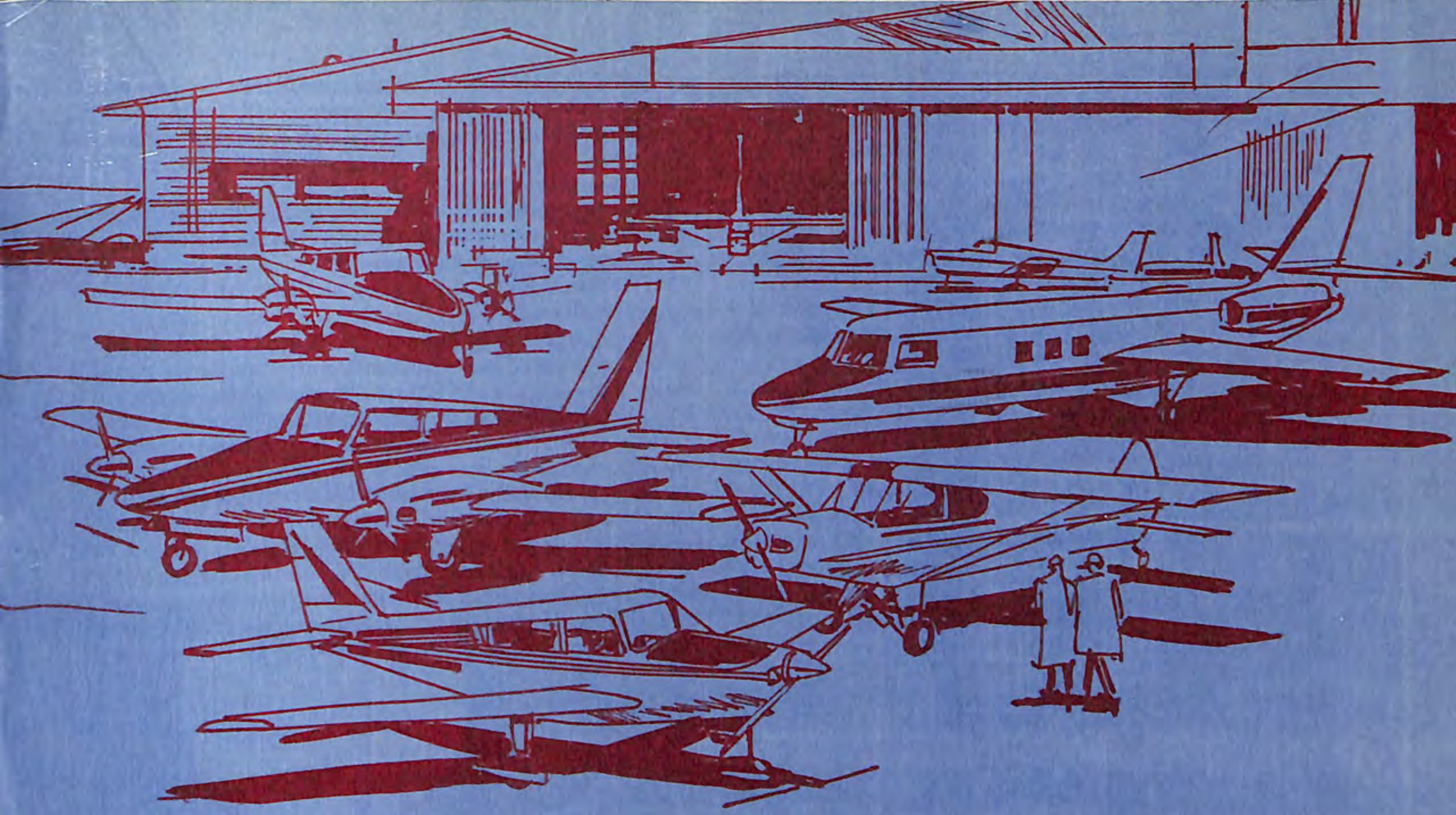
Quelques audacieux persistèrent. Cependant, douze ans après le raid de Lindbergh, le premier décompte officiel des appareils civils aux États-Unis n'en mentionnait que 13 000.

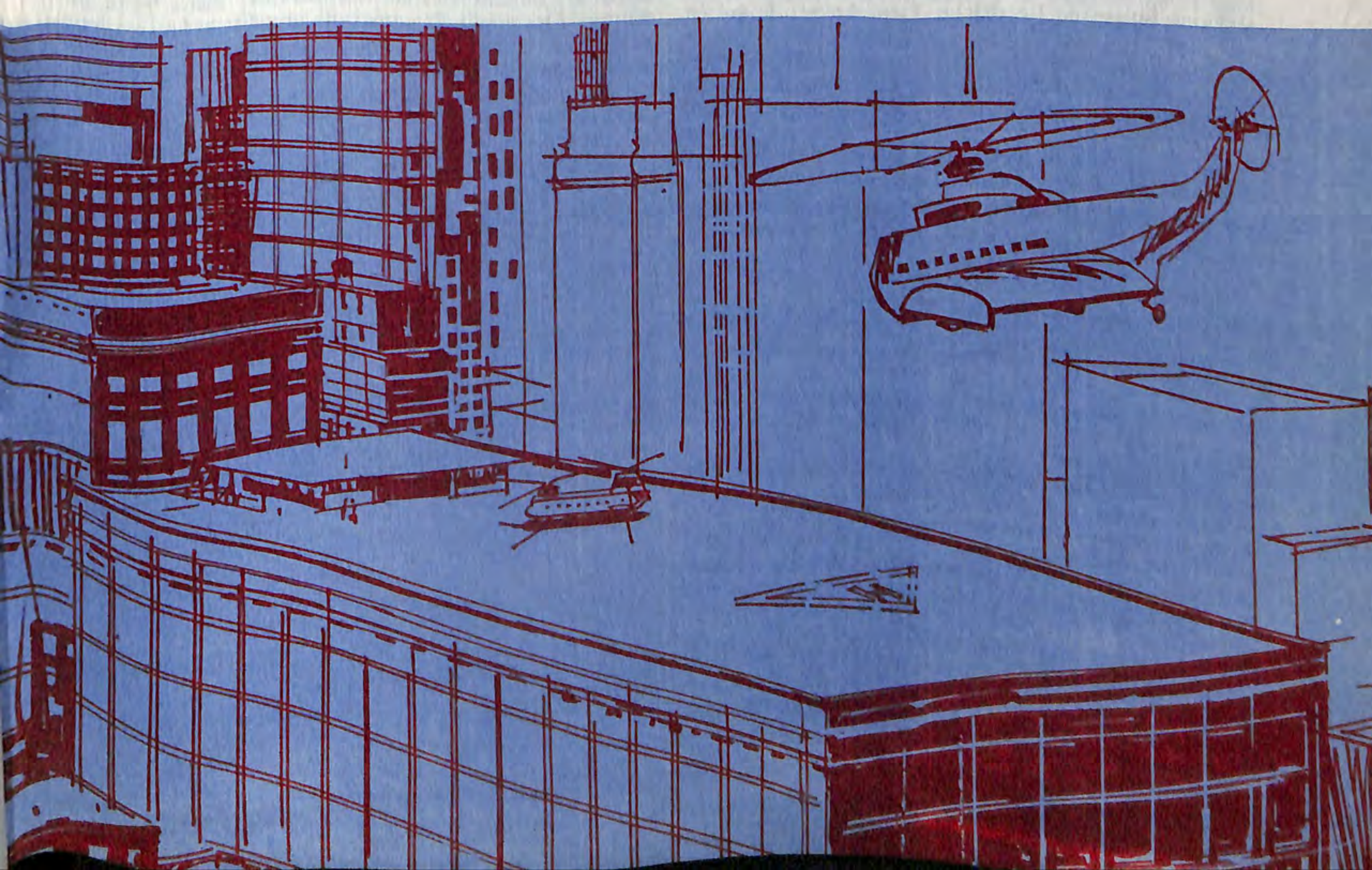
Au cours de la même année – en 1939 – était inauguré un programme de formation d'aviateurs civils dont l'objectif ambitieux était de former 11 000 nouveaux pilotes par an. (Aujourd'hui, alors que le stimulant artificiel de l'aide gouvernementale n'existe plus, 11 000 nouveaux pilotes civils reçoivent leur brevet *chaque mois*.)

Après la Deuxième Guerre Mondiale, l'aviation privée américaine connut sa deuxième phase de croissance. La démobilisation de milliers de jeunes hommes qui étaient devenus des pilotes chevronnés amena certains augures à prédire de nouveau que les voyages aériens allaient connaître un développement fantastique. Mais ces prédictions ne tenaient pas compte du fait que la plupart de ces jeunes pilotes voudraient regagner leur foyer, achever leurs études, trouver un emploi et fonder une famille. Elles ignoraient aussi que, pour maints de ces hommes, le pilotage d'un avion réveillerait le souvenir des combats.

Mais il y en eut qui persévérèrent. Ils aménagèrent de petits aérodromes. Ils assurèrent leur subsistance en organisant des vols de plaisance et en formant une poignée d'élèves-pilotes.

Tandis que ces amoureux de l'air alimentaient l'avia-





tion privée, deux autres influences se manifestaient, qui étaient destinées à s'allier dans les années 60. Les constructeurs concevaient et réalisaient des appareils de type amélioré et, d'autre part, le progrès économique et social exigeait des moyens de transport plus rapides et plus souples.

L'aviation privée est entrée maintenant dans sa troisième phase de croissance. Les avions sont devenus bien autre chose que de simples véhicules qui volent. Ils font gagner du temps aux hommes d'affaires, propagent les talents des professeurs et multiplient les missions secourables des médecins.

Aujourd'hui, aux États-Unis, plus de 9 500 aérodromes sont utilisés par 100 000 appareils privés. Sur 302 de ces aérodromes, où sont installées des tours de contrôle, les appareils privés ont effectué l'an dernier plus de 35 millions de décollages et d'atterrissages et il n'est pas possible d'évaluer les millions de vols faits par les avions utilisant les aérodromes dépourvus de tour. Les trois quarts des vols passant par les 302 aérodromes équipés sont le fait d'appareils privés. Le quart restant est du domaine des transports aériens et de l'aviation militaire.

Chaque semaine, les usines américaines produisent quelque 300 avions destinés au secteur privé. Certains sont exportés (2 503 l'an dernier, à destination de 70 nations) : ils ont représenté au cours des deux dernières années, en nombre, à peu près les effectifs des flottes exploitées par toutes les lignes aériennes du monde (à l'exception de l'U.R.S.S. et de la République de Chine, dont les chiffres ne sont pas connus).

Ces avions sont utilisés pour des tâches multiples, allant du saupoudrage des champs de coton au Soudan à l'envoi d'urgence de secours médicaux dans les régions isolées de l'Australie. Deux heures de vol en Afrique, le long d'un fleuve, ont permis de prospecter les ressources hydrauliques et les possibilités d'irrigation sur 300 kilomètres. Cette opération aurait exigé un mois par des moyens terrestres. En Amérique du Sud, un planteur transporte par air son café fraîchement récolté depuis son exploitation de montagne jusqu'au marché urbain. Il lui faut 45 minutes contre 3 jours par charrette à bras. Au Brésil un avion monomoteur transporte 7 000 poussins par voyage, de ses couveuses jusqu'aux fermes isolées.

L'aviation se développe si rapidement aux États-Unis que son succès même est la source de ses problèmes. Les aéroports sont bondés. La main-d'œuvre, à ses différents niveaux, se raréfie. Mais ces maladies de croissance sont le résultat de solutions apportées à des problèmes plus vastes et plus sérieux. C'est ce qu'il fait, et non ce qu'il est, qui a donné toute son importance à l'avion privé.

Il y a sept ans, de l'engrais a été répandu par voie aérienne sur une pépinière expérimentale. La végétation de cette parcelle a connu une croissance plus rapide de 30 % que celle des arbres avoisinants, qui n'avaient pas été traités. L'avion pourrait ainsi réduire de 20 ans la durée qui s'écoule normalement avant que les sapins Douglas aient atteint le stade de l'abattage (60 ans) et aiderait à répondre à la demande en bois de construction, qui augmente sans cesse.

Si le facteur temps joue un rôle important en sylviculture, il est également essentiel pour l'homme d'affaires qui se rend compte qu'aller lentement peut signifier aller à la ruine. Une firme américaine, avant de se décider à acheter son propre avion, analysa ses voyages d'affaires et constata que, dans le cas d'une ville fréquemment visitée par ses fondés de pouvoir, l'avion de la société pourrait économiser 29 heures et 30 minutes sur les allers et retours comparables effectués par avion de ligne.

Les données économiques du transport aérien régulier imposent une concentration des services là où se trouve la masse des voyageurs. L'aviation privée comble la lacune, de sorte que l'homme d'affaires peut planifier ses horaires à sa convenance.

Quelle que soit l'importance que l'aviation privée présente aujourd'hui et promette de présenter demain pour le progrès économique et social des États-Unis, elle n'approche pas du rôle capital que ce mode de transport peut encore jouer dans d'autres parties du monde. Les pays en voie de développement trouvent en particulier dans l'avion privé le véhicule pionnier qui leur permet de développer leurs ressources et d'accélérer leur croissance. Un seul avion ouvre tout d'un coup au commerce bien des zones éloignées et met en contacts fréquents bien des civilisations.

En bref, l'appareil de l'aviation privée est devenu une force puissante de progrès et de paix.

Les hélicoptères

Il y a vingt et un ans, le 8 mars 1946, le Bell 47B recevait la première licence délivrée à un hélicoptère commercial. Aujourd'hui, plus de 10 000 hélicoptères civils et militaires sont en service dans plus de 80 pays. Des appareils construits aux États-Unis volent dans le monde entier, du Canada, où ils sont utilisés pour le ravitaillement du réseau de radars DEW, jusqu'aux jungles de Bornéo ; ils supportent des températures allant de – 45 à + 50 degrés centigrades, et sillonnent les airs du niveau de la mer jusqu'aux hautes altitudes des Andes et des Alpes.

Dès le début de sa carrière, l'hélicoptère a démontré qu'il était un instrument sûr pour des travaux courants tels que la surveillance des lignes électriques, le saupoudrage et la pulvérisation de divers produits sur les récoltes, le taxi aérien et les opérations de sauvetage. Maintenant, l'hélicoptère prouve qu'il est seul capable de surmonter l'obstacle du terrain, et de donner accès à des régions considérées comme inaccessibles.

L'annuaire des pilotes d'hélicoptères de 1966, établi par l'Aerospace Industries Association of America, dénombre, pour le Canada et les États-Unis, 933 pilotes, 2 318 hélicoptères et 183 écoles de vol.

Trente-neuf modèles sont actuellement construits aux États-Unis. Ils vont du Gyrodyne QH-50D, hélicoptère radioguidé sans pilote, à la grue volante Sikorsky S-64A, qui peut transporter, dans la cabine suspendue sous la grue, 67 passagers et un équipage de 5 hommes.

Le premier hélicoptère qui ait pris l'air fut construit en France, il y a exactement soixante ans, par Louis Bréguet, qui prouva que le vol vertical était possible. L'Espagnol Juan de la Cierva, qui mit au point l'autogire aux environs de 1925, apporta lui aussi une importante contribution au vol vertical.

En 1909 et en 1910, le jeune ingénieur Igor Sikorsky procéda aux essais d'un hélicoptère ; mais le moteur dont il disposait alors n'était pas assez puissant. Trente ans plus tard, le même Igor Sikorsky, que ses avions multimoteurs et ses Flying Clippers transocéaniques avaient rendu célèbre, s'intéressait de nouveau à l'hélicoptère. Il disposait alors des groupes moto-propulseurs adéquats, et il mit au point le VS-300, premier hélicoptère utilisable construit sur le continent américain.

En 1951, la Kaman Aircraft Corporation lançait le premier hélicoptère à turbine. La turbine, qui a été perfectionnée par la suite, a radicalement transformé l'industrie des appareils à voilure tournante. Elle a réduit les frais d'entretien, amélioré les rendements et accru vitesse et rayon d'action. Les hélicoptères peuvent voler à plus de 360 km/h, et certains à des altitudes de 11 000 mètres environ.

Les lignes aériennes régulières du Groenland, de Grande-Bretagne et des États-Unis utilisent maintenant des hélicoptères américains à turbine. Au Groenland, l'hélicoptère dessert régulièrement des régions éloignées et jusqu'alors inaccessibles. En Grande-Bretagne, cet appareil assure un service rapide régulier entre le continent et les îles Scilly, voyage qui prenait plusieurs heures par mer.

Des hélicoptères à turbine de plus petit modèle, pouvant transporter cinq personnes, sont également construits. Ils sont utilisés par les entreprises industrielles et commerciales et les hommes d'affaires.

En 1966, 1 116 000 passagers ont emprunté les appareils des trois compagnies de navigation aérienne par hélicoptère à service régulier existant actuellement aux États-Unis (Los Angeles Airways, Inc., New York Airways, Inc., et San Francisco and Oakland Helicopter Airlines, Inc.). Ce total pour 1966 représente une augmentation de plus de 55 % sur 1965 ; il prouve que le public accepte de plus en plus l'hélicoptère et que la demande de services aériens reliant l'aéroport au centre de la ville s'intensifie. Les voyageurs qui se rendent à New York, par exemple, peuvent maintenant effectuer par air la totalité du déplacement. La compagnie New York Airways assure un service d'hélicoptère reliant les trois aéroports de la région à un héliport installé sur une jetée, au bas de Wall Street, et à un emplacement aménagé en pleine ville sur le toit du building de la Pan American. Des services analogues fonctionnent à Los Angeles et San Francisco.

L'hélicoptère n'a pas seulement prouvé qu'il était l'appareil susceptible du plus grand nombre d'utilisations. Il a également démontré qu'il était indispensable aux opérations de sauvetage. C'est au cours de la guerre de Corée qu'il en a donné la preuve pour la première fois. Plus de 2 300 combattants ont été alors évacués par hélicoptère, et c'est à cet appareil que l'on attribue la forte réduction du taux de mortalité parmi les blessés.

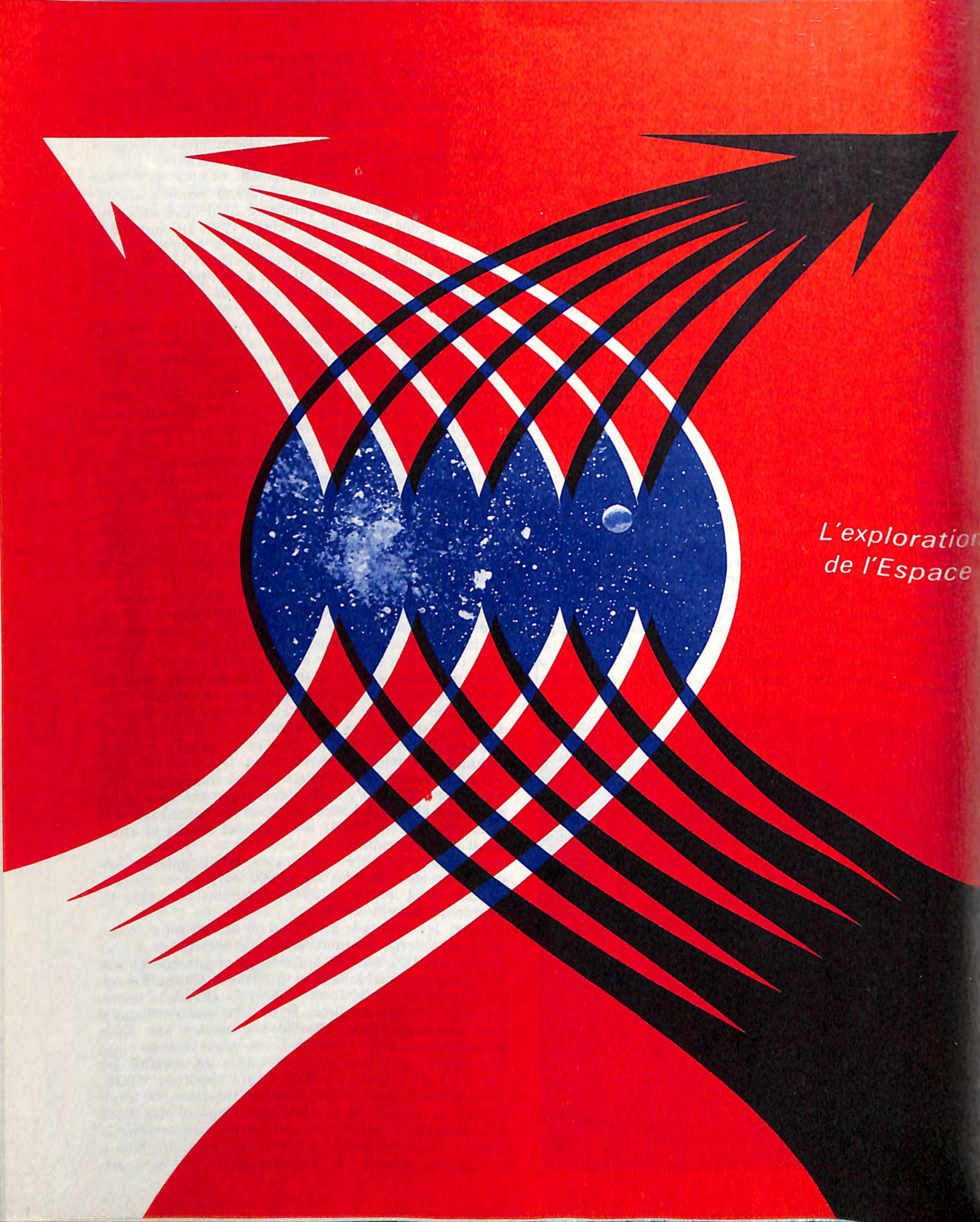
On estime que les hélicoptères américains ont déjà sauvé plus de 100 000 existences. Appareils militaires et appareils civils ont été utilisés conjointement en 1965 pour effectuer le sauvetage d'environ 2 000 personnes frappées par le cyclone Betsy, à La Nouvelle-Orléans (Louisiane). Pendant les graves inondations de Tampico, au Mexique, en 1955, les hélicoptères ont ramené en lieu sûr 9 262 personnes.

L'hélicoptère connaît de multiples utilisations. Il peut aider à sauver les victimes d'accidents de la route en les transportant jusqu'à l'hôpital : un nombre croissant d'établissements hospitaliers aménagent des héliports sur leurs toits ou sur des terrains adjacents. Dans l'avenir, il sera sans doute utilisé en cas d'accident pour enlever les voitures inutilisables, dégager la route et éviter les embouteillages.

L'industrie cinématographique utilise également l'hélicoptère, qui lui fournit la plate-forme volante idéale où installer une caméra pour les prises de vue aériennes. Les géologues l'emploient pour la prospection pétrolière, sur terre et en mer. Les services forestiers américains font appel à lui pour combattre les incendies de forêt. Sur les aéroports, cet appareil joue le rôle de véhicule d'urgence et d'extincteur. L'industrie du bâtiment lui fait soulever le matériel lourd, installer les tours de télévision et les poteaux télégraphiques. Les banques s'en servent déjà pour accélérer l'acheminement des chèques et des traites, ainsi que les opérations qui s'y rapportent. Dans plus de 40 villes des États-Unis, les hélicoptères de la police règlent la circulation, recherchent les criminels évadés et effectuent des patrouilles.

Les constructeurs américains d'hélicoptères employaient en 1966 plus de 44 000 personnes. La production s'est élevée à 2 500 appareils, soit près du double de celle de 1965.

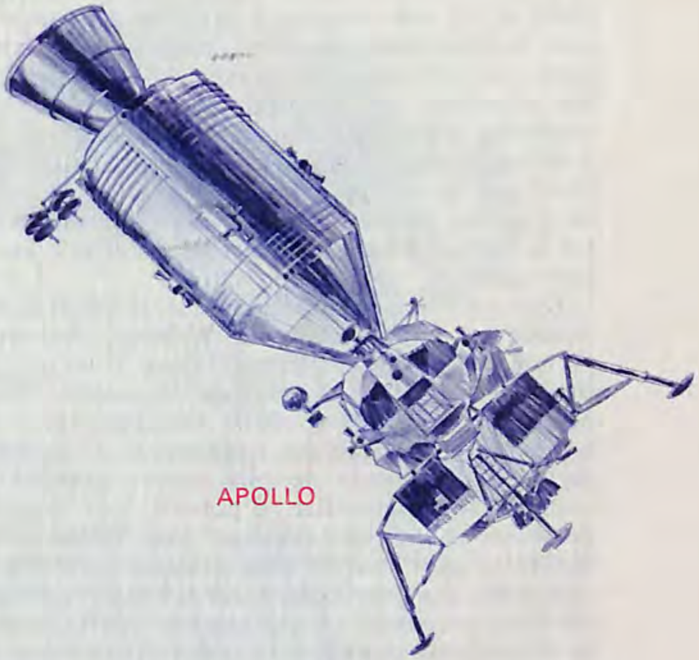
Outre les appareils à turbine en service ou en cours de production, de nouveaux hélicoptères et autres appareils VTOL (ADAV - décollage et atterrissage à la verticale) sont actuellement à l'étude. Citons notamment le rotor rigide, le rotor à cycle chaud, le turboréacteur, l'hélice carénée, la turbine sous carrossage. Ces innovations sont destinées à assurer une force ascensionnelle supplémentaire, une vitesse accrue et un plus vaste rayon d'action, associés à un abaissement des frais d'exploitation. Les futurs appareils VTOL, dotés d'une vitesse susceptible de dépasser 600 km/h et de transporter un nombre sensiblement plus élevé de passagers, pourront assurer les déplacements relativement courts, par exemple d'un centre de ville à un autre, évitant ainsi les trajets ville-aéroport.


L'exploration
de l'Espace

L'été prochain marquera le 10e anniversaire de l'Age spatial et, tandis qu'approche cette étape, une question se pose : « Qu'a réalisé l'homme au cours de la première décennie d'exploration spatiale et que signifient ces recherches pour les peuples de la Terre ? »

La réponse est que l'homme a accompli une série de miracles scientifiques et techniques qui permettent d'affirmer que ces premières années de l'Age spatial forment la décennie la plus fructueuse de l'histoire, pour ce qui est de l'amélioration des conditions de vie de l'humanité. La technique, dont l'évolution s'est trouvée accélérée par les impératifs découlant de la politique d'exploration spatiale, a été en mesure de convertir bien des progrès acquis en avantages concrets au bénéfice de l'humanité : satellites météorologiques et de communication et centaines d'innovations qui, bien que moins spectaculaires, sont, au total, fort importantes et vont des techniques chirurgicales améliorées aux lames de rasoir plus efficaces.

Ces applications des engins spatiaux, ainsi que les produits corollaires nés de la recherche spatiale, fournissent déjà une justification partielle de l'effort et



APOLLO

L'APPEL DE L'AVENIR

des investissements qui ont été consacrés, depuis dix ans, à l'exploration extra-terrestre. Si l'on compare à un iceberg la masse des bénéfices que l'homme a déjà retirés de la recherche spatiale, les avantages dont nous venons de parler n'en représentent que la partie visible. C'est dans la partie immergée, constituant les neuf dixièmes de l'iceberg, que se trouvent les gains les plus importants : un trésor d'informations nouvelles sur l'univers et une aptitude de plus en plus grande à les utiliser pratiquement. C'est là un bénéfice intangible, une promesse plutôt qu'une réalité, mais une promesse dont la réalisation est inéluctable.

Les États-Unis, qui ont construit environ 70 % de tous les véhicules spatiaux lancés à ce jour, ont naturellement supporté les plus grosses dépenses. A la date anniversaire du 4 octobre 1967, les divers programmes spatiaux non militaires auront coûté près de 35 milliards de dollars.

Quels profits auront procurés ces investissements? Tout d'abord, le rétablissement du prestige des États-Unis, qui avait reculé aux premiers jours de l'Age spatial. Les événements ont clairement démontré par la suite que la technique américaine ne le cède à aucune autre. Les capacités techniques sont un facteur essentiel de la prééminence du monde libre. Le prestige ne peut s'évaluer en dollars, mais son importance est indiscutable, car, pour jouer un rôle de chef de file, il faut avoir la confiance de ceux que l'on conduit.

Pour le réaliste à la tête froide, qui recherche des preuves plus concrètes de la rentabilité de ses investissements, il y a les véhicules spatiaux d' « application », ceux qui sont utilisés pour des buts pratiques plutôt que purement scientifiques. C'est dans ce domaine que les aspects internationaux des bénéfices de la recherche spatiale sont les plus apparents.

Les satellites géodésiques établissent la carte de la Terre avec une précision qui n'avait encore jamais été possible. Des chercheurs étudient l'emploi éventuel de satellites de navigation, véritables étoiles artificielles qui permettraient de déterminer avec une grande exactitude la position des avions au-dessus des océans. Plus de 50 nations se sont réunies au sein du Consortium international de Communications par satellites, afin d'exploiter les possibilités de transmission mondiale, par relais spatiaux, des messages télégraphiques et téléphoniques et des programmes de télévision.

Un nouveau type de véhicule spatial « d'application » se dessine maintenant à l'horizon : le « satellite de relevé des ressources terrestres », instrument qui permettra de répertorier les vivres, le pétrole, les minéraux, le bois et l'eau de la Terre entière, afin que ces ressources puissent être administrées et utilisées avec plus d'efficacité pour subvenir aux besoins de la population, face à une expansion démographique explosive.

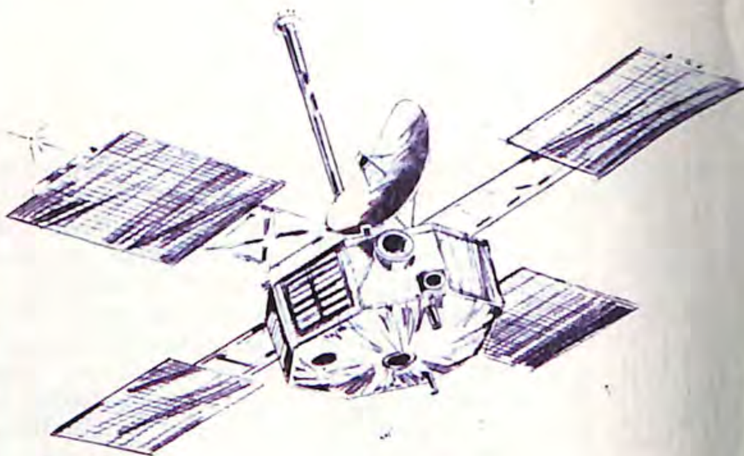
Le meilleur exemple de la contribution qu'un véhicule spatial d'application peut apporter à l'amélioration de la vie de l'homme est peut-être donné par le satellite météorologique primitivement lancé par l'Administration Nationale de l'Aéronautique et de l'Espace et aujourd'hui employé par l'Administration des Sciences de l'Environnement du département du Commerce des États-Unis, dans le cadre d'un système mondial utilisé par plus de 40 nations.

Il n'est personne qui ne puisse utiliser avec profit de quelque manière la prévision du temps. Mais, pour beaucoup, des prévisions météorologiques d'une grande exactitude présentent une importance vitale. Citons, par exemple, les agriculteurs, les spécialistes du transport aérien, les responsables de manifestations en plein air ou les propriétaires de maisons qui se trouvent sur le parcours de cyclones destructeurs. Depuis sept ans, les satellites météorologiques ont pris près d'un million de clichés des formations nuageuses qui recouvrent la Terre et les ont relayées à des météorologistes au sol pour la préparation de « nephanalyses », diagrammes du temps qui sont expédiés dans le monde entier. En bien des occasions, ces satellites ont assuré un service de sentinelle d'une valeur inestimable. Dans la mer des Antilles, le golfe du Mexique, l'océan Atlantique et le Pacifique, ils ont prévenu de l'approche d'ouragans et de typhons, permettant ainsi des évacuations massives sur le parcours de ces perturbations et sauvant des vies sans nombre.

Tout en ayant prouvé sa valeur, le satellite météorologique est encore dans son enfance. Aujourd'hui, il permet d'établir des prévisions sur trois ou, à l'occasion, sur cinq jours. Mais, dans le proche avenir, viendront des véhicules spatiaux beaucoup plus élaborés, en même temps que des ordinateurs et autres équipements au sol dotés de plus vastes possibilités; leur combinaison permettra d'obtenir des données plus nombreuses et en assurera une transmission plus rapide et une analyse plus effective. Cet équipement permettra des prévisions exactes à long terme pour une ou deux semaines, ce qui laissera aux utilisateurs plus de temps pour se préparer aux perturbations, et augmentera ainsi les avantages du système. On a estimé que les satellites météorologiques peuvent permettre à la seule agriculture de réaliser tous les ans une économie de 2 milliards et demi de dollars.

Le satellite météorologique montre aussi comment les bienfaits de la recherche spatiale américaine s'étendent au reste du monde, dans le cadre de la politique de coopération technique. Les premiers satellites exigeaient un équipement au sol complexe et coûteux pour la réception des signaux de l'engin et leur traduction en photographies utilisables. Reconnaissant qu'il y avait là un obstacle à l'utilisation mondiale du système, l'Administration Nationale de l'Aéronautique et de l'Espace et les industries aérospatiales qui travaillaient pour elle mirent alors au point un système appelé « Transmission Automatique des Images » (A.P.T.). Alors que les premiers satellites envoyaient des images sous forme de signaux de télévision, ligne par ligne, l'A.P.T. transmet une photo entière de la couverture nuageuse par un procédé analogue à celui qui est utilisé pour transmettre des radio-photographies. Ces images peuvent être captées dans le monde entier

OBSERVATOIRE GÉOPHYSIQUE SUR ORBITE (OGO)



MARINER

par des stations au sol quand un satellite est à portée, et l'équipement nécessaire peut être acheté pour environ 5 000 dollars, soit une dépense qui est dans les moyens d'une nation en voie de développement.

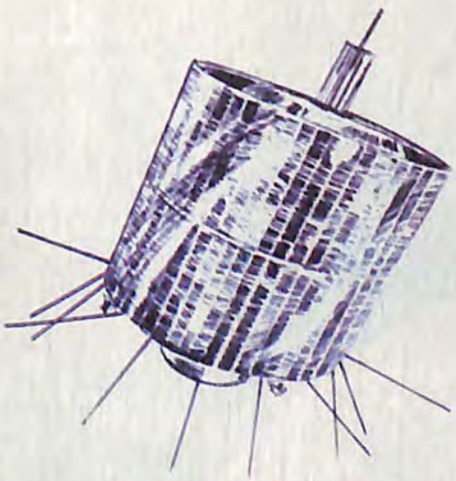
Les esprits réalistes peuvent aussi comprendre les avantages apportés par les produits et objets dérivés de la recherche spatiale. Bien peu de gens se rendent compte cependant du grand nombre de ces sous-produits, dont seuls les plus dignes d'alimenter l'actualité sont portés à la connaissance du public par la presse ou la télévision. La dernière liste de la N.A.S.A. dénombre plus de 1 200 produits ou techniques qui n'existaient pas il y a dix ans.

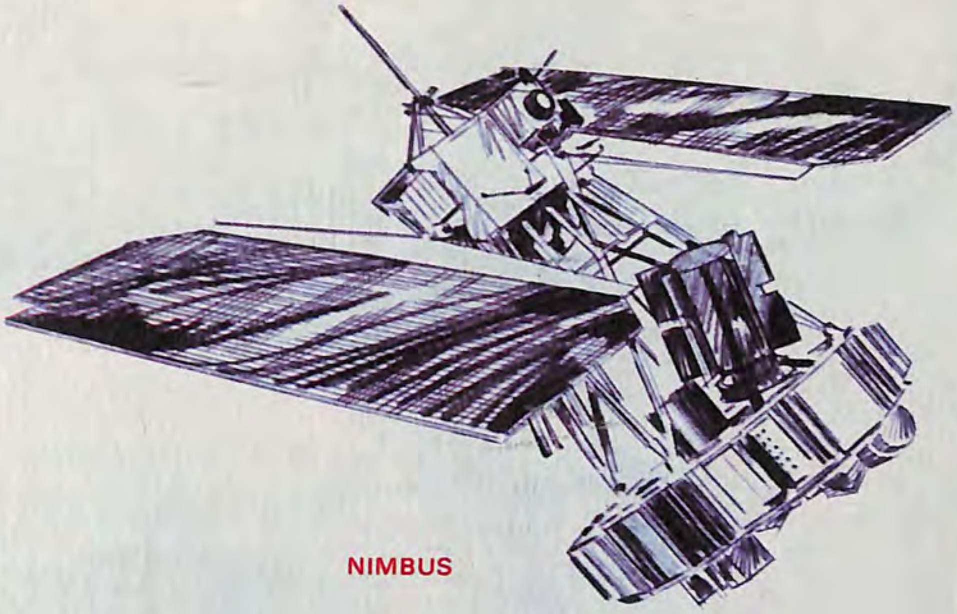
Le plus grand bienfait apporté par une décennie de recherche spatiale n'est pas encore très bien compris, car sa signification n'apparaît pas à première vue aux esprits pragmatiques. A quoi sert, peut-on se demander, de connaître la surface de la Lune, l'atmosphère de Vénus, ou de savoir par quels moyens un homme peut quitter sa planète et y revenir?

En manière de réponse, l'administrateur-adjoint de la N.A.S.A. délégué aux sciences, le docteur John E. Naugle, conte l'histoire de l'électricité. Il est difficile, sinon impossible, d'imaginer quoi que ce soit qui ait eu une répercussion plus frappante et plus décisive sur la vie de l'homme que l'énergie électrique, et cependant, du point de vue de ses applications pratiques, c'est une réalisation relativement récente qui n'a abouti qu'après des centaines d'années de réflexion, d'expérimentations et de compilations de données apparemment sans utilité.

La première expérience connue portant sur l'électricité, nous dit le docteur Naugle, remonte à quelque 600 ans avant Jésus-Christ, quand un philosophe grec nommé Thalès observa qu'un morceau d'ambre, frotté sur un tissu, attirait des particules.

Durant des siècles, des centaines d'expérimentateurs apportèrent des éléments d'information à la masse croissante des données relatives à l'électricité. Vers 1830, le savant britannique Faraday démontra que l'énergie mécanique peut être convertie en énergie électrique. Interrogé à la Chambre des Communes sur l'utilité de ses recherches, Faraday répondit : « Un beau jour, vous frapperez mon invention d'un impôt. »


SATELLITE D'APPLICATIONS TECHNIQUES (ATS)


NIMBUS

Cependant, jusqu'aux dernières années du XIX^{e} siècle, la plupart des savants n'envisageaient aucune utilisation pratique de l'électricité, qui présentait surtout, à leurs yeux, un intérêt théorique. Pendant deux millénaires et demi, l'homme avait édifié une tour de connaissances se présentant comme une pyramide inversée, chaque palier étant plus large que celui qui se situait au-dessous. Puis la technique, qui avait progressé à une cadence sans cesse plus rapide, sortit de l'enfance.

Thomas Edison réalisa l'ampoule à incandescence et avec Lane Fox, en Angleterre, organisa le premier système de distribution d'électricité. Alexander Graham Bell appliqua l'électricité à la transmission de la parole, et Guglielmo Marconi mit au point le télégraphe. Depuis, le catalogue des applications de l'électricité a pris les proportions d'un annuaire téléphonique, allant du bevatron à cette super-commodité de l'existence moderne qu'est l'ouvre-boîtes électrique.

La recherche spatiale est en train d'édifier une nouvelle pyramide de connaissances, non dans un seul domaine, mais dans des centaines, non pas à la cadence indolente de la civilisation antérieure, mais à un rythme incroyable, même aux yeux de ceux qui sont le plus étroitement mêlés à la plus ambitieuse entreprise de l'homme. Chaque petite parcelle d'informations sur l'univers est une pierre minuscule enchâssée dans la vaste mosaïque des connaissances humaines.

La cadence à laquelle les connaissances scientifiques sont traduites en avantages concrets est fonction du progrès de la technique. C'est en cela que réside la contribution extrêmement importante, mais mal comprise, de la recherche spatiale : elle impose à la technique un véritable « forcing » et en accélère le rythme à une cadence toujours plus rapide.

Avant l'Age de l'espace, l'industrie aérospatiale des États-Unis avait été déjà placée de force dans une position de suprématie technique, pour répondre aux exigences extraordinaires de la défense nationale et du transport aérien moderne. Mais l'espace a créé un problème d'un ordre de grandeur entièrement nouveau, commandé par un impératif national qui réclamait des progrès techniques prodigieux dans un laps de temps limité. On peut se faire une idée de ces progrès par ce bref résumé – qui n'est pas exhaustif :

Le premier satellite scientifique américain, Explorer 1, avait un diamètre de 15 centimètres, pesait 14 kilos et transportait trois appareils scientifiques. Le plus perfectionné, l'Observatoire Géophysique sur Orbite, mesure 15 mètres avec ses mâts télescopiques déployés, pèse plus d'une demi-tonne et porte 90 kilos d'appareils scientifiques.

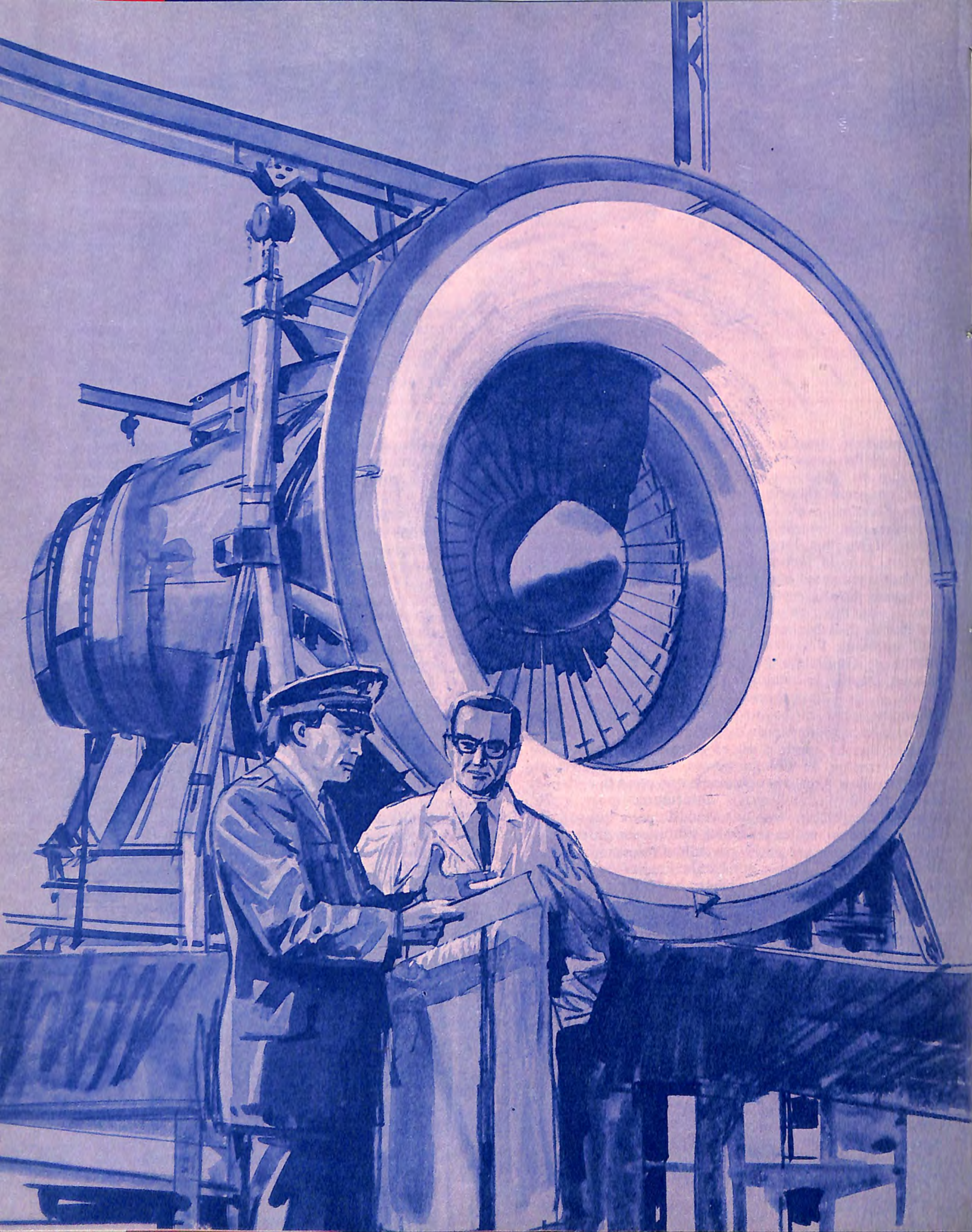
La première sonde lunaire américaine, Pioneer 1, lancée en 1958, a atteint une altitude de 112 500 kilomètres, soit moins du tiers de la distance de son but, la Lune. Comparons-la avec le Surveyor 1 de l'an dernier, qui est descendu doucement pour se poser sans heurt sur la Lune, ou avec Mariner 4, qui a parcouru 523 millions de kilomètres jusqu'à Mars et a envoyé 21 photos historiques de la planète rouge.

Le véhicule de lancement qui a envoyé le premier Américain dans l'espace développait une poussée de 34 tonnes. La fusée lunaire Saturne V, plus haute de six étages que la statue de la Liberté, produit exactement 100 fois cette puissance.

Après un vol initial d'une durée de 15 minutes, les États-Unis ont totalisé en moins de six ans près de 2 000 heures d'expérience de vol humain dans l'espace. Le premier véhicule spatial piloté, Mercury, pesait moins de 1 400 kilos et assurait à l'astronaute la protection d'un environnement climatisé pour un maximum de trois jours. Apollo, dans sa version lunaire, pèse près de 40 000 kilos, et le plus petit de ses trois modèles a quatre fois la dimension de Mercury. Le dispositif de contrôle de l'environnement peut faire subsister trois hommes pendant 14 jours. Ce délai sera porté à 45 jours dans les versions ultérieures. Ce vaisseau spatial, qui est l'une des inventions les plus complexes de l'homme, peut voler jusqu'à la Lune, orbiter autour d'elle, détacher un véhicule d'exploration pour faire atterrir deux hommes sur le sol lunaire, accoster le véhicule à son retour et ramener en toute sécurité l'équipage jusqu'à la Terre.

L'Age de l'espace a ainsi fait progresser la technique américaine sur des milliers de fronts.

Mais le véritable exploit de cette décennie de progrès incroyable a été d'amener la science et la technique à franchir, l'une par l'autre, de nouvelles frontières.



L'aviation militaire

DES PROGRÈS CONSTANTS

L'aviation n'a jamais connu de prophète infaillible. Personne n'a jamais été capable de prévoir avec exactitude les progrès que l'aéronautique pourrait effectuer dans un laps de temps donné.

Aucun secteur de l'aéronautique n'illustre mieux que l'aviation militaire cette inaptitude à figurer l'avenir. Le monde de l'aviation militaire d'aujourd'hui est tout à fait différent de ce que la plupart des gens, il y a une dizaine d'années, pensaient qu'il allait être. Le meilleur exemple en est fourni par la controverse sur les avions et les fusées. A un moment donné, on croyait généralement que, dans le domaine militaire tout au moins, les missiles avaient définitivement détrôné les avions.

L'expérience en a décidé tout autrement. Le caractère durable et solide de l'avion, son aptitude à remplir les missions les plus variées en ont fait l'un des éléments essentiels des armées importantes. Les hélicoptères, en outre, ont rejoint les avions en première ligne.

Personne ne prévoyait certainement, en 1927, la grande variété d'avions militaires qui voleraient 40 ans plus tard, la haute qualité de leurs performances et l'étendue de leurs utilisations. Pourtant, cette année-là, les perspectives d'avenir pour l'aviation paraissaient particulièrement brillantes. Mais la réalité devait dépasser tous les espoirs. L'aviation européenne témoignait alors d'une vigueur exceptionnelle. Les États-Unis répondirent à leurs concurrents par neuf grands raids, venant s'ajouter à la traversée épique de l'Atlantique par Lindbergh.

Les progrès techniques durant la décennie qui suivit la Première Guerre Mondiale furent stupéfiants. L'industrie, américaine et européenne, avait résolu le problème du poids par l'emploi de l'aluminium laminé. La puissance des moteurs à pistons s'accroissait rapidement. Les long-courriers civils et militaires capables de transporter quelque vingt personnes sur plusieurs centaines de kilomètres établissaient de nouveaux records de régularité en service quotidien. La vitesse maximale des avions de chasse avait été portée à plus de 240 km/heure, soit un progrès de l'ordre de 50 % par rapport aux meilleurs modèles de la guerre. Les performances saisissantes réalisées au cours de compétitions telles que la Coupe Schneider, où la vitesse atteinte fut de près de 400 km/heure, ne laissaient aucun doute sur les progrès qui s'annonçaient.

En 1927, l'Armée de l'Air américaine prévoyait la mise en service, pour 1932, de 1 892 avions dont 59 capables de transporter ensemble un millier de soldats pour une seule opération.

L'achat de ces avions de transport a marqué aux États-Unis la naissance d'une tendance qui s'est par la suite largement développée : la première force aéromobile était créée. Pendant et après la Deuxième Guerre Mondiale, des milliers d'avions de transport militaires ont été construits. Ils ont rendu les plus grands services en temps de guerre comme en temps de paix.

Leur efficacité en temps de paix a été démontrée pour la première fois de façon éclatante durant le pont aérien de Berlin en 1948. Plus de 300 quadrimoteurs venant des États-Unis, de Grande-Bretagne et d'autres nations ont, pendant des mois, assuré le ravitaillement de la ville.

Même alors, vingt ans après le raid de Lindbergh, on ne se rendait pas toujours compte que le transport par air était encore dans son enfance. Le moteur à réaction, né en Europe, commençait tout juste à être utilisé. Bien des techniciens étaient pessimistes quant à la perspective de le voir remplacer le moteur à pistons dans le domaine militaire ou commercial. Le moteur à réaction, affirmaient-ils, aurait une très courte durée d'utilisation entre révisions, et il consommerait des quantités prodigieuses de carburant.

Peu de prévisions techniques ont été aussi erronées. La durée d'utilisation entre révisions d'un réacteur commercial s'élève à 10 000 heures, soit environ cinq fois celle du meilleur moteur à pistons. Sa consommation de carburant se rapproche de celle des meilleurs moteurs à essence.

Aujourd'hui, une ère révolutionnaire s'est ouverte pour les déplacements à longue distance des troupes et du matériel. Le plus grand avion de transport du monde, le C-5A, est en cours de réalisation à la Lockheed Aircraft Corp. pour le compte de l'Armée de l'Air américaine. Cet appareil pèsera plus de 317 tonnes et transportera au moins 500 hommes au-dessus de l'Atlantique, à plus de 800 km/h. La société General Electric fabrique les très puissants réacteurs à soufflante de 18,5 tonnes de poussée qui actionneront le C-5A.

Les possibilités de ces nouveaux avions sont prodigieuses. Un seul d'entre eux peut remplacer vingt au moins des quadrimoteurs utilisés pour le pont aérien de Berlin. Du point de vue militaire, le C-5A peut jouer un rôle très important, car il est capable de déplacer par la voie des airs des divisions complètes, y compris leurs plus gros chars d'assaut. Auparavant, seules les unités pourvues d'un armement léger pouvaient être transportées par avion.

De grands progrès sont également effectués dans le déplacement tactique des troupes, grâce aux hélicoptères et aux petits avions de transport. Dans certaines unités, camions et véhicules terrestres ont été purement et simplement éliminés pour le transport des troupes en opérations.

Les appareils à voilure tournante vont des petits biplaces aux hélicoptères lourds – qui peuvent emporter plus d'hommes que le Douglas DC-3, principal transporteur de la Deuxième Guerre Mondiale – et même à la grue volante Sikorsky S-64A, qui peut soulever des charges de 11 tonnes. Des vitesses de croisière de plus de 320 km/h ont été réalisées par des hélicoptères expérimentaux. La prochaine génération de véhicules opérationnels sera ainsi dotée d'une vitesse supérieure de près de 100 % à celle de la plupart des hélicoptères d'aujourd'hui.

L'introduction du moteur à réaction a fait progresser les performances des avions de chasse et des bombardiers de façon spectaculaire à la fin de la Deuxième Guerre Mondiale, les vitesses de pointe passant d'environ 650 km/h à 970 km/h. Cependant, la portée des gains qui allaient être réalisés dans les vingt années suivantes était alors à peine entrevue. De nombreux techniciens de l'aéronautique, parmi les plus respectés, croyaient qu'une « barrière sonique » empêcherait les avions pilotés de voler à une vitesse supérieure à 1 240 km/h.

En 1947, le capitaine Charles Yeager, de l'Armée de l'Air américaine, en volant à une vitesse supersonique sur l'avion expérimental Bell X-1, prouva de façon décisive que la « barrière sonique » n'existait pas.

Depuis cette date, des progrès techniques ininterrompus ont permis la réalisation dans plusieurs pays de chasseurs et de bombardiers qui volent à une vitesse de croisière subsonique élevée et peuvent pousser des pointes à deux fois la vitesse du son (environ 2 100 km/h) pour de courtes périodes. Le rayon d'action et la charge utile des chasseurs et des bombardiers se sont aussi accrus rapidement quand des moteurs à réaction améliorés sont entrés en service. Les chasseurs-bombardiers les plus modernes, tels que le McDonnell F-4 et le Republic F-105, peuvent transporter des charges plus lourdes sur de plus longues distances que certains bombardiers lourds de la Deuxième Guerre Mondiale.

Voici plusieurs années, une autre étape importante a été franchie. Un avion à vitesse de croisière supersonique capable d'être maintenue sur des parcours intercontinentaux a été construit aux États-Unis par Lockheed. Plusieurs problèmes nouveaux et très difficiles ont dû être résolus pour mettre au point cet appareil, le SR-71, qui vole à Mach 3 (plus de 3 200 km/h). A cette vitesse, les températures extérieures de l'avion atteignent des niveaux sans précédent. Les sections antérieures de la voilure, du fuselage et de l'empennage sont portées au rouge sous l'effet de températures supérieures à 230° centigrades. L'aluminium classique ne pourrait résister à une telle chaleur. Il a donc été nécessaire d'innover en recourant pour la première fois au titane.

De difficiles problèmes de température ont dû également être résolus pour la mise au point du groupe motopropulseur du SR-71, le Pratt et Whitney J 58. En plusieurs domaines, ce gros turboréacteur a ouvert la voie à des conceptions techniques nouvelles.

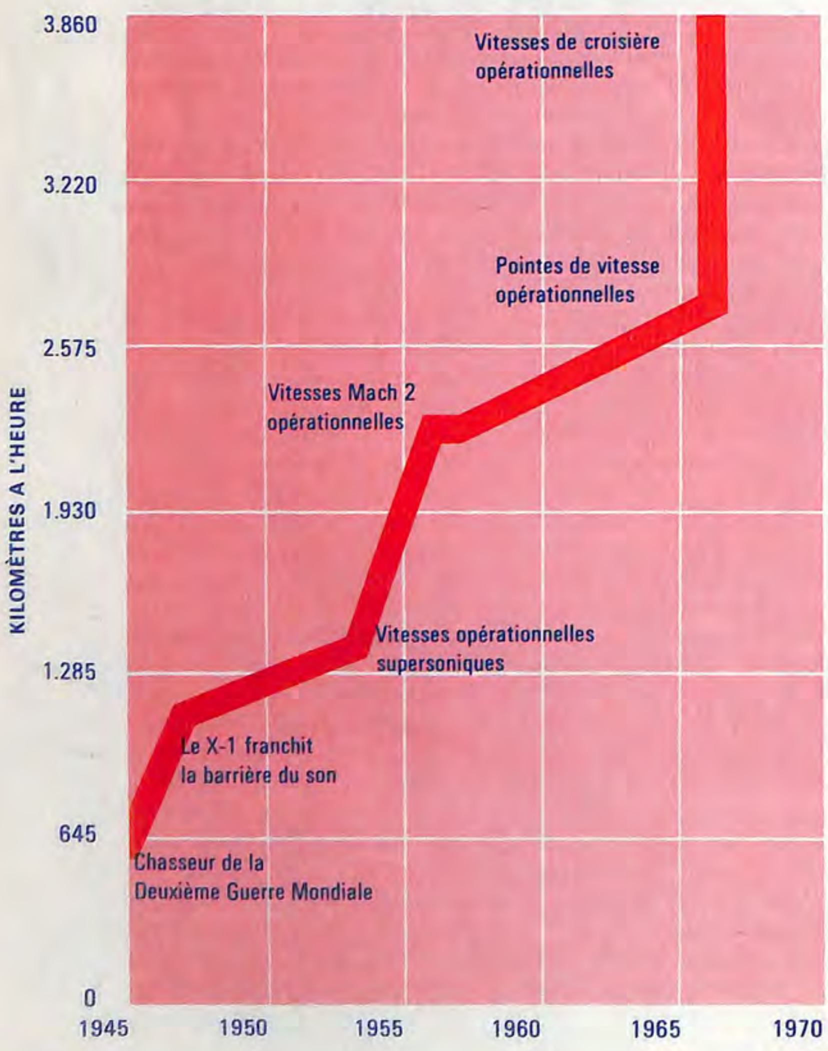
Le SR-71 a été suivi, pour les essais en vol, par le North American XB-70, qui vole également à Mach 3. L'un et l'autre de ces avions représentent de véritables bancs d'essai d'une importance capitale pour la technique des hautes températures que réclame la réalisation des avions commerciaux supersoniques tels que le Concorde, actuellement en cours de construction en Angleterre et en France, et le transport supersonique Boeing, qui sera produit aux États-Unis.

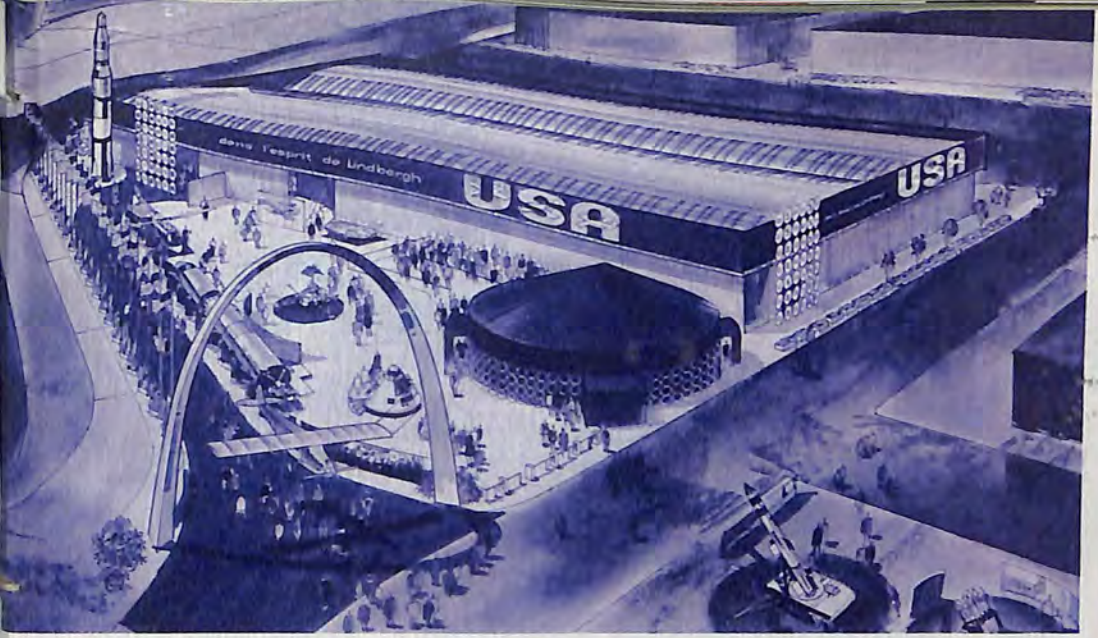
En dépit d'une maîtrise technique croissante et de l'impressionnante série des progrès réalisés en 40 ans, toute prévision relative à l'aviation demeure hasardeuse. Bien des problèmes difficiles doivent être résolus avant que les vitesses opérationnelles puissent être portées à plus de Mach 3, que les avions de transport supersoniques deviennent aussi rentables que les avions à réaction subsoniques actuels, et que les appareils à décollage et atterrissage verticaux puissent entrer largement en exploitation.

Les compétitions aéronautiques des années 20 et 30, qui ont fait progresser les vitesses et les techniques en Europe et en Amérique, n'ont plus cours aujourd'hui. Les vols expérimentaux les ont remplacées et ouvrent d'aussi vastes perspectives. Le North American X-15, par exemple, a déjà dépassé Mach 6 (plus de 6 400 km/h).

La recherche aéronautique est toujours en pleine vigueur en Europe, au Japon et en Amérique. A moins d'un changement radical dans l'ordre des choses, dans 40 ans, en 2007, le monde de l'aviation sera aussi différent de celui d'aujourd'hui que l'était comparativement celui du jeune Charles Lindbergh en 1927.

L'ÉVOLUTION DE LA VITESSE DES AVIONS MILITAIRES





« DANS L'ESPRIT DE LINDBERGH »

La participation des États-Unis au Salon de l'Aéronautique et de l'Espace, à Paris, est un nouvel hommage aux pionniers français et européens qui, aux premiers jours de l'aviation, ont imprimé leur marque sur les efforts américains.

Depuis qu'elle existe, cette manifestation constitue un foyer de coopération aéronautique internationale, et les États-Unis sont tout particulièrement heureux de se conformer à cette tradition génératrice de progrès.

Les États-Unis ont participé aux salons de Paris depuis le premier, qui s'est tenu au Grand Palais en 1909 ; la grande attraction était cette année-là l'avion à bord duquel Louis Blériot venait de traverser la Manche, de Calais à Douvres, effectuant ainsi la première traversée maritime de l'histoire.

Le thème de la participation des États-Unis, « Dans l'esprit de Lindbergh », commémore le raid historique sans escale de Charles A. Lindbergh, qui vola de New York à l'aéroport du Bourget les 20 et 21 mai 1927, et rend hommage à la contribution de la France et des autres nations à l'histoire aéronautique et aérospatiale.

La réplique de l'avion de Lindbergh, « The Spirit of St Louis », a été spécialement construite à Santa Ana (Californie) pour ce retour à Paris. L'appareil est présenté sous une maquette grandeur nature de la « Porte de l'Ouest », l'arc triomphal de 200 mètres de haut érigé à Saint-Louis (Missouri).

La section américaine cherche à illustrer les activités aérospatiales américaines en présentant :

- Les réalisations accomplies aux États-Unis depuis le vol de Lindbergh jusqu'à nos jours, et les perspectives pour les 40 années à venir.
- La contribution des États-Unis à la coopération internationale, soit notamment les facilités réciproques pour les liaisons aériennes, les échanges de renseignements dans le domaine de la recherche théorique et appliquée et des expériences, l'utilisation en commun des satellites de communication et d'étude ainsi que des installations de lancement.

Le pavillon des États-Unis traduit les efforts déployés de concert par l'industrie aérospatiale américaine et les services gouvernementaux des États-Unis, sous le patronage et la coordination du département du Commerce, qui fut chargé le premier du développement de l'aviation civile, un an avant le vol de Lindbergh. Il illustre par les stands individuels des compagnies privées et ceux des organismes gouvernementaux les succès obtenus depuis 40 ans.

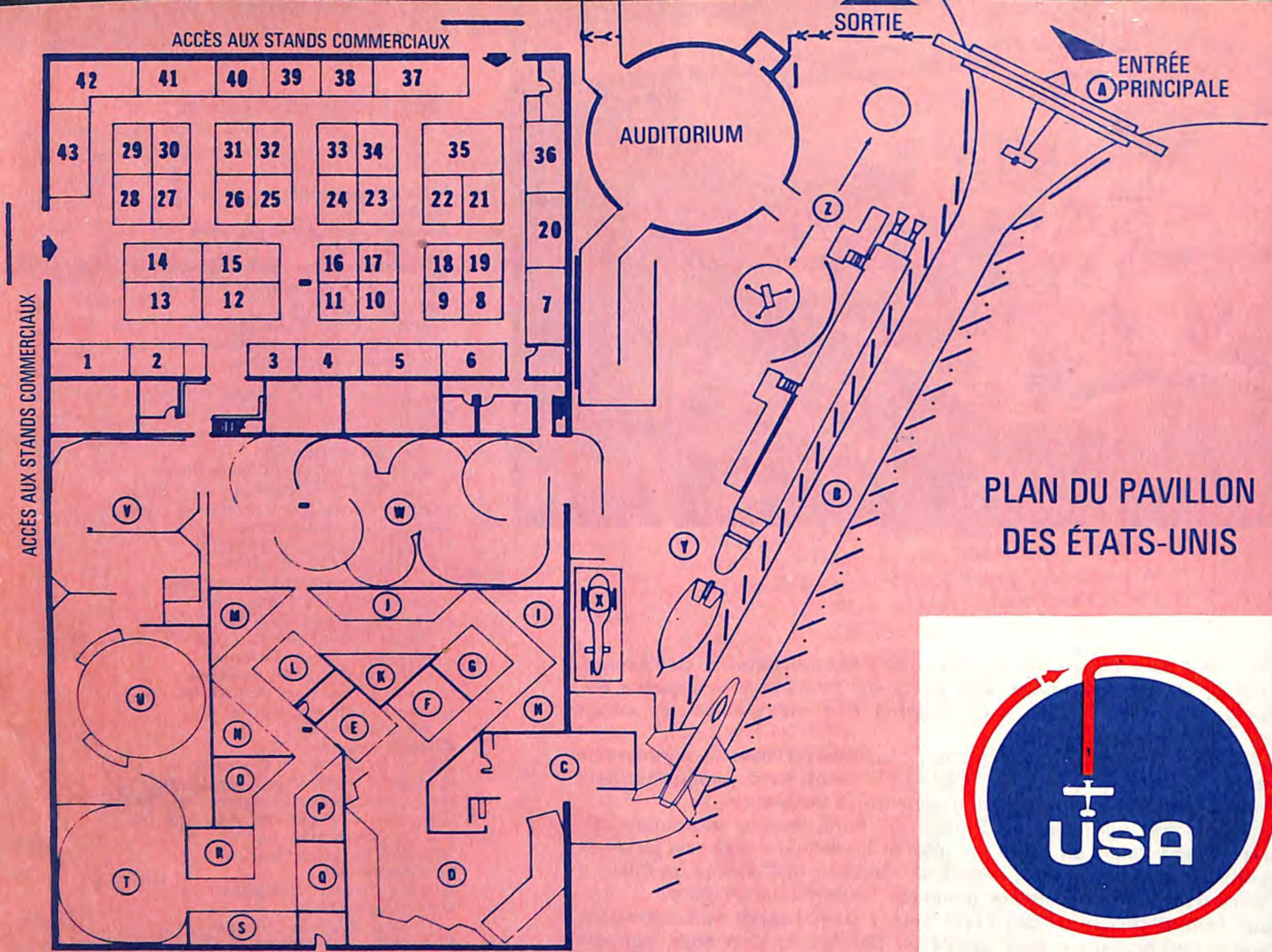
L'industrie aérospatiale des autres nations se voit ainsi offrir l'occasion de connaître les plus récents équipements américains. L'intérêt toujours plus grand que porte le public aux utilisations civiles de la technique aérospatiale est aussi pleinement reconnu : le pavillon des États-Unis leur consacre près des trois quarts de sa surface.

Une section commerciale montre enfin les productions des fabricants américains de pièces détachées et d'équipements d'infrastructure. (L'admission à cette section est limitée aux visiteurs appartenant au monde des affaires.)

SOCIÉTÉS MEMBRES DE L'A.I.A.

Abex Corporation
Aerodex, Inc.
Aerojet-General Corporation
Aeronca, Inc.
Aeronutronic Division, Philco-Ford Corporation
Aluminum Company of America
Avco Corporation
Beech Aircraft Corporation
Bell Aerospace Corporation
The Bendix Corporation
The Boeing Company
Cessna Aircraft Company
Chandler Evans, Inc.
  Control Systems Division of
  Colt Industries, Inc.
Continental Motors Corporation
Cook Electric Company
Curtiss-Wright Corporation
Douglas Aircraft Company, Inc.
Fairchild Hiller Corporation
The Garrett Corporation
General Dynamics Corporation
General Electric Company
  Defense Electronics Division
  Flight Propulsion Division
  Missile & Space Division
  Defense Programs Division
General Laboratory Associates, Inc.
General Motors Corporation
  Allison Division
General Precision, Inc.
The B. F. Goodrich Company
Goodyear Aerospace Corporation
Grumman Aircraft Engineering Corp.
Gyrodyne Company of America, Inc.
Harvey Aluminum, Inc.
Hercules Incorporated
Honeywell Inc.
Hughes Aircraft Company
IBM Corporation
  Federal Systems Division
International Telephone & Telegraph Corp.
  ITT Federal Laboratories
  ITT Gilfillan, Inc.
Kaiser Aerospace & Electronics Corporation
Kaman Corporation
Kollsman Instrument Corporation
Lear Jet Industries, Inc.
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Marietta Corporation
McDonnell Company
Menasco Manufacturing Company
North American Aviation, Inc.
Northrop Corporation
Pacific Airmotive Corporation
Piper Aircraft Corporation
PneumoDynamics Corporation
Radio Corporation of America
  Defense Electronic Products
Rockwell-Standard Corp.
  Aircraft Divisions
Rohr Corporation
Ryan Aeronautical Company
Solar, Division of International
  Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company
  Sperry Phoenix Company
Sundstrand Aviation, Division of
  Sundstrand Corporation
Thiokol Chemical Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
  Aerospace Electrical Division
  Aerospace Division
  Astronuclear Laboratory
  Marine Division

PLAN DU PAVILLON DES ÉTATS-UNIS



EXPOSANTS AMÉRICAINS

A. Entrée principale
B. L'allée Lindbergh
C. Entrée du pavillon
D. Federal Aviation Agency
E. General Electric Company
F. United Aircraft Corporation
G. The Garrett Corporation
H. North American Aviation
I. Wyman-Gordon Company
J. Litton Industries
K. Northrop Corporation
L. Beech Aircraft Corporation
M. McDonnell Company
N. Trans World Airlines
O. Lockheed Aircraft Corporation
P. Pan American World Airways
Q. The Boeing Company
R. Ling-Temco-Vought
S. General Dynamics Corporation
T. Environmental Science Services Administration
U. Communications Satellite Corporation
V. Atomic Energy Commission
W. National Aeronautics & Space Administration
X. Bell Helicopter Company
Y. Exposition en plein air - Département de la Défense
Z. Exposition en plein air - N.A.S.A.

1. Astra Aircraft Corporation
2. RCA Aviation Equipment Department
3. Inflight Motion Pictures
4. Latrobe Steel Company
5. Wyman-Gordon Company
6. Eastern Stainless Steel Corporation
7. Honeywell Inc.
8. Gray Company
9. Bild Industries
10. Zep Aero
11. Voltron Products
12. Conduction Corporation
13. General Connectors Corporation
14. United Control Corporation
15. Ampex Great Britain
16. Standard Pressed Steel Company
17. Schick Products
18. Brodsky, Hopf & Adler
19. Hazeltine Corporation
20. Atlantic Research
21. Borg-Warner International
22. General Precision
23. Baird-Atomic, Inc.
24. Airco Supply Company
25. Allen Aircraft Radio, Inc.
26. Abex Corporation
27. Lawrence Electronics
28. Dorne & Margolin
29. Motorola
30. Stratoflex, Inc.
31. Chicago Aerial Industries
32. Northeast Aircraft Corporation
33. Laboratory for Electronics
34. Anglo-American Aviation
35. Link Group (General Precision)
36. Aeroquip Corporation
37. Westinghouse Electric International
38. Ryan Aeronautical Company
39. Del Mar Engineering Laboratories
40. Lockheed-California Company
41. Hardman Tool & Engineering Company
42. Aeromaritime, Inc.
43. REA International Corporation

Les sociétés aérospatiales américaines qui exposent hors du pavillon des États-Unis sont les suivantes : The Bendix Corporation, Cessna Aircraft Company, Grumman Aircraft Engineering Corp., Hughes Aircraft Company, IBM Corporation, International Telephone and Telegraph Corp., Kollsman Instrument Corp., Martin Company, Piper Aircraft Corp., Rockwell-Standard Corporation's Aircraft Divisions.

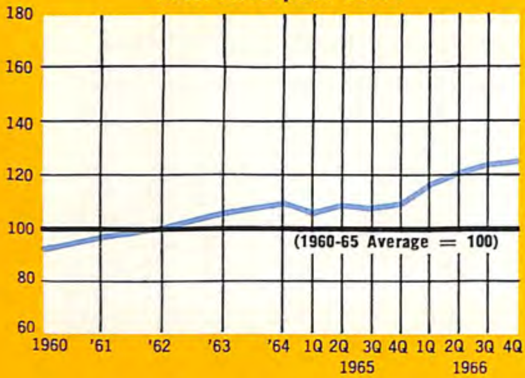
aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · JUNE 1967

AEROSPACE ECONOMIC INDICATORS

CURRENT

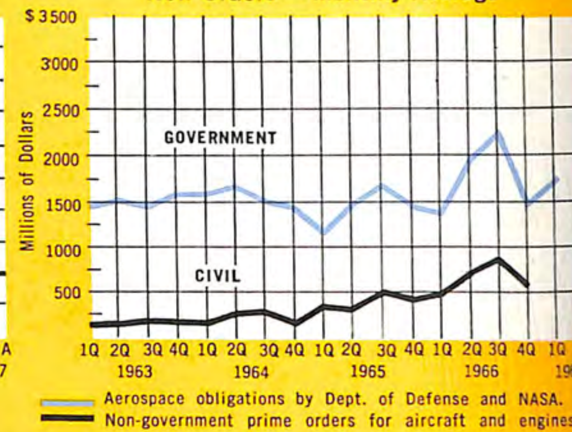
Total Aerospace Sales



Value of Civil Aircraft Shipments

OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-65 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD†	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.4	Quarter Ending Dec. 31 1966	20.7	23.8	24.2
	Billion $	Quarterly	4.8		5.2	6.3	6.3
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	March 1967	988	1,134	1,580
Aircraft	Million $	Monthly	601	March 1967	663	721	1,034
Missiles & Space	Million $	Monthly	550	March 1967	325	413	546
Aerospace expenditures: Total	Million $	Monthly	1,067	March 1967	1,190	1,192	1,521
Aircraft	Million $	Monthly	561	March 1967	729	776	1,006
Missiles & Space	Million $	Monthly	506	March 1967	461	416	515
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	March 1967	345	359	277
Expenditures	Million $	Monthly	130	March 1967	428	324	382
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	692	April 1967	1,385	1,200	1,094
Value	Million $	Monthly	15	April 1967	34	31	28
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	Quarter Ending Dec. 31 1966	20.4	26.9	27.8
U.S. Government	Billion $	Quarterly	11.6		13.7	15.8	16.0
Nongovernment	Billion $	Quarterly	3.7		6.7	11.1	11.8
EXPORTS							
Total (Including military)	Million $	Monthly	110	March 1967	139	142	176
New Commercial Transports	Million $	Monthly	24	March 1967	55	41	63
New Utility Aircraft	Million $	Monthly	2	March 1967	9	8	9
PROFITS				Quarter Ending Dec. 31 1966			
Aerospace — Based on Sales	Percent	Quarterly	2.3		3.5	2.7	2.9
All Manufacturing — Based on Sales	Percent	Quarterly	4.8		5.7	5.4	5.4
EMPLOYMENT: Total	Thousands	Monthly	1,132	March 1966	1,247	1,375	1,381 E
Aircraft	Thousands	Monthly	499	March 1966	524	601	604
Missiles & Space	Thousands	Monthly	496	March 1966	551	599	602
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	March 1967	3.34	3.47	3.49 E

R Revised
E Estimate
* 1960-65 average is computed by dividing total year data by 12 or 4 to yield monthly or quarterly averages.
† Preceding period refers to month or quarter preceding latest period shown.
# Averages for 1961-65.

AEROSPACE HIGHLIGHTS

The following summarizes the highlights of the aerospace industry's activities in the past year and is excerpted from a message to the membership by Karl G. Harr, Jr., president of the Aerospace Industries Association, in the AIA Annual Report.

The achievements of the aerospace industry in 1966 were unprecedented.

Sales reached a record $24.2 billion, an increase of 17 percent over the previous year, representing the largest annual gain in sales in a decade and a half. Gains were reported in all major categories — aircraft, missiles and spacecraft — with aircraft accounting for nearly half of all sales.

Exports of U. S. aerospace products achieved a record of $1.5 billion, due to a 19 percent increase in commercial transport exports and a 28 percent increase in general aviation aircraft.

Employment in the aerospace industry averaged 1,298,000, a rise of 14.6 percent over 1965, highest annual increase in recent years.

Aerospace payrolls increased to $11.2 billion, a gain of 18.2 percent over the previous year.

Backlog of orders at the end of 1966 rose to $27.8 billion, a rise of $7.4 billion over 1965, and almost double the backlog reported at the end of 1961.

The industry met the challenge of providing the equipment for Vietnam operations while responding to an increasing demand for its civil aircraft — commercial transports, general aviation and V/STOL aircraft. Concurrently space exploration moved ahead on a broad front of manned flight and scientific spacecraft.

The industry produced 344 commercial transports, up from 233 in 1965. The output of general aviation aircraft amounted to 15,747 units, worth $444 million. There were 586 civil helicopters produced, as well as a record number of military helicopters.

In space exploration by the end of 1966 the U. S. had accumulated 2,000 hours of manned orbital flight time, about 80 percent of the world's total experience. Lunar Orbiter 2 was placed in orbit around the moon and, in addition to spectacular views of the crater Copernicus, provided photographs of twelve potential Apollo landing sites. An Applications Technology Satellite was launched to initiate a new series of communications, meteorological and control experiments in a synchronous equatorial orbit. A major accomplishment was cloud cover photography of one-third of the earth. In all there were 97 spacecraft launches during the year.

Finally, during the year there emerged a much greater degree of realization of utilizing the industry's highly advanced technological and managerial capabilities for the solution of problems other than defense and space exploration. The application of industry's techniques to a wide variety of socioeconomic problems still is in an evolutionary phase, but the proposition that they can and will be used was firmly established.

AIA

aerospace

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

PRESIDENT • Karl G. Harr, Jr.
PUBLISHER • Glen Bayless

VOL. 5, NO. 6 JUNE 1967

EDITOR • Gerald J. McAllister
ASSOCIATE EDITORS • Richard W. Balentine
• John J. Lee
ECONOMIST • Gerson N. Chanowitz
ART DIRECTOR • James J. Fisher

CONTENTS

The purpose of AEROSPACE is to:

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

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

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

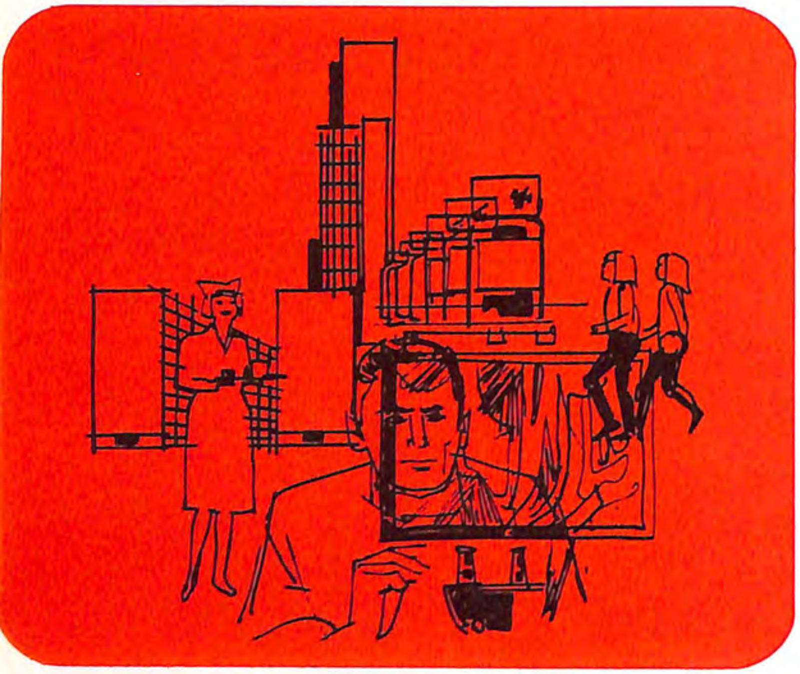
Foster understanding of the aerospace industry's capabilities to apply its techniques of systems analysis and management to solve local and national problems in social and economic fields.

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

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

Western Office: McCulloch Building, 6151 West Century Blvd., Los Angeles, Calif. 90045

TECHNOLOGY'S



DIVIDENDS

- Metals originally developed for use on space rockets now being used to fashion stronger, lighter and less expensive dental appliances.
- Coating developed to prevent fogging on the windshield of the X-15 research rocket plane being used in the manufacture of heated cradle covers that maintain a constant temperature around an infant.
- Reflective or heat absorbent paint developed for outer surfaces of space vehicles that are now used on rooftops to help control the temperature in buildings.
- Shock-absorbing aluminum tubes designed to soften lunar landings that serve as elevator shaft safety device and may eventually lead to impact-absorbing devices for automobiles.
- Heat-resistant electronic components able to lengthen the lives of radio and television sets and better withstand their self-generated heat.
- Lightweight plastics developed for rockets are now used in railway tank cars weighing half as much as steel cars.
- "Lunar walker," a remotely operated instrument with mechanical legs for unmanned exploration, having the potential for a walking chair that can perform tasks impossible for conventional wheel chairs.

These few examples illustrate some of the unusual and often unexpected ways in which the results of America's aerospace industry technology, spurred by the challenge of the space age, are providing beneficial dividends for almost everybody.

The direct pay-offs of this technology — such as weather, communication and navigation satellites — are already well known.

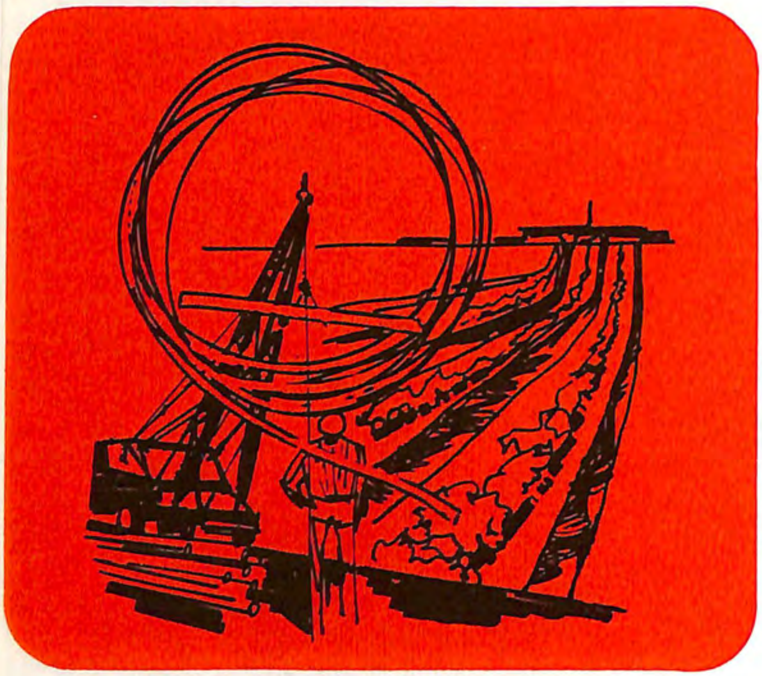
Yet these and countless other technology spin-off benefits are making important contributions in industry, medicine, transportation, or in the community and the home. A switch, devised for pilots and astronauts and actuated only by voluntary movement of the eyes, may tomorrow help paralyzed or limbless patients turn pages or operate motorized wheel chairs; space age plastics and other materials designed to withstand sterilization are being used for surgical gloves and electrical insulation in high-temperature environments; sealants for the seams of spacecraft are used to fill spaces between floor and bathroom tiles.

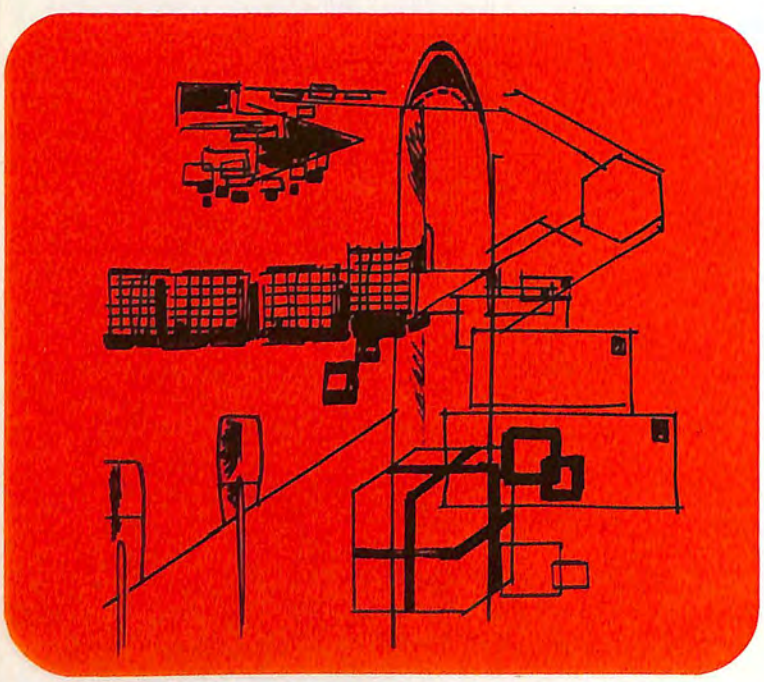
These examples are exciting. But far more important is the transfer of aerospace techniques and management to socioeconomic areas.

Aerospace engineers and executives have learned how to organize a diversity of skills in order to cope with the complex of disciplines that are invariably involved in many of today's social and economic problems. In sum, the industry has learned when to call up and use other specialists, how to achieve the interweaving of diverse skills in an age when technology is changing at a phenomenal rate.

It is this revolution in interdisciplinary management techniques that has created a "national asset" industry that is giving increasing evidence of contributions to national objectives of economic growth and environmental quality. Through the systems approach application of technology and management, the aerospace industry is coping with problems far removed from the production of aircraft, missiles or spacecraft.

To the aerospace industry, space exploration is only the dramatization of a more fundamental characteristic of the era the world has entered. John R. Moore, Executive Vice President of North American Aviation, Inc., describes this characteristic as *complexity* — increasing





with the birth of every child; with the geometrical multiplication of knowledge; with the depletion and/or pollution of our air and water resources; with our insatiable appetite for electrical power; with the congestion of our thoroughfares; and with the urban problems of metropolitan sprawl.

Contamination of our water resources is now a critical problem of national concern. Over the years great strides have been made in controlling and directing the course of our rivers. At the same time, however, the contamination of these resources has reached a point where we are now faced with a problem of cleaning up contaminants or finding sources to augment the supply.

Aerospace industry expertise is today being directed toward resolving those problems.

Avco Corp., for instance, has recently developed a program, employing the technique of systems analysis, that will provide a method for evaluating water technology, benefits and costs of water programs and facilitate a continuing assessment of state and regional policies, plans and programs, thereby enhancing the formulation of national water resource policy, planning and program management.

Aerojet-General Corp., working with the Department of the Interior, is applying an advanced technology method of "reverse osmosis" in combating industrial water pollution in a pilot plant operation in Odessa, Texas. Similar application of the reverse osmosis technique is being demonstrated by General Dynamics Corp. in experimental pilot plant tests with sanitation authorities of Los Angeles County and San Diego, California.

Both operations show promise of providing water of reasonably high quality from waste at a cost of about 30 cents per thousand gallons.

The reverse osmosis technique is also being applied as a method of extracting impurities from sea water. United Aircraft Corp. is examining various materials for filter membranes, while water desalting constitutes a major activity of Westinghouse Electric Corp. In 1966, Westinghouse contracted to build six desalting plants with a capacity of 13.8 million gallons of water a day, including plants in Kuwait, Key West, Florida, and St. Thomas, Virgin Islands.

At the other extreme, space age engineering at Douglas Aircraft has resulted in the development of a series of compact, low temperature salt water evaporators capable of meeting the fresh water needs of sea-going vessels ranging from pleasure boats to large freighters.

North American Aviation is studying methods of sea water purification through chemical means for the Department of Interior's Office of Saline Water.

The allied problem of air pollution is also receiving attention by the aerospace industry. Attacking the problem through the elimination of the source of pollutants is back of the fuel cell experiments of United Aircraft, as are initial developments by General Dynamics of a zinc-air battery for vehicle propulsion designed to replace the internal combustion engine. Westinghouse and General Electric are building atomic-powered electric generating equipment.

Resources of the sea provide an almost limitless supply of food and minerals. Efforts by aerospace companies to tap this wealth and to lessen the rigors and dangers of underseas exploration are becoming increasingly significant.

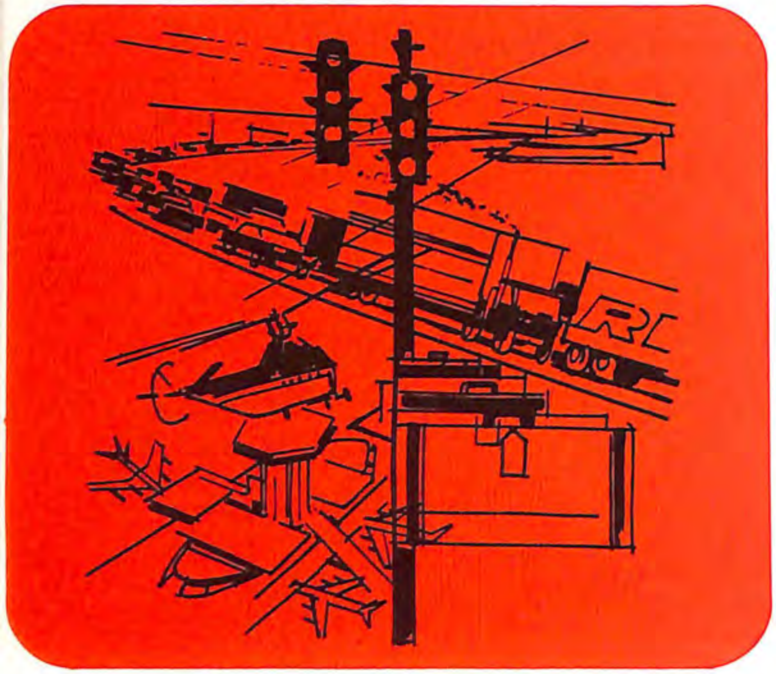
General Precision, Inc. is engaged in developing technology, systems and equipment required to exploit oceanographic resources or investigate phenomena for scientific and commercial purposes. The company's two-compartment submersible decompression chamber is currently under contract to Esso Norway for deep-water oil drilling off Stavanger, Norway.

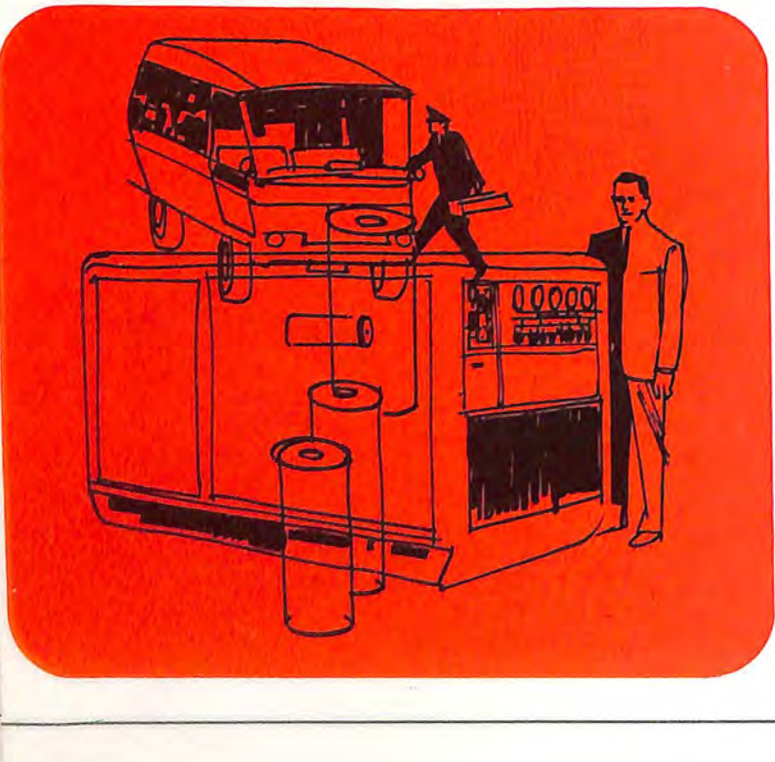
Westinghouse is likewise engaged in a variety of activities associated with the rapidly growing field of oceanology.

A three-man undersea vehicle called DEEPSTAR-4000 is the first of a family of submersibles built by Westinghouse to descend to great depths and do useful work. The vehicle is under contract to the Navy Electronic Laboratory, San Diego, California. The second DEEPSTAR, one capable of diving to 2,000 feet, is being assembled in the company's facilities near Baltimore. A third vehicle, DS-20,000, is being designed for use down to 20,000 feet.

Similarly North American's Ocean Systems Operations is working with the Mobil Oil Company on an advanced submersible work boat which will operate to depths of 2,000 feet. Gyrodyne Company of America, Inc. is plumbing the depths through the use of a pilotless helicopter and a dropped "bathythermograph."

The value of planning and management techniques developed by aerospace companies is demonstrated in the role of the Northrop Corp. in oceanographic activ-





ities. As prime management contractor for the Navy's Deep Submergence Systems Program, Northrop's role in this program involved managerial responsibilities for the coordination of all engineering drawings of rescue vehicles, assistance in drafting aims and goals of various DSSP projects and analysis and studies of underseas programs such as *Sealab II* and *III*.

Science Engineering Associates, a division of Kaman Corp., conducts basic research on environmental forecasting of deep or shallow waters, the effects of sea motion on ship design, tidal wave generation and effects, the optimum location and design for underwater pipelines and the design and assembly of special equipment for measuring oceanographic parameters.

One of the great new hopes for dealing with complexity of modern life is the startling advances made in recent years in information gathering and retrieval, for which a capability must exist if efficient operations are to be assured in private or public management.

Lockheed Aircraft Corp., for example, is conducting an information system project for Alaska. From the study phase of this proposal will come a coordinated plan for the development and implementation of electronic data processing for the state, taking into consideration current and future needs of all elements of the state government.

Similar systems engineering techniques are also being applied to the field of medicine.

One of the world's most advanced medical complexes will soon be created in Edmonton, Alberta, with engineering and planning techniques originally developed for space and missile systems, according to Dr. J. Donovan Ross, Alberta's Minister of Health. TRW Inc. has been retained to provide consulting services based on space-age technology in planning a Health Sciences Center for patient care, medical education and research.

Lockheed is analyzing existing hospital practices and developing a Hospital Information System concentrating on relieving the doctor and nurse from the necessity of recording and transmitting by hand all instructions and directions concerning patients in their care.

United Aircraft Corp. is translating its knowledge of airborne telemetry systems into physiological monitoring devices for use by the medical profession and in research. Transmitters, about the size of a cigarette package, which can be carried in a patient's pocket to transmit signals to a remote receiver to provide data of the patient's physical condition, have been developed by company engineers.

Garrett Corp., under contract to the U. S. Army Medical Service, has developed a complete, air-transportable 400-bed hospital primarily for use in support of combat troops in frontline areas. This facility combines the technology of inflatable structures, gas turbine power units, and environmental systems developed for commercial and military aerospace applications.

In the area of human and community needs the technology-management expertise of the aerospace industry offers a great potential. Just as the concentration of research efforts produced radically new innovations in the military and space sciences, industry emphasis of a similar scale on difficult economic and social problems is contributing to the meeting of human and community needs.

The decision by California to examine the feasibility of applying aerospace industry systems techniques to problems of state-wide concern provided a meaningful guide. The assessment of crime and delinquency by the Space-General Corp., government information by the Lockheed Aircraft Corp., transportation by North American Aviation, and waste management by Aerojet-General Corp., all excited a great deal of interest nationally. Vice President Hubert H. Humphrey summed it up:

"The pioneering efforts of California . . . to involve industry in finding new scientific and technological approaches to problems of crime and delinquency, government information, transportation, and waste management are significant for the entire Nation. . . . What is learned and recommended as a result of this work will be of interest to leaders at all levels of government throughout the country.

"I have been convinced for many years that such urgent public problems . . . can be resolved more effectively by systematically bringing our best scientific and engineering resources to bear on them. The defense and space programs have taught us how to mobilize these talents to achieve gigantic goals, and we can now use what we have learned to help realize the Great Society."

More and more the industry is working on how to better apply its talents to city problems what it has learned through systems development for defense and space programs.

Some examples:

- General Electric Company's center for advanced studies in Santa Barbara, California, TEMPO, has an experimental program with Detroit to introduce program packaging and budgeting techniques. Additional work is under way on applying systems analysis techniques to such facets as overall urban planning, integrated police, fire and ambulance communication networks, traffic flow monitoring and remote surveillance of public buildings.
- Northrop Corp. is conducting contract negotiations with Venezuela to provide a management support program to the Ministry of Public Works.
- TRW as planner for the United Community Services Priorities Project in the San Bernardino, California area is *donating* its services for the next year to develop a procedure that will help the UCS give considerably more service than ever before for each dollar contributed by the public.
- To help meet the challenge of lifting the quality and efficiency of education in our cities, and especially urban ghettos, General Electric and Time, Inc. have formed General Learning Corporation as a joint venture. Among its activities is the operation of a Job Corps Center in Clinton, Iowa.
- Both Sperry Rand Corp. and General Precision have developed systems for synchronized traffic control networks as a means of relieving metropolitan traffic snarls.
- The Garrett Corp. prepared a study for the San Francisco Bay Area Rapid Transit District to determine passenger comfort requirements of the Bay Area's rapid transit vehicles.
- Westinghouse, United Aircraft and Garrett are applying aerospace-developed technology to the design of high-speed, lightweight, economical ground transportation systems.
- Lockheed is undertaking a study for Sudan to provide a master plan for development of all forms of transportation from 1968 to 1980, while Northrop is performing a contract study for Chile on national air transportation requirements.

This age is one of vast social change sparked by modern technological advancement. Human and community needs are awesome. The aerospace industry is fully committed to actions aimed at ameliorating these challenging needs.

AEROSPACE NOTES

Aerospace Facts and Figures Documents Industry Growth

The 15th annual edition of *Aerospace Facts and Figures* just published by AIA reveals that during 1966 the aerospace industry experienced its greatest rate of growth since World War II. *Facts and Figures* documents this growth statistically relating these levels to previous years.

In the foreword, Karl G. Harr, Jr., president of AIA, points out that "notwithstanding the priority accorded providing military aircraft for Vietnam operations, the portion of military and space sales continued to decline, falling from 76 to 75 percent of total sales between 1965 and 1966 . . .

"The industry's present rate of growth may be overshadowed during the next decade," says Harr. "Forecasts of aerospace sales show levels exceeding $30 billion in the 1970s, a rise of 25 percent over 1966."

UTC Produces Solid Propellant That Can Be Sterilized

United Technology Center, a division of United Aircraft Corporation, has produced the first solid propellant to successfully withstand the rigors of dry heat sterilization. The new fuel exceeds the standards for sterilization set by the Jet Propulsion Laboratory, which include six 53-hour cycles at 275 degrees F. Under these conditions the fuel will not change physically, as others do, and will not ignite below 300 degrees, providing a reliable margin of safety.

In addition to its higher operating temperatures, it has a significantly longer storage life than other solid propellants. It also has a very low burning rate, 20 to 30 percent lower than other formulations, which is particularly important in upper stage applications requiring small diameter rockets with long burning times.

Adaptable to rockets of any size, the fuel can serve as the basis for an entire family of fuels for a wide variety of missions in space.

Lockheed Uses Electronic Wind Tunnel for Wing Design

Lockheed-Georgia Company has found a way to tailor wings for tomorrow's aircraft by computer in a research laboratory. Called "airfoil synthesis," the new programming technique converts a computer into an electronic wind tunnel capable of evaluating and testing new designs for aircraft wings. Airfoils or wing cross sections for any type of aircraft can be designed, analyzed and tested under various flight conditions by the computer and electronics engineer working as a team.

A TV-type screen displays computer

developed data and design information. The engineer uses a hand-held light pen to activate the computer and to communicate with the memory bank of the electronic wind tunnel.

The engineer signals the computer to provide a basic wing design in accordance with his instructions. The computer-derived design is then displayed on the screen and the computer literally asks the engineer if he likes the design.

B-52 to Test Fly GE's Turbofan Engine for C-5A

The 41,000-pound thrust TF39 turbofan engine which General Electric is building to power the U.S. Air Force C-5A cargo transport is to be flight tested this year in a modified B-52 bomber. As shown in this artists sketch, the C-5A engine will be installed in the right inboard nacelle replacing the two engines utilized in normal operation of the B-52.

This test program occurs about 15 months prior to actual flight test of the TF39 in the Lockheed-built C-5A.

Included in the modified B-52 are an installed data acquisition system and an instrumentation console. Certain B-52 systems will also be modified to more closely duplicate the basic C-5A systems applicable to the TF39 engine, including the electrical system, throttle and stopcock, hydraulic system, fire detection and extinguishing system, and pneumatic system.

Computerized Manikin Teaches Anesthesiology to Doctors

Applying aerospace engineering techniques, medical researchers at the University of Southern California working with engineers of Aerojet-General Corporation's Von Karman Center have devised the most complex medical teaching tool ever developed.

Using a lifelike manikin named Sim One, resident physicians in anesthesiology can learn how to administer anesthetics and control the breathing of patients. Computer programmed, electronic systems drive the mechanical actions of the manikin to simulate the symptoms and physiological responses an anesthesiologist may encounter during an actual operation.

Sim One is also programmed to provide appropriate responses to the injection of four different drugs as well as to the administration of both nitrous-oxide and oxygen.

The Computing Sciences Division of

Aerojet has reduced to mathematical equations all the physiological responses which project directors wished the simulator to perform.

It is believed that Sim One may be the first of a whole generation of medical simulators which can be used in medical training.

Advanced Welding Technique Employed on Apollo Engine

Bell Aerosystems employs an advanced welding technique for use in the construction of the Lunar Module ascent rocket engine which it is building for Project Apollo. Metal surfaces are bonded together by means of an aluminum alloy wire in the company's Laminar Flow Clean Room.

The wire is fed down from an overhead coil through the gunbarrel-like torch. The wire serves as a "consumable electrode." Melting in the intense heat, it is deposited in the joint. An inert gas, helium, protects the molten metal in the welding puddle and the arc from interacting with the oxygen in the surrounding air.

The rotating bed carries the metal past the arc at a speed of 16 inches per minute. The pulsing of the current ensures that the aluminum alloy will be deposited in a very fine, even spray. The brief bursts of high current, uniformly pulsed, are needed to produce the tiny droplets.

Cessna Develops Aviation Education Programs

In an effort to interest students in aviation, Cessna Aircraft Co. has developed three educational programs designed to make young people aware of the impact aviation has had upon social traditions, cultural structures and business practices and to give them some insight into how rapid advances in aviation technology will affect the entire course of their lives.

Separate educational programs are available for use in elementary schools, high schools, and junior colleges. These are the first to be offered on a nationwide basis.

One of the major goals of the program is to acquaint students with the vocational opportunities which will be available to them in aviation.

Literature on the program is available from Cessna.

Boeing Tests Water Fog As Crop Protector

A water fog has been discovered by The Boeing Company which is evaporation resistant and may be used to protect crops and trees from the effects of killing frosts. Boeing researchers estimate that a warm blanket of mist laid over a field of crops could hold in 80 percent of the heat the ground radiates into the air.

The secret is cetyl alcohol, one of the "long chain" alcohols which react with water to create fog. Computer studies indicate that about 10 gallons of water and as little as one one-hundredth pound of cetyl alcohol could produce a "flying cloud" large enough to cover an acre of crops with an insulating blanket of stable fog.

If the water fog proves out in field tests, Boeing engineers believe it may also be useful in crop dusting as a carrier for chemicals, and for the control of rain or hail. In the latter, the cetyl alcohol would coat cloud particles, impair their natural seeding process and impede formation of rain and hail.

Rohr Completes Tape-Wrapped Rocket Nozzle for Aerojet

Rohr Corporation has completed a 22.5-ton submerged rocket motor nozzle which is to be assembled to a 260-inch diameter rocket motor developed by Aerojet-General Corp. for test firing at its rocket propulsion facility in June. The Rohr nozzle, with ablative plastic liner components, is adaptable for thrust vector controls.

One third of the 45,000-pound weight of the nozzle is in the structural steel shell. The complete nozzle is 176 inches in height and has a major exit cone diameter of 180 inches. The nozzle throat is 89 inches in diameter.

Rohr's task was to use state-of-the-art materials, carbon-phenolic and silica-phenolic fabric tapes, for fabricating the seven individual ablative components and precisely mate each component with the steel shell into the final assembly. A 1,000-psi hydroclave densifying and cure pressure was used to mold the individual ablative components as a highly-uniform mass.

The photo shows the tape wrapping of the big exit cone which is done parallel to center line using carbon and silica-phenolic materials.


IT ALL STARTS WITH METALS

A few months ago a San Diego surgeon was confronted with the problem of replacing the breastbone of a patient whose chest had collapsed. One of his requirements was a type of steel that would be compatible with human tissue. The steel had to be flexible enough to permit its being shaped to the contour of the patient's chest, smooth enough and free of oxidizing elements to prevent irritation of the tissue to which it would be attached. Just any type of steel would not do, but it was determined that a special steel would meet the requirements.

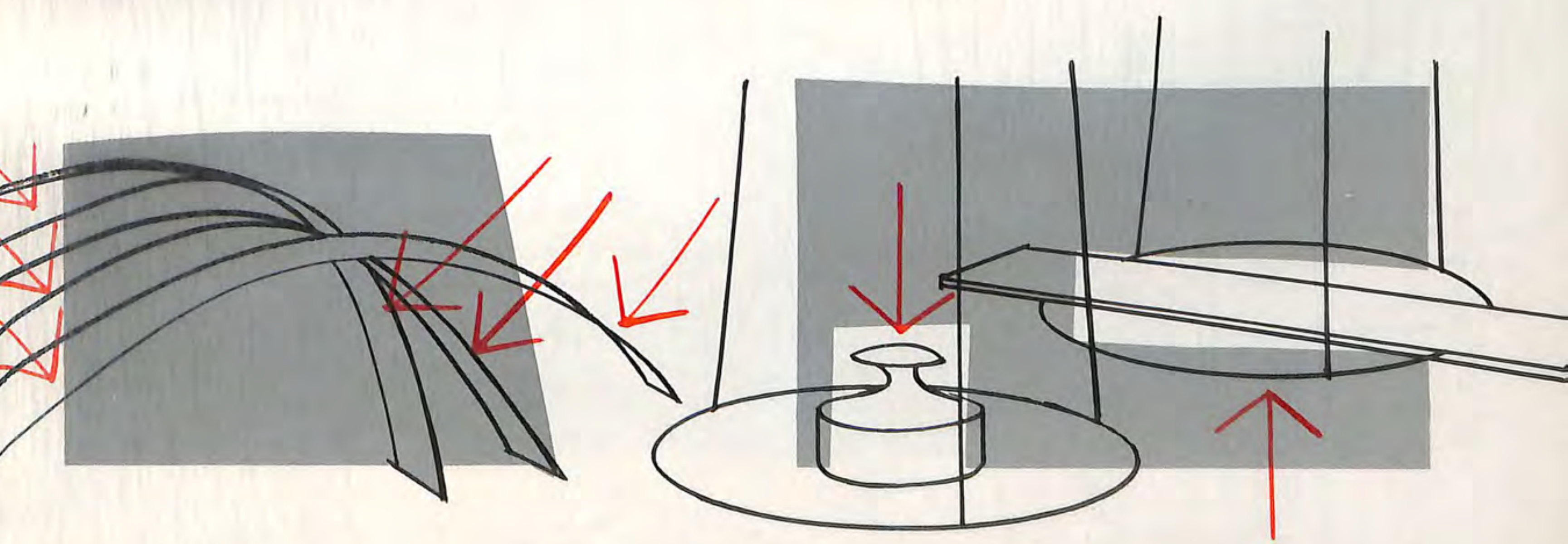
The surgeon found the type of steel he needed at Rohr Corporation. From it he shaped struts one-half inch wide, 15 inches long, and 1/32-inch thick. He curved the struts to the proper arc, drilled 1/64-inch holes in the ends, and attached them to the ribs on each side with sutures. The operation was successful and the patient is now leading a normal life.

The foregoing is but one of the more amazing examples of metals developed by and for the aerospace industry and later adapted to a wide variety of products and processes. Some of the various alloys of aluminum and steel have made possible the manufacture of light weight outdoor and indoor furniture, lighter weight and more powerful internal combustion engines and, more recently, jet engines and space vehicles.

Virtually all of the currently used metals necessary in the production of modern aircraft began with steel, aluminum, titanium, and tantalum, to name a few, and when combined with other elements has resulted in metals suitable not only for their original purposes, but for a wide variety of products, many of which could not have been produced with the materials available a few years ago. It is no exaggeration to say that the aerospace industry has contributed more to the development of metals than any other segment of our economy because, without these developments, the modern airplane and many other products would not be possible.

Metallurgists, in and out of the aerospace industry, working with designers of airplanes and space vehicles, have engaged in a constant search for stronger, lighter weight, and more heat resistant metals ever since the pioneer airplane builders got away from wood and fabric wings and fuselages. At first, aluminum was satisfactory as an airplane skin. Primitive alloys gave it sufficient strength and, at speeds around 100 miles an hour, or even double, skin friction with the atmosphere was of no consequence.

But engineers and designers were not content with low speed aircraft and with each step upward in both payload capacity and greater speed, new alloys were developed by the metallurgists. Whether the metals came first and then were applied to the aircraft, or whether the need for them inspired their development is like the age old question of which came first, the chicken



or the egg. At any rate, each need kept pace with the other.

The development of the jet engine and its capabilities of sending an airplane through the atmosphere at speeds approaching and then far exceeding the speed of sound hastened the search for new and exotic metals for structural members. When skin temperatures at supersonic speeds suddenly are elevated from 650°F to 800°F neither aluminum nor steel in the forms traditionally used are sufficient to withstand such heat in critical areas of the aircraft. Titanium alloys proved to be one answer, but now even the light-weight metal with its high melting point is nearing its limit, and extensive research is going on to develop an improved structural material so that the search for the ultimate speed through the atmosphere can continue.

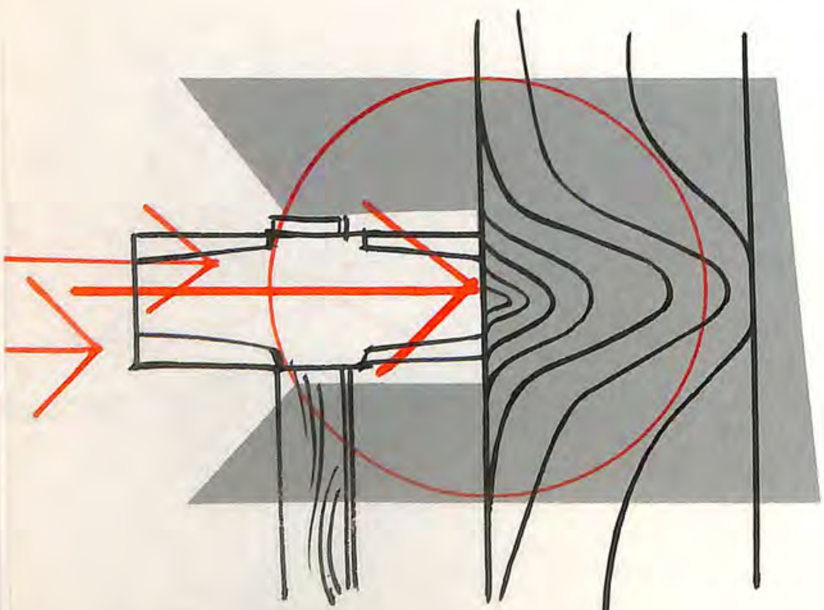
General Dynamics, at its Fort Worth division, has taken an important step in this direction in the development of panels for the tail section of the F-111. These panels are made of boron filaments, imbedded in fiberglass and then pressed together under heat. In addition to adding strength and greater heat resistance these panels have effected a weight saving of about 500 pounds per airplane.

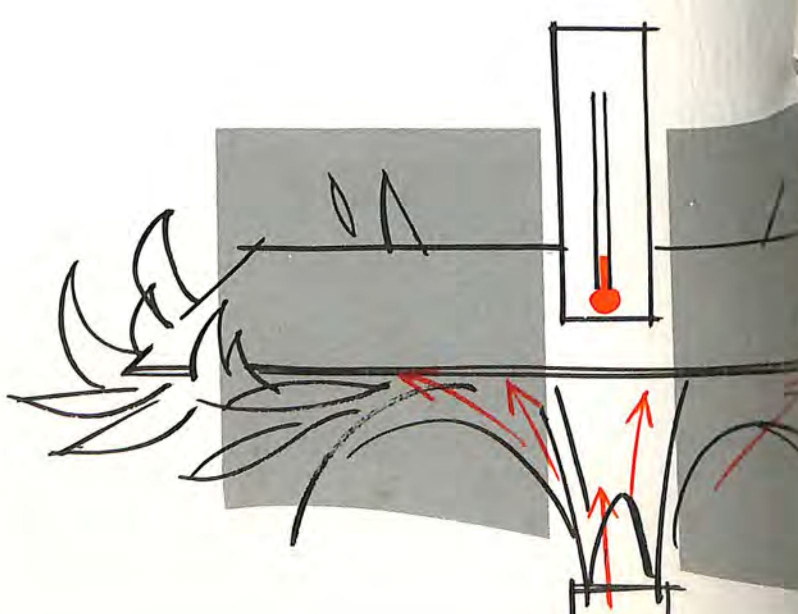
Rohr Corporation is experimenting with panels composed of boron filaments laid up with alternate sheets of aluminum foil between facing sheets of heavier aluminum, and then compressed under heat. Panels thus made are one-third the weight of steel panels of comparable size and thickness, have 3½ times the stiffness of aluminum, and retain the same strength at 700°F that they have at room temperature. The material has a tensile strength more than twice that of steel.

The major drawback to the use of these panels currently is their high cost, approximately $4,000 for slightly more than a square foot. However, as has been the case in all new developments of metals, this cost eventually will be reduced. But for quite some time it appears that the use of the boron-aluminum material will be economically feasible only in certain critical areas of extremely high speed military aircraft.

One of the early breakthroughs in the use of stainless steel in the aircraft industry came with its use in the exhaust systems for reciprocating engines. Solar, now a division of International Harvester, some 30 years ago specialized in the manufacture of these exhaust systems. At first, they were made of "black iron" and had a life of about 50 hours. The late Fred Rohr, then employed at Solar, believed that stainless steel would be more durable, and persuaded a military customer to let him experiment.

The first system made of stainless steel disintegrated along the weld line in less than an hour. Metallurgists, called in from the steel producer, discovered that welding rearranged and weakened the steel molecules and that a different stabilizing agent must be found. They came up with an alloy of molybdenum and tita-





nium as a stabilizer. It proved successful and the exhaust systems lasted more than a thousand hours.

Another breakthrough in the search for a material that would withstand heat and stress and at the same time provide sufficient strength for supersonic, and top speed subsonic aircraft, was stainless steel honeycomb. Structural panels consisted of a honeycomb core, made from thin ribbons of stainless, then brazed to facing sheets of steel with silver as the brazing agent. These panels now are used on high-speed supersonic military aircraft and space vehicles, in critical areas.

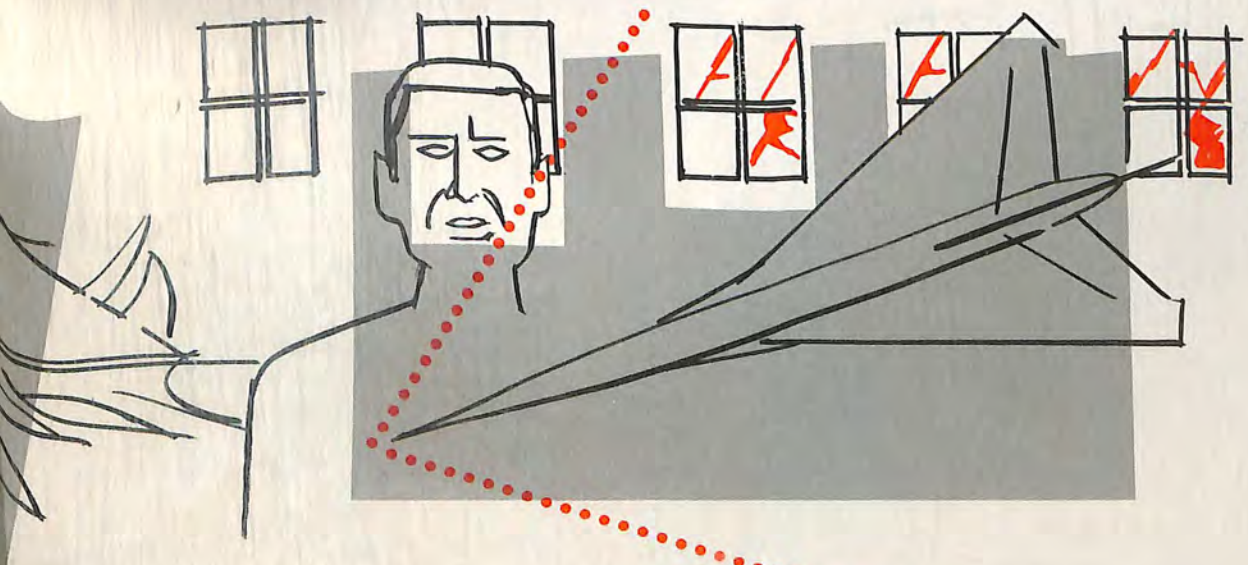
But as supersonic speeds are increased in current and upcoming versions of both military and commercial airplanes, a still greater resistance to heat, and even lighter weight, is required to withstand the rigors of atmospheric flight. This has led to the development of titanium honeycomb.

Titanium honeycomb is difficult to make. In the first place, titanium must be formed at elevated temperatures, which makes it necessary to heat the titanium ribbon as it passes through the punch press that forms it into cells, on its way to that portion of the machine that welds the cells together. With this major problem solved, titanium honeycomb core is being produced and, brazed into structural panels, has moved the industry another step toward solution of the heat-strength problem in critical areas of the supersonic airplane.

The development of a new metal seldom comes as a sudden inspiration to a single individual. With virtually every aircraft and engine builder faced with the same problem — finding a material that will help win the battle against weight and heat — chemists and metallurgists throughout the industry, as well as those in the plants of the steel and aluminum producers, constantly are at work in research and development. At conferences and technical meetings they present papers detailing some of the results of their experiments. Ideas are exchanged and, eventually, a pooling of these ideas leads to success. A single idea brought up at these meetings frequently sets up a chain reaction of ideas that solves the problems that may have appeared insolvable at first.

Now, as the industry moves into the production of supersonic commercial aircraft, the metals required, and developed, bear little resemblance to those that were available 20, or 25, or even 10 years ago. The higher speed subsonic airplanes now in common use could not have been produced a quarter century ago, even had designers and engineers been capable of designing them. The metals then available would not have stood up.

Looking back a few years, when nobody dreamed of an airplane that could travel faster than sound, or reach an altitude of 70,000 feet, one is hesitant to say what will be the limit of speed or altitude for comfortable air travel, both for passengers and those on the ground. Whatever it may be, the answer must come from the metal experts.



Travelers Take the High Road