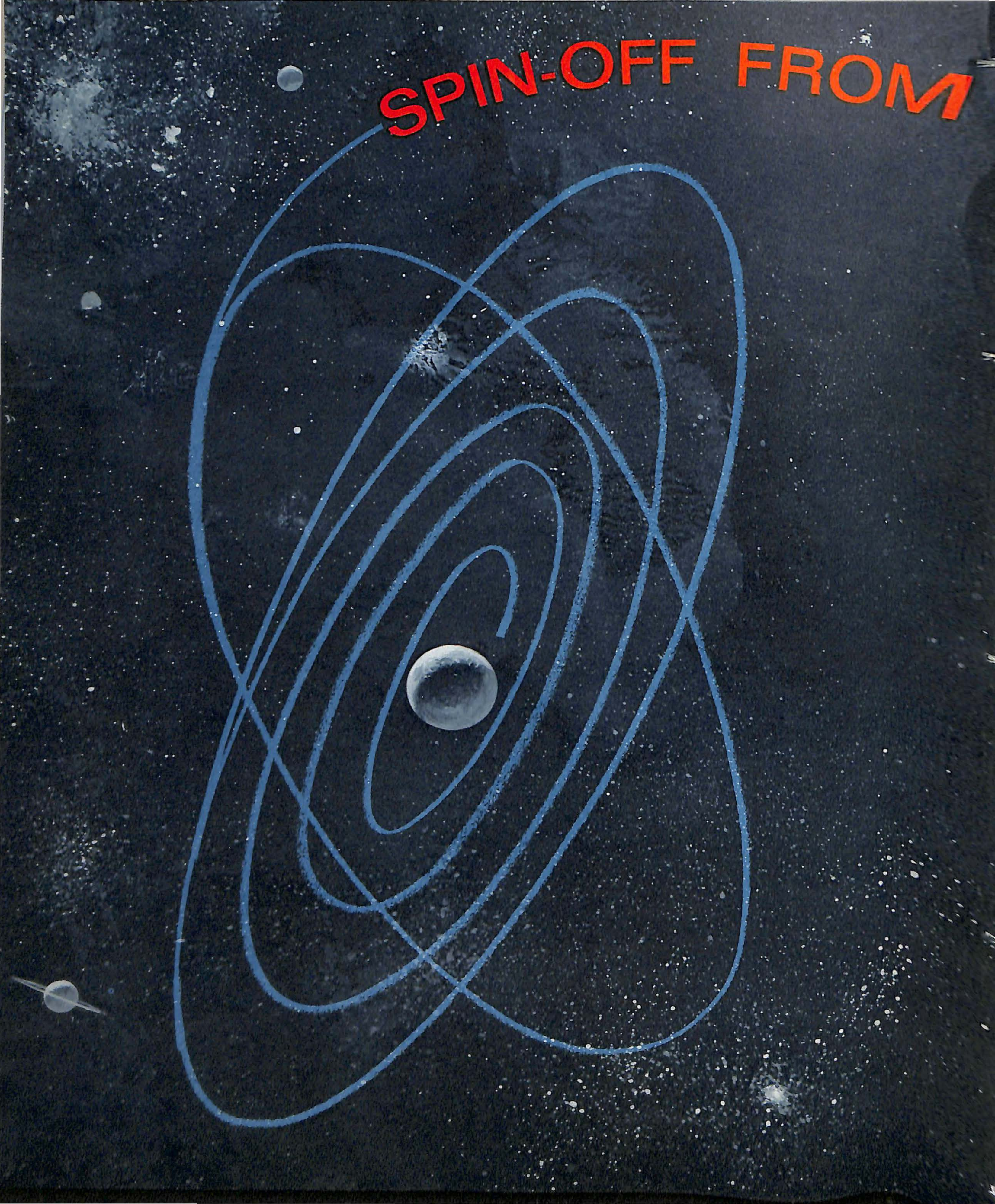

SPIN-OFF FROM

SPACE:

AN INTERIM REPORT

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

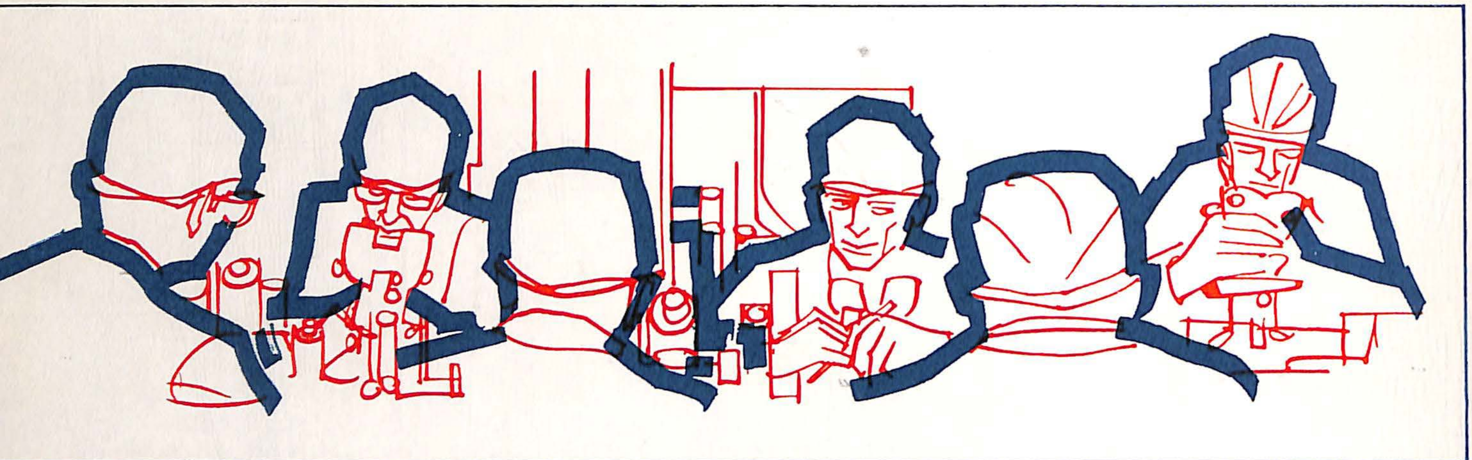
It has been eight years since the launching of Sputnik marked the arrival of the Space Age. Since that date, the scope of this new area of man's activities has expanded to enormous size. For the United States, as well as the Soviet Union, this has involved a commensurate commitment of human and material resources.

Thus, although the Space Age is still in its infancy, it is not amiss to take a preliminary inventory of the benefits accruing to this nation as a result of its substantial investment in space — run off a trial balance, as it were. Where can we look for these benefits? No gold has been found floating around in outer space or resting on the surface of planets which can be applied to offset the depletions on our national treasury — no tobacco, no exotic natives, no Fountains of Youth. Except for accretions to scientific knowledge, we have nothing from "out there" to show for our investment. Nor do we have any promise of an early return of that kind.

So we must look elsewhere — in short, here below. Have we as a nation and as a people yet received any benefits at all commensurate with our investment? From the point of view of one trying to justify our national space effort, this may seem like a particularly poor time to choose for such a trial balance. We have not yet even placed man on the moon, the first tiny tangible step in his exploration of space. We are just now beginning to feel the accumulated impact of knowledge and experience in terms of reliability, confidence and cost. In short, that which lies immediately ahead will be infinitely more impressive than that which has gone before in terms of recognizable steps toward mastery of this new dimension.

Even so, however, the balance sheet is already beginning to take form. Almost every aspect of our national life has begun to show a positive and beneficial impact of this nation's decision to be a major participant in man's greatest adventure.

There has been the direct economic impact on the communities and regions where the major parts of this large national effort are centered. There has been introduced into our national economy a wide variety



of radically new industrial techniques. There have evolved new standards of excellence in engineering, testing, design, reliability, environment control, and the skill and dedication of personnel. There has accrued an enormous quantitative and qualitative knowledge about the universe, including the planet on which we live. There has ensued a marked stimulus to education, particularly scientific education, at all levels of our system — kindergarten through postgraduate school. There have been some end products applicable to general public consumption, although this is but a trickle of the flood that is coming. And last, but far from least, there has been an important impact on national self-confidence as the cumulative effect of our successes vindicates the judgments as to the nature of our program and affirms our national capabilities.

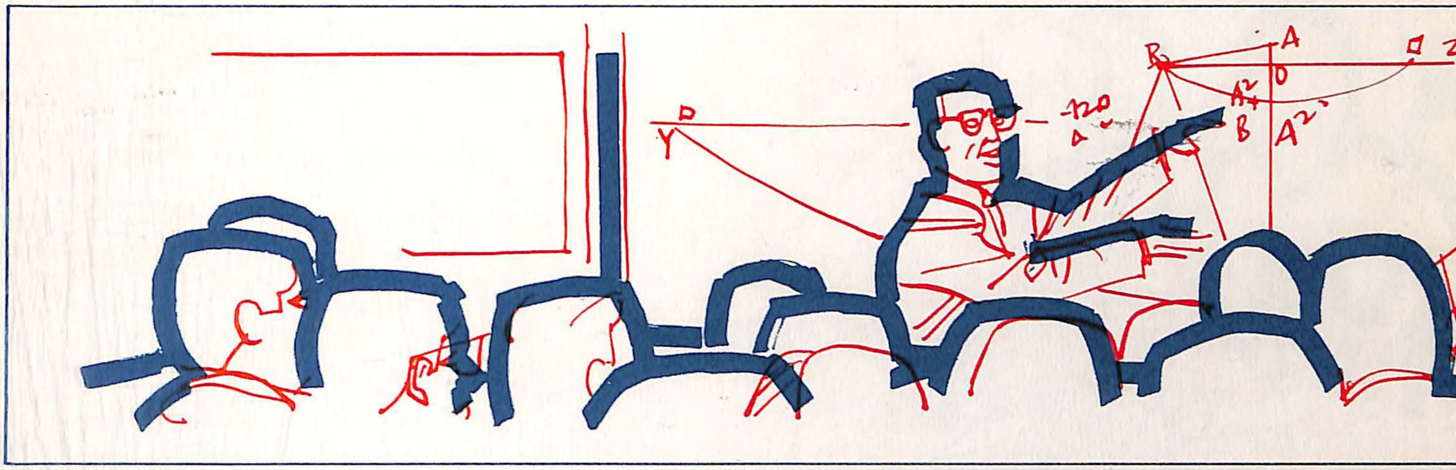
Even at this early stage of our national space effort, therefore, the profit column is impressive. Although perhaps no single one of the foregoing benefits is, in itself, a full justification of our national expenditures of human and material resources, their sum — even now — would seem to justify such an effort.

In those regions and communities which have been selected as principal centers for this activity, either as the home of government installations or as the location of industrial space effort, the direct economic benefits are real and substantial. At Clear Lake, Texas, a city, soon to reach a population of 100,000, has sprung from a cattle-grazing flatland to accommodate NASA's Manned Spacecraft Center; and every variety of supporting business and service demanded by a new community is growing apace. The story is the same in varying degree throughout the space crescent of Texas, Louisiana, Mississippi, Alabama and Florida. Brevard County, Florida, for example, which embraces Cape Kennedy, will have a population of 300,000 people by 1970, more than ten times its 1950 population. But the direct economic impact is far from limited to the space crescent. The quarter of a million parts that will go into the Apollo project will be supplied by 20,000 industrial firms located in 47 states. The services of more than 300,000 skilled people, throughout the nation, will be needed to complete this project.

The development of revolutionary industrial techniques in the course of our space effort has already had a real and direct effect elsewhere in our economy. For example, techniques to ensure cleanliness, developed for astronauts, have been adopted in surgery involving open-heart and brain operations. New plastics, metals and tools developed in response to the requirements placed on space research are already being applied to a variety of medical needs. In hospitals, the condition of critical patients is monitored, analyzed and reported by sensing devices and computerized machinery first developed for aerospace use.

The non-space application of space-developed techniques also has had its impact in industry. Principles of systems management, new knowledge about tolerance factors, new applications of computerized machinery, new techniques for metal bending and casting, for welding, for the evaluation of production, and for ensuring component reliability and quality control, are cropping up in all segments of American industry.

The commercial application of Automatically Programmed Tools (APT) provides a good example. Delicate space hardware requires machining of metal with tolerance factors of less than one-millionth of an inch, a standard beyond the competence of even the most skilled machinists. The response to this need was the development of APT, which automatically selects, initiates and controls — by means of coded punch tape — the cut to be made, the hole to be drilled, or the pattern to be etched. A bakery equipment manufacturer in Michigan found that the bigger, more complex, less costly machinery demanded by its customers necessitated steel fittings and joint couplings far more exact than could be machined by hand, even by machinists who had done this job for 25 years. APT



provided the solution. By means of its use, equipment of superior quality can now be produced at substantially reduced costs.

Add to such techniques the new ceramics, compact electronic devices, lightweight metals, printed circuit and transistor developments which are outgrowths of aerospace research, as well as the techniques being used in the production of consumer products which are already impressive and of substantial and widespread benefit.

In addition to specific techniques, the demands of our national space effort also served to introduce new industrial standards and the means of achieving them. Today's spacecraft assembly man dresses in aseptic white, including cap, gloves and shoes. Before entering his workroom, he stands in a sealed air shaft while a 30-mile-per-hour stream of air ensures the removal of all dust particles from his clothing and body. His assembly room is kept to a finely controlled temperature and humidity. Even his perspiration is not tolerated.

The quality and reliability of his work is kept to the same standard. It is not enough that a seam weld *look* perfect or even pass standard tests. It must *be* perfect; for that seam must hold under launch pressures that would rip apart a steel bridge. To this end, many new weld inspection techniques have been devised. These are, of course, made generally available and are now being applied far afield from the space industry.

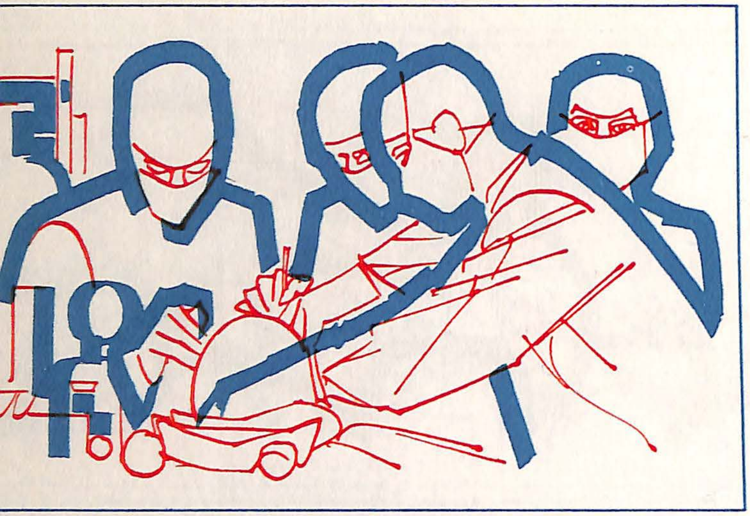
Testing standards have similarly been upgraded. Consider the process of a tiny valve to be used in a pump in a booster engine. Perhaps five separate firms may produce the parts of such a valve, all of them milled to a millionth of an inch tolerance. Each of these parts is extensively tested prior to its shipment to the valve contractor for assembly. The valve is then assembled in a completely sterile environment, and, once again, checked and rechecked before shipment to the pump contractor for installation. The pump is then extensively tested prior to its installation in the booster engine; and, finally, the booster engine is tested by a protracted series of static firings. The effect of such standards of care in quality control and reliability assurance already has begun to permeate the wide swath of American industry which contributes to or is aware of this kind of effort.

Not the least of the new standards demanded of and produced by our industrial space effort is found in the area of personnel motivation. Until the mass production, assembly line age, the artisan and craftsman prided himself and achieved respect upon the quality of his skill. Acceptance among his fellows was all the motivation a Cellini or a Revere needed. Today, "what is worth doing is worth doing well" is more apt than ever before. The aerospace industry has gone to all lengths to live up to it. Too often, in industrial fabrication and assembly, the user of the product becomes so impersonal to the maker that striving toward perfection falters.

In World War II, aircraft manufacturers found they could motivate the welder and riveter by identifying the plane being built with the hero pilot, or the heroic squadron. The worker was constantly reminded that skill and care meant safety and performance to the pilot.

In space research, development and exploration, the identity becomes even more imperative. Aerospace companies go many routes attempting to achieve that goal. A leading aerospace company, for example, developed a "Zero Defects" program aimed at reminding, rewarding, and emphasizing to the worker that rejects are expensive, and if undetected, contributors to tragedy. Other companies have instituted variations of the zero defects promotional program.

A second motivation campaign called, "The Critical Parts Program," to ensure that all 98 subsystem assemblies that go into a major space booster system will work, precisely in sequence, has been sold as an industry wide concept.



Another company reports that employes were amused and, more importantly, impressed, when a sign was tacked above the door of its main assembly room that reads: "In NASA we trust. Everything else we check."

Meeting the reliability requirements of space products has created a new dimension to U. S. manufacturing techniques.

If reliability of a specific component or system were the only benefit derived from these promotions, the time and effort would have been more than well spent. However, it is obvious that a person directed into one area of personal discipline, will carry that dedication into other activities of family and community life.

Further, these skills sharply honed have gone and will go on to be used profitably elsewhere. The communications satellite linking the earth by voice and picture even in its infancy is performing far beyond expectations. Workers' dedication to making the most minute circuitry perfect results in computers that assimilate and process knowledge on an unprecedented scale, TV sets that are virtually fool proof, phonographs that reproduce music with astounding fidelity.

The space effort has supplied — in addition to stimulating a worker to care about how he uses his tools — a defining and refining of technical and scientific knowledge. The new world of space exploration systems require materials, and structures hardly imagined in the sub-sonic and sub-orbital eras.

Though an airframe designed a generation ago may be the engineering foundation of today's space booster, ciphering have little similarity to today's exercises and there the similarity ends, just as yesterday's lessons in mind-stretching brought on by the new approach to mathematics. Education from the primary grades through college now is demanding ever more intensive effort on the part of students in order to meet today's requirements for mathematicians, physicists, astronomers, metallurgists, biologists, and even agronomists.

The findings of scientific satellites, the pictures of the moon and Mars transmitted by Ranger and Mariner, illustrate the effectiveness of science and technology.

"The space program has stimulated education; it has expanded research and development," says Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council. "It has encouraged the development of new materials, new processes, new products."

Fully translating space research findings into commercial products is still a long way off. To be sure, the teflon pan has gone on the kitchen utensil rack; new lightweight sheets have been rigged on fibreglass sailboats boasting light metal and laminated masts and fittings. Miniaturized, transistorized radios have become inexpensive and commonplace. Sensors recording and triggering adjustments in central home air conditioners are offsprings of space research and development. The index of NASA's newly created Office of Technology Utilzation numbers 20 pages today; but the beginning of civilian application is only just beginning.

"Progress is not just a growth of technological skills or material wealth," Dr. Abe Silverstein, director of NASA's Lewis Research Center in Cleveland, Ohio, has said. "It is an advancement toward excellence in every aspect of our lives and a striving toward a culture and civilization that will recognize both the grandeur of the universe and the dignity of man."

Taking a trip to the moon, either actually or vicariously, enhances the pioneering spirit of man at his best — when he is curious. Like the mountain to be climbed, the ocean to be sailed, outer space is there to be conquered. "Change is the basic continuing dynamic of the universe," Dr. Silverstein has added. "We are not privileged to accept it or reject it. It occurs."

The impatience of the young to learn has increased with each succeeding launch from Cape Kennedy since Alan Shepard's first modest space flight. Step by step, the Mercury flights, and the two-man Gemini launches have reinforced the confidence all of us have that free man is able, and willing, to continue to explore.

The unbroken series of successes in manned space flight also has left an indelible impression on the rest of the world; our national prestige is high; and our talents and imagination are unquestioned and understood.

Perhaps in order best to appreciate even at this early date the overwhelming impact of our space effort upon our economy, the aspirations of and stimulus to our children's minds, our national spirit and prestige, our scientific and technical knowledge, our standards of industrial excellence, our advancement of technical skills and techniques, and a thousand other areas, one need only consider where this nation's economy, its prestige, its educational motivation, and the like would be had the United States decided to sit out this great adventure and leave it to other nations.

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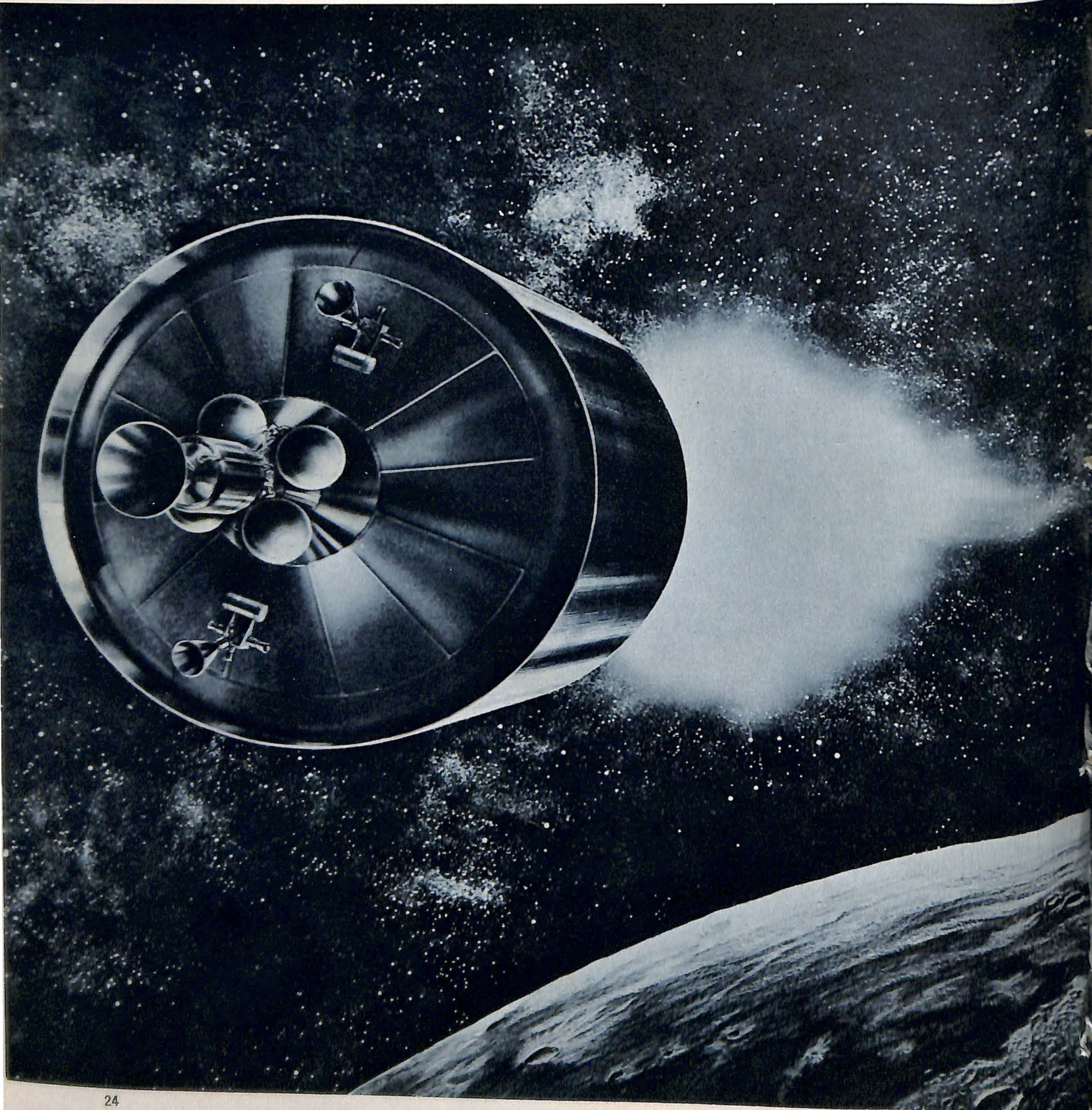
A nuclear-powered vehicle orbits Mars in this artist's conception.



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- SPACE EXPLORATION: THE NEXT STEPS
- EXPERIMENT IN TOMORROW
- THE INNOVATION INDUSTRY
- GENERAL AVIATION: GENERATOR TO THE ECONOMY

A mobile field hospital developed by the Garrett Corp. is an example of the diversified capabilities of the aerospace industry.

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VOL. 3 NO. 3 FALL 1965

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;

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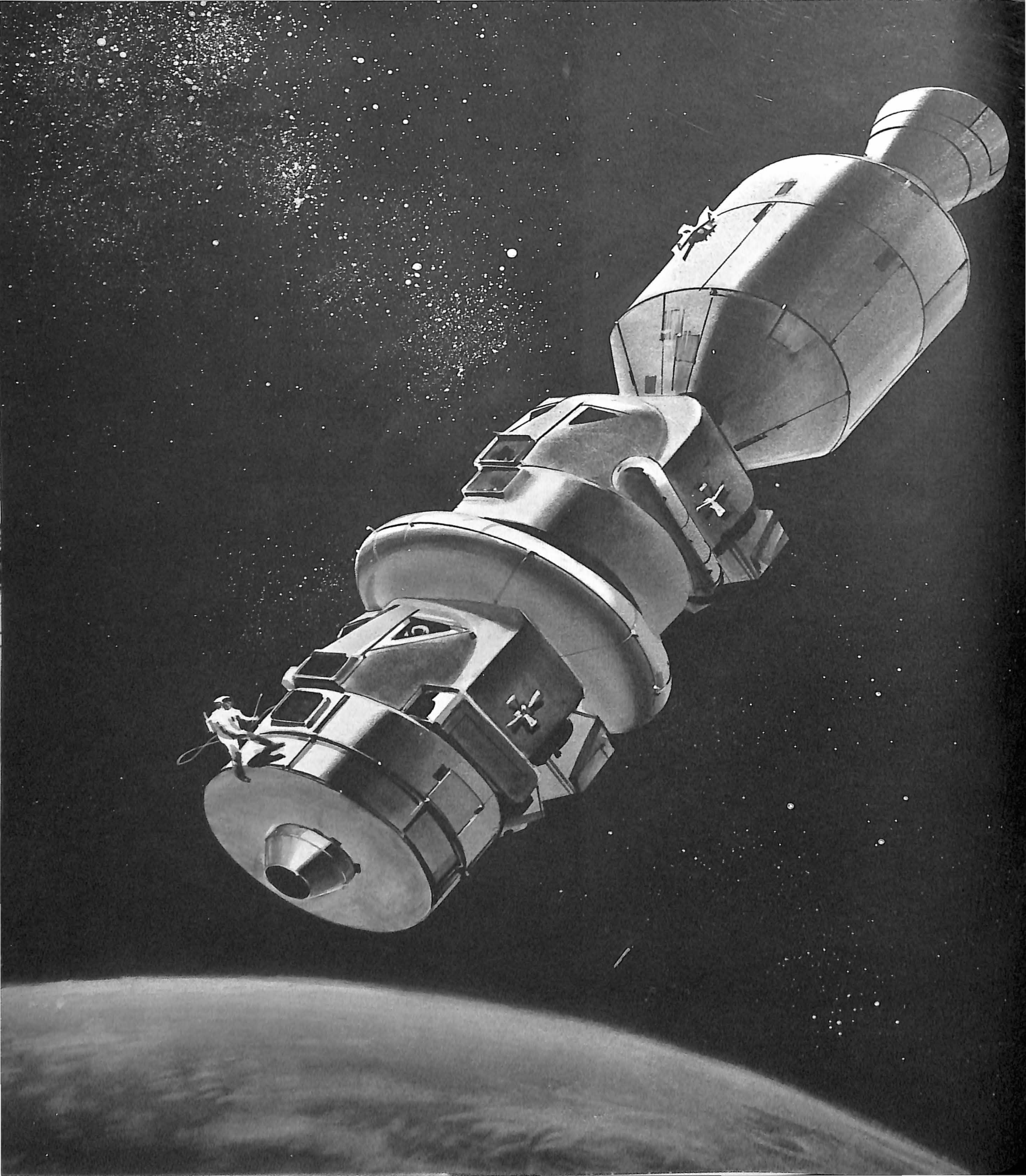


SPACE EXPLORATION:

The Next Steps

October marks the start of the ninth year of the Space Age and the United States has come a long way since 1957, when space was the exclusive province of Russia. The success of civil space projects like Mercury, Ranger, Mariner and Gemini have restored a great deal, if not all, of America's lost prestige. These and a wide variety of other programs have provided the United States with a solid and broad base for future space exploration.

The National Aeronautics and Space Administration is now preparing to embark on another giant step in the conquest of space — the Apollo program, which will culminate with the landing of two men on the moon. This program will formally get under way within the next few months with the first unmanned test of the Apollo spacecraft boosted by a brand new launch vehicle, Saturn IB. The anticipated on-time firing of this test, together with the current advanced status of major Apollo hardware being developed by aerospace contractors, gives reasonable assurance that the United States will be able to meet its commitment of a lunar landing before the end of the decade. Which brings up the question: Where do we go from there? What direction will the U.S. civil space program take after that historic moon landing?

The question is a complex one and there is as yet no pat answer in terms of Step One, Step Two, Step Three. It is possible, however, to list those projects the nation will be capable of carrying out in the immediate post-lunar landing period, the early years of the decade of the seventies. Looking further down the line, beyond 1975 and into the eighties, the picture is less clear. But even in this "way out" area, NASA had already defined the program alternatives, the various projects that *may* be undertaken within the framework of anticipated technological progress.

In the field of unmanned space research, NASA already has one tentatively-approved project for the seventies. This is the Voyager spacecraft, which will explore Mars during the favorable opportunities of 1971 and 1973. Mariner II and Mariner IV, which made "fly-by" investigations of Venus and Mars, were spectacularly successful spacecraft, but in terms of the information scientists would like to have about these neighboring planets they only scratched the surface.

The Mariners were designed for launch by the Atlas/Agena booster system, so allowable spacecraft weight was less than 500 pounds and the vehicles were limited in the amount of equipment they could carry. The new boosters coming along will permit construction of planetary spacecraft several times the size and weight of the Mariners, with far more effective information recording and data transmission systems. Mariner IV, for instance, was able to send 21 television pictures of Mars over a period of 10 days; Voyager will be capable of sending 2,000 photos in a similar time period. Mariner IV recorded Mars data only during a brief fly-by period; Voyager will be

◀ Artist's conception of a Space Operations/Bioscience Laboratory for a 90-day duration earth orbit mission.

able to orbit the planet for a long time and return continuous data. Voyager will also carry a capsule which will land on Mars and transmit information about the surface and lower atmosphere.

The Voyager program will not only contribute a wealth of scientific information, including data of importance to the search for life forms beyond earth, it will also pave the way for the manned expedition to Mars. The issues of funding and national priority aside, man simply does not know enough about the Red Planet and interplanetary space to initiate such a program today.

The Voyager "bus" and its propulsion unit can also be adapted to further investigation of Venus, and many of its subsystems will have direct application to later probes which will extend to the limits of the solar system. Already under study, for possible accomplishment in the seventies, are missions to Mercury, Jupiter, the comets and the asteroids, the mysterious bodies revolving around the sun between the orbits of Mars and Jupiter.

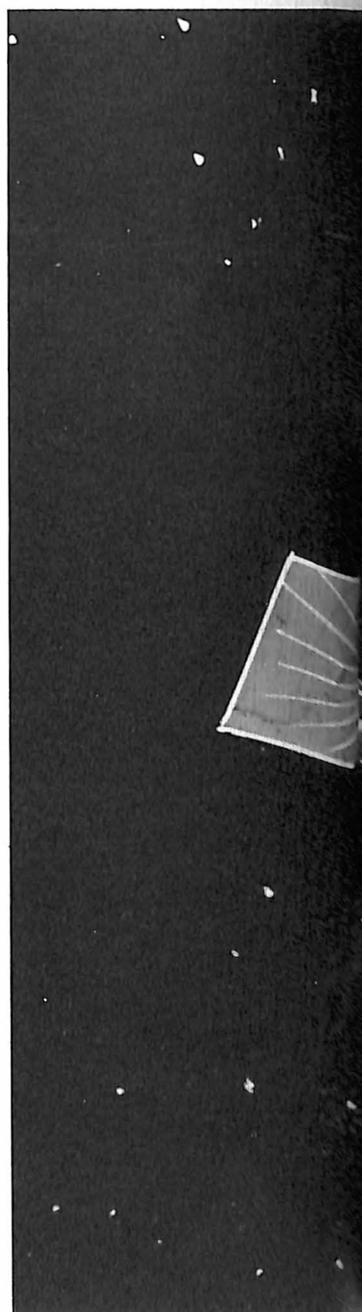
Manned spacecraft will probably take over many of the investigative assignments currently being explored by unmanned craft, but there will still be plenty of missions for automated spacecraft, particularly in the fields of physics, astronomy and applied satellites—those which provide direct benefits. For example, there is the weather satellite. With the Weather Bureau preparing to introduce an operational meteorological satellite system this year, one might assume that there is no further need for research on weather reporting spacecraft. Far from it. Existing satellites provide primarily cloud cover photographs; a really accurate long-range weather predicting system must provide continuous global measurements of such factors as pressure, temperature, humidity and wind velocity at various altitudes. Science must now learn how to add these capabilities to the highly beneficial but less than optimum service provided by current weather satellites.

As for tomorrow's manned spacecraft, NASA has already identified a number of specific missions that can be performed in the years during and immediately following the lunar landing. These missions come under the general heading of Apollo Applications, because they involve hardware — spacecraft, launch vehicles and both spaceborne and ground-based equipment — developed for the basic Apollo program and modified to meet the new requirements. About the first of the year, NASA will initiate the Apollo Applications "program definition" phase and by mid-1966 the space agency expects to be able to spell out the nature of manned flights in the 1968-71 period, their costs and their schedules.

During the past year, NASA has conducted many studies on Apollo Applications missions and compiled a list of more than 150 desirable experiments, most of which will probably be accomplished in the program. The largest area of experiment is exploration of the lunar surface; attention will also be focused on "space technology and operations," or development of equipment and techniques for the very advanced missions of the future, and on space science, in particular biomedicine, the physical sciences, astronomy and astrophysics. The experiments fall into three general categories: those that will be conducted in earth orbit, in lunar orbit and on the surface of the moon.

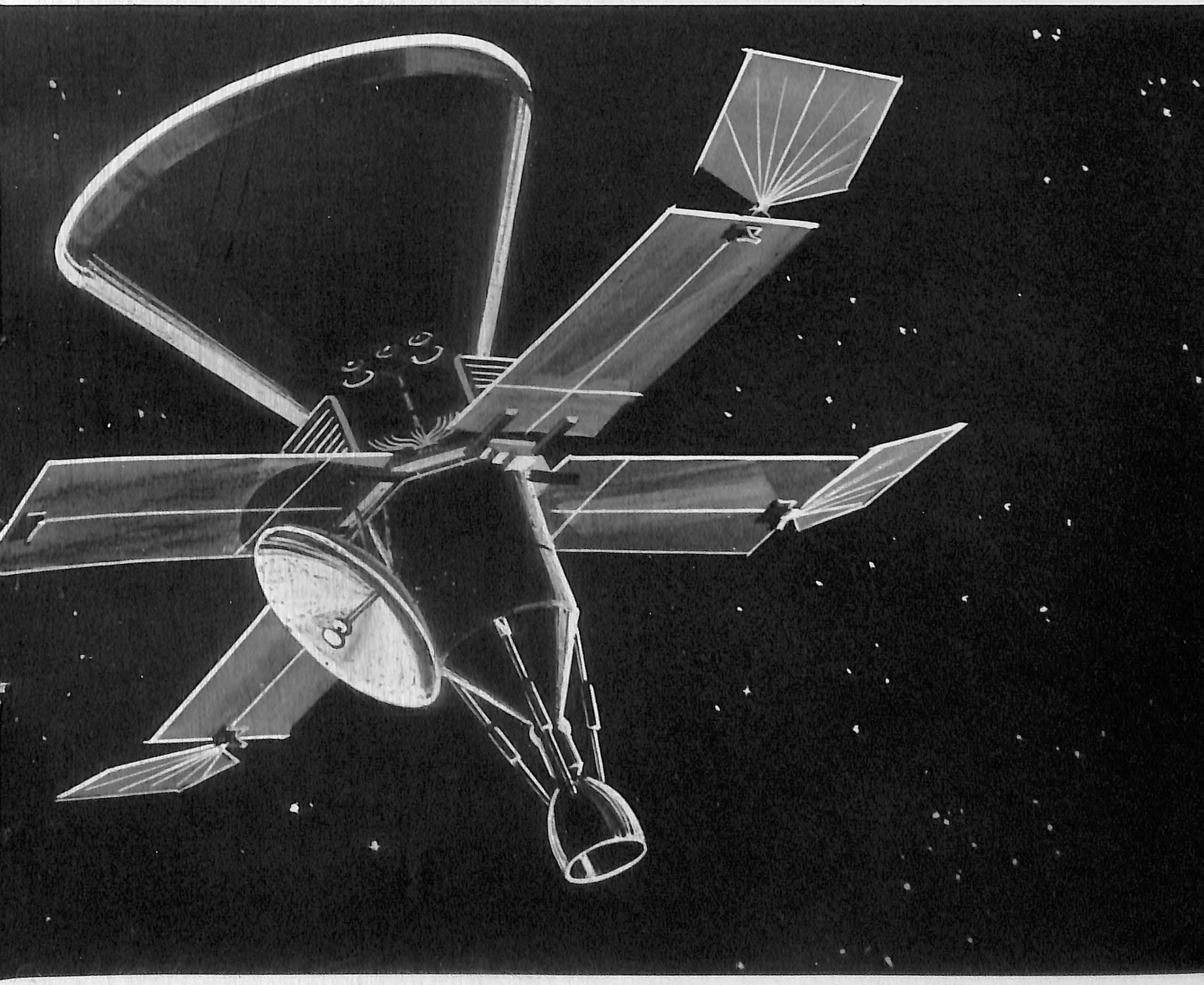
Of the most interest in the earth-orbital experiment category is the "extravehicular activity" which captured the public fancy in the Gemini project, but the type of outside-the-spacecraft effort NASA has in mind for the Apollo Applications program goes far beyond the fascinating space walk of astronaut Ed White. The astronauts will remain long periods in space and perform extensive maneuvers by means of a backpack propulsion unit. In an effort to develop in-space maintenance and repair techniques, they will

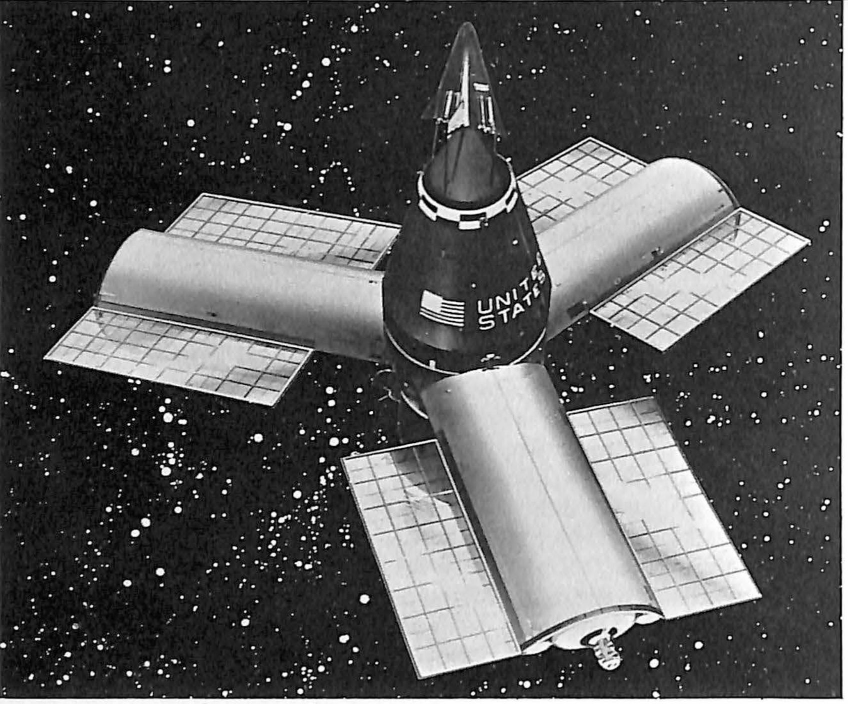
The Voyager spacecraft will explore Mars in 1971 and 1973. Voyager will be capable of sending 2,000 photos of Mars over a ten-day period.



employ special tools in actual work on the exterior of their spacecraft. They will practice in-space refueling and transfer of supplies from one spacecraft to another. Toward the day when it may become necessary to assemble an earth-orbiting space station or a huge planetary spaceship in orbit, they will erect large external structures, like radio and optical antennas. They will attempt to recover a previously-launched unmanned satellite, perhaps one already orbiting, to acquire information on long-term space effects on materials and sensors. Finally, they will calibrate, check out and launch a satellite from a point in orbit, investigating a potential technique of the future which could provide more accurate insertion into orbit and higher probability of success.

A key part of the Apollo Applications program will be a group of 24 "biomedicine/behavioral" experiments aimed at determining the effects of long-duration weightlessness, and, if such effects prove harmful, at finding methods of counteracting them. After the eight-day flight of Gemini 5, it would seem that weightlessness is not much of a problem. But medical scientists, looking toward possible future missions of one to three years, are not satisfied with eight days experience. Theoretically, weightlessness can induce such symptoms as blood pooling in the legs, dizziness and loss of calcium in the body system. The biomedics have prepared a series of experiments involving, at first 14 days, later as much as three months exposure to weightlessness. Apollo Applications allows not only





Artist's conception of a 24-man space station which could provide an anti-gravity effect to counteract weightlessness.

From the earth orbital phase of Apollo Applications, NASA will be able to define the requirements for the initial Orbital Station, or, to use the old science fiction term, space station. The station may be designed for six to nine men or it may be larger; it may operate at low altitude or it may be sent into synchronous orbit, remaining in a fixed position with reference to a point on earth. It will need a logistics system, boosters and spacecraft to ferry supplies and crew changes up from earth. The objectives of this first step will be to perfect equipment which can operate for very long periods with minimum maintenance — electrical power, life support, communications, etc. The successful development of such equipment is the key to the next step, a much larger, permanent orbiting station.

This advanced station may evolve in one or more of several possible directions. Listed by NASA officials as possibilities are an Application Center, a Research Laboratory Facility and an Earth Orbital Assembly and Launch Facility.

The Application Center would be used for development and operation of space facilities which can provide direct, practical benefit to life on earth. For example, it might include a Resource Inventory Station to conduct continuing surveys of national resources in such fields as agriculture, forestry, geology and oceanography; a man-monitored Communication Station capable of providing radio and TV broadcast directly to home sets without need for earth-based intermediate equipment; and a manned Weather Station for ultra-accurate long-range weather forecasting.

In the Research Laboratory Facility, it would be possible to conduct very advanced, man-directed experiments in such areas as astronomy and the biological and physical sciences.

It is still too early to tell whether a manned planetary expedition can be launched directly from earth, or whether the spacecraft will be so large that it must be assembled module by module in earth orbit. If so, there will be a need for the Earth Orbital Assembly and Launch Facility for development of in-space assembly and checkout tecnhiques.

All of these super space stations would require a more advanced logistics system, and it appears that there might be two types of ferry craft: one to operate from earth to a station in low altitude orbit, another for orbit-to-orbit operations. The ferry craft will have to be maneuverable during transit through the atmosphere so that they can land at specific earth bases, and for the significantly improved economy of operation that will be requisite to their development, their boosters will have to be reusable.

In the evolution of the lunar base, the step after Apollo Applications is the temporary base for extensive scientific research. Such a base would house six to nine men and would serve as a center of operations from which two-man crews could range in a roving vehicle over extended regions of the moon.

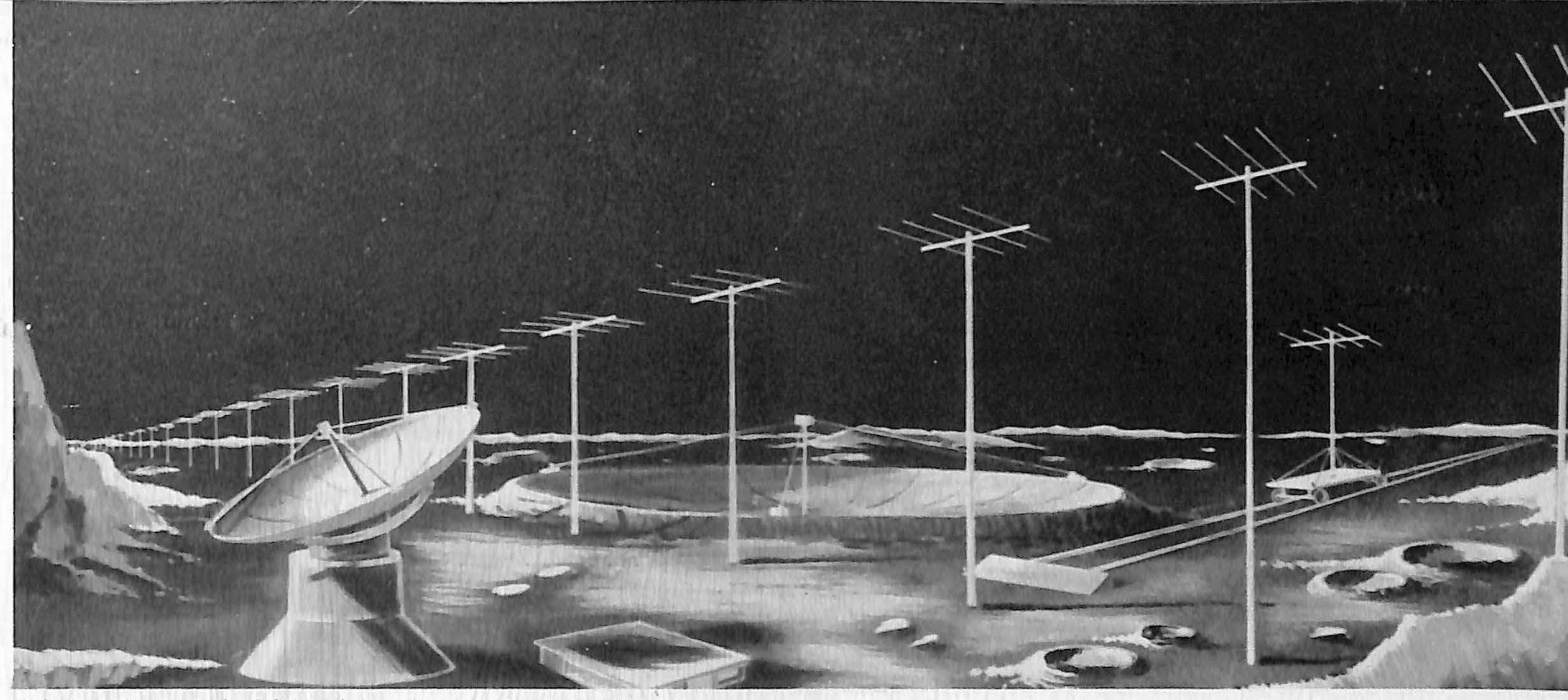
After a period of operations from the temporary stations, it is likely that there will be built a permanent station similar to the Antarctic staging base at McMurdo Sound, a base capable of supporting life indefinitely with earth-aid in the form of frequent resupply and personnel change flights. From the permanent station could evolve an even more ambitious facility, a research complex made up of a number of specialized laboratories engaged in astronomy, geology, geophysics, bioscience and other fields of interest.

The presently foreseeable ultimate in manned moon stations is the Resource Processing Station which would obtain water, minerals, oxygen and other resources for use either at the lunar base or for planetary expeditions. There are already studies under way aimed at discovering ways of processing possible lunar surface material to obtain these resources.

It is generally agreed that the first step in manned planetary exploration is the mission to Mars and the "fly-by" type of mission offers the earliest chance of accomplishment. Like Mariner IV, the manned spacecraft could make the trip without major propulsive maneuvers and the fly-by therefore imposes only modest demands for new launch vehicles. Although it has the disadvantage of a short "contact time" with the planet, it nonetheless has considerable attraction from the scientific viewpoint, since the crew could launch and monitor a number of instrumented landing probes during the period of close passage. The major utility of the fly-by, however, would be use of the spacecraft as a test bed for evaluating the performance of equipment to be used on later missions.

At a later date, there will come the manned landing on Mars, most likely supported in advance by unmanned flights delivering shelter, food, power sources, surface roving vehicles and experiment packages. Carrying the evolution further, the next project would be the permanent Mars base to be used for extensive exploration of the planet, for astronomical observations far beyond the scope of earth-orbit or lunar facilities, or as a staging base for launching and resupplying missions to the outer planets.

For all of these possible way-out missions, the



A long-range concept of interest to astronomers will be the construction of large radio astronomy antenna arrays on the moon.

requirements are enormous and well out of reach of current technology, though they are within the capabilities of foreseeable technological gain between now and 1985. To cite one major example, there is the launch vehicle. It is theoretically possible to assemble in earth orbit a large space station, a lunar logistics vehicle, or a planetary spacecraft, by sending up the components in multiple launches of a booster like Saturn V. But there is a limit to the efficacy of this technique. Saturn V is in itself a costly vehicle and there comes a point where the number of launches required to assemble a large spacecraft and the complexity of the assembly operation makes it impractical.

Therefore, the way-out missions may require boost vehicles of much higher energy than the currently incredible, 7,500,000 pound thrust, 250,000-pound payload Saturn V. These boosters will most likely have nuclear components, at least in the upper stages, so the time at which such systems become available, now unpredictable, becomes a key factor in the timetable.

But the demands on science and technology go well beyond launch vehicles. A consideration of the requirements for a manned landing on Mars gives some idea of the enormity of the tasks ahead. First, the spacecraft's on-board equipment must be ultra reliable, capable of operating without major failure for from 400 to 600 days. There is a need for a new entry capsule which can land on Mars — and again on earth — at speeds much higher than those at which Apollo will re-enter the atmosphere on its return from the moon. There must be supply modules for delivery of cargo to the surface of the planet. Communications systems for continuous contact between earth and the spacecraft, involving distances up to 300,000,000 miles, must be provided. There is a need for a foolproof, extremely long duration power source, both on board the spacecraft and on the surface of the planet. Shelters and surface transportation vehicles, each with its own life support system, must be developed and there are many other items of yet-to-be-invented equipment which are necessary for an expedition of such magnitude.

It is obvious, in view of the many developmental unknowns, that any timetable for these advanced missions is largely guesswork, and NASA has not attempted to provide one except to indicate that these projects might be feasible before 1985. The greater question is in what order will the follow-on programs be tackled and at what level of funding and national priority.

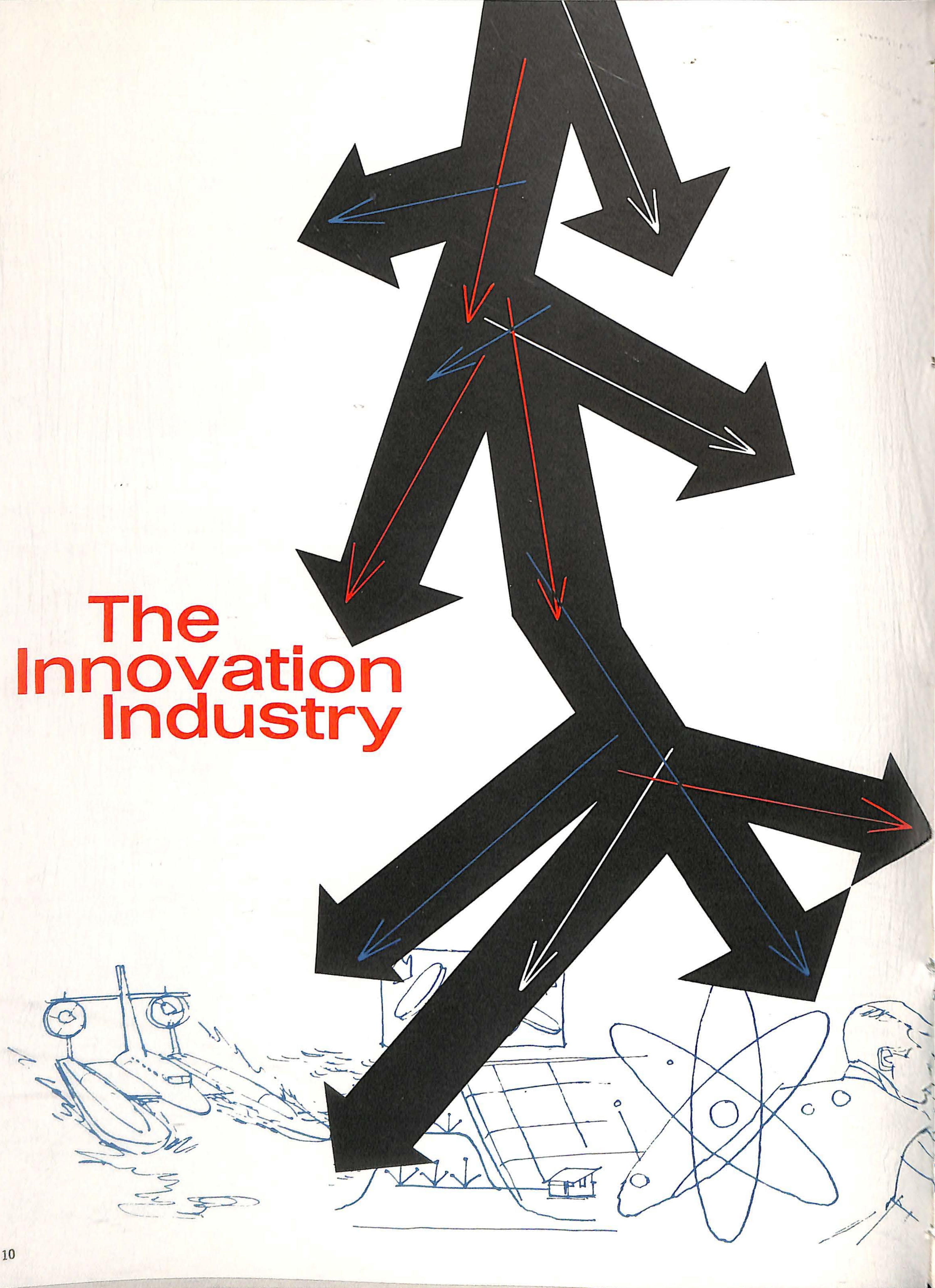
In Congressional testimony, NASA officials set forth five program alternatives. Three of them are the separate earth-orbital, lunar and planetary evolutionary steps. The fourth is "maximum effort," in which NASA would move forward in all three areas as rapidly as technology permits. The fifth is the "balanced program," in which all three areas would be pursued on a "limited scope" or stretch-out basis. This program would bring about accomplishment of the most desirable goals within the three areas, in a much longer time period than the maximum effort program, but at a greatly reduced annual cost.

The decision as to the selection of the program alternative to be carried out must take into consideration which approach offers the greatest benefit to the nation and to the world. Is man's primary objective in space research direct economic benefit to his way of life on earth? If such is the case, than the emphasis should be on earth-orbital applications. Or are there less visible but potentially greater benefits in unlocking the secrets of the universe through extensive lunar and planetary exploration?

And to what extent will the nation support funding for the follow-on programs, a question complicated by the fact that the exact costs are not yet defined.

The decisions are considerations for the President, the Congress and the people. —*James J. Haggerty, Jr.*

The Innovation Industry



Diversification is not a new development in the aerospace industry; since the end of World War II it has been the industry's distinguishing characteristic.

In the past two decades, the industry has been engaged in a wide variety of assignments, with its main efforts being in the design, development and production of weapon systems for national defense, space exploration systems and a wide variety of civil aircraft.

In the course of carrying forward these assignments, the product line has changed many times. Many of today's aerospace products did not exist 15 years ago.

The requirements of national goals in defense and space exploration have led to the creation of the most powerful and productive scientific, technological and managerial force in history. The talents and techniques of this force, for the foreseeable future, will be devoted principally to aircraft, missiles and spacecraft and their myriad components and supporting systems. However, diversification continues.

Aerospace diversification can take several forms. For example, Martin Company, along with many other aerospace firms, broadened its basic aerospace product lines to diversify but did not expand into unrelated areas.

The change in Martin products sold to the government is revealing. Missiles and rockets accounted for 13 percent of Martin sales in 1955; in 1964 they accounted for 58 percent. By contrast, 76 percent of the 1955 sales came from aircraft compared with only 2 percent in 1965. However, Martin today is increasing its efforts in aircraft design.

Martin also accomplished diversification in another way by consolidating Martin (virtually 100 percent government business) and American Marietta (97 percent commercial business). Today Martin-Marietta Corp. sales are about 70 percent government, with the remainder in such commercial items as cement, lime, sand, aggregates, printing inks and super-alloys.

Another pattern of product diversification is evident in the programs of United Aircraft Corporation. William P. Gwinn, president of UAC, states: "Even as flight remains its primary concern, United Aircraft is diversifying into promising new activities, some of them oriented, not to flight, but to land and sea. Pratt & Whitney Aircraft is harnessing jet power for ships and stationary industrial applications. Norden is perfecting guidance and navigational systems for submarines and surface vessels. Hamilton Standard is making power-conversion devices for fire alarm boxes and controls for hydrofoil vessels. Sikorsky Aircraft is fabricating missile parts."

Like other aerospace firms, United Aircraft is spending millions of dollars of earnings for forward programs. The firm has plowed back, in the past five years, more than $160 million of its profits for research and development of new products. Mr. Gwinn says: "From today's research comes the products of tomorrow. What the firm is doing in research must enter into any assessment of its future."

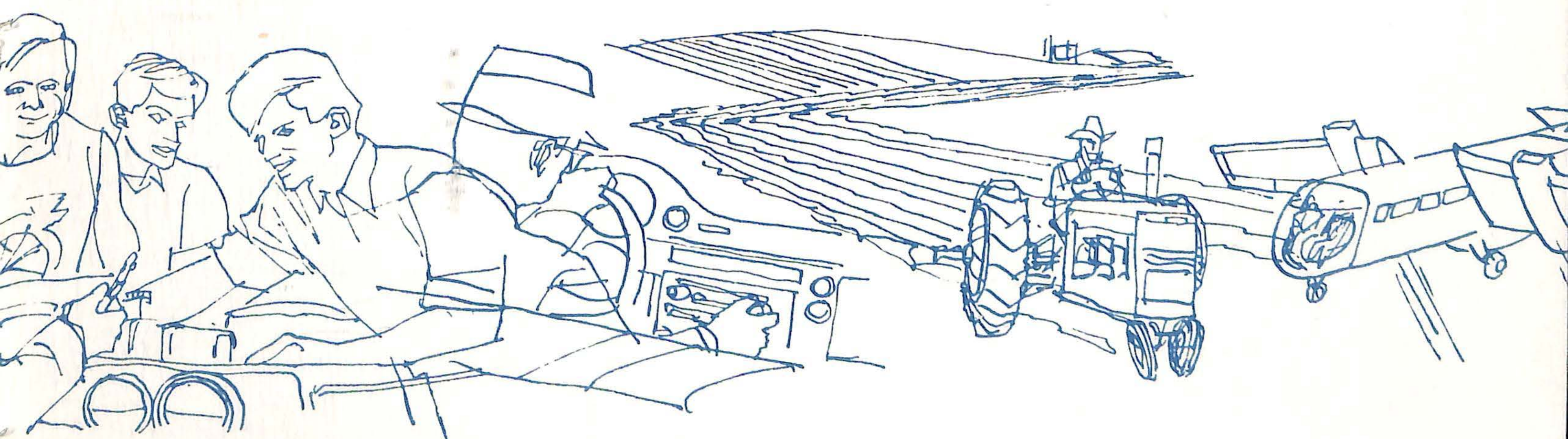
It was also inevitable that portions of the industry's highly viable technology would be applied to areas unrelated to its primary tasks in defense and space.

A well-publicized manifestation of applying this technology to other areas are the study contracts awarded by the state of California to aerospace firms. Projects and companies are:

- Crime and control of criminals — Space General Corp.
- Information collection — Lockheed Aircraft Corp.
- Waste disposal — Aerojet-General Corp.
- Transportation — North American Aviation, Inc.

The study on crime by Space General Corp. has been submitted to California's Governor Edmund G. Brown. Governor Brown stated: "This is a unique experiment. And the analysts in our Department of Corrections who have checked it out say it is an unqualified success. . . . The systems engineers put California in a laboratory, so to speak. They have documented methods of dealing with crime they think could be improved. They believe that in five years we could rearrange our court procedures; improve our methods of predicting outbreaks in crime; change our approach to parole; and produce a more efficient system for dealing with crime at a lower cost."

Lockheed's study of California's information handling requirements was divided into phases. In the analysis stage, information was gathered from 80 major organizations — state, city and county units — on information needs and flow. The later phases evolved a conceptual design for a statewide information system and a development plan through which it could be put into effect. Lockheed recommended that California



install, over the next decade, a comprehensive statewide information service that will permit one-time collection of information and make it available to any authorized governmental organization in the form and at the place required. The system recommended, Lockheed reported, is technically possible, economical, legally sound, and consistent with existing electronic data processing systems in California. Improved governmental effectiveness and better service to the people and businesses of the state would result, Lockheed stated.

The waste disposal study by Aerojet-General found that costs for disposal of wastes — rubbish, garbage, sewage, smog, factory effluents, farm waste, radioactive wastes, etc. — will soar to a multibillion level by 1990 unless steps are taken soon to organize an overall waste management system.

The Aerojet report found that the direct cost of getting rid of waste, using present techniques, will triple to $1 billion annually within 25 years. Pollution damage to crops, industry, property, tourism, etc., will increase the annual cost to more than $7 billion.

The study on transportation, made by North American, found that systems analysis is the one approach capable of encompassing the entire transportation planning task.

Governor Brown, after reviewing the report, said: "North American Aviation's report on transportation makes the answer unanimous. Systems engineering is not only a sound approach to social problems, it may well be the only sound approach. . . . The idea of transferring talented systems engineers from the field of space hardware to the broader field of human need is, in itself, a breakthrough of significant proportion. . . . We intend to do more than admire these reports — we intend to use them."

North American found that the demands in California for transportation of people and commodities may swell in excess of 500 percent and 700 percent, respectively, in 50 years. The study found that construction of a functional computer model of a transportation system for California would be an integral part of the effort. This model would be composed of six sub-models, most of which could be used independently for specific purposes.

Rep. Henry S. Reuss, D., Wis., who introduced legislation to provide for the development of new systems of urban transportation, noted the capabilities of the aerospace industry to deal with this burgeoning problem. "Technological breakthrough," he said, "is a space age phrase which has yet to be applied generally to earthly space age problems. Wonders have been accomplished in their efforts to send a man to the moon. There is no reason why this same genius cannot be put to use to send a man more speedily from his home to his place of work or other city destination.

"While conducting the research, the engineers could undoubtedly take advantage of advancements made by the space industry, particularly in the area of propulsion. The people who run our mass transit program could learn a great deal from the people who are testing new vehicular and propulsion devices for our space program and perhaps adapt some of the space advances to urban transportation use."

These are major socio-economic problems that are finding a road to solution through aerospace technology.

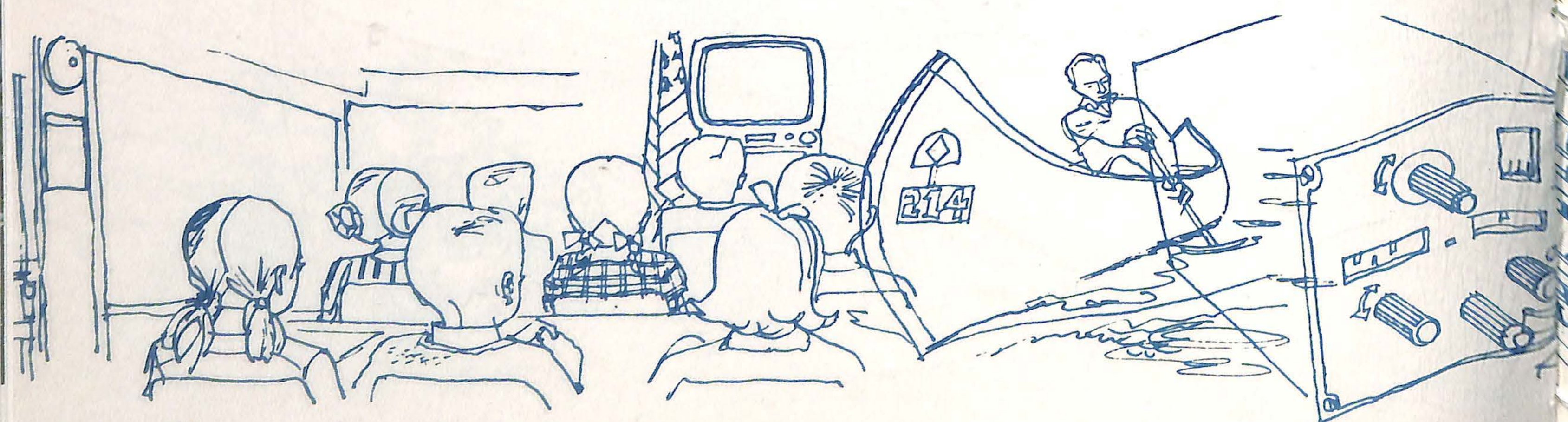
Aerospace techniques and technology also apply to many other fields.

Among them are:

Desalination. The idea of converting salt water to fresh is one of man's most ancient goals. But the goal has long defied an economic solution. Today the government is making a strong move to achieve that goal with the appropriation of $200 million for a five-year research program. President Lyndon B. Johnson said these funds would not "build a single desalting plant." He explained that the $200 million appropriation stands as a concrete "commitment — the steps across the threshold toward the breakthrough that must and will come, in my judgment, in the last half of the 1960s."

Several aerospace firms are actively working to make the President's prediction a fact. Westinghouse Electric Corp., for example, since 1951 has installed 57 desalting units from Kuwait on the Fersian Gulf to Lanzarote in the Canary Islands. General Electric, North American Aviation and Aerojet-General are also engaged in desalination work. There are energetic managers and technicians in the aerospace industry working today to meet desalting objectives.

Oceanography. The oceans cover almost three-fourths of the earth's surface. Today there is more scientific knowledge of the space above us than the oceans below, and space technology is directly applicable to oceanography. It is known that the oceans



represent vast untapped resources that this nation may need — resources of food, water, minerals and even power. The oceans are also important to our national security as technological advances increase the threat from submarines.

The oceans specifically offer mining for diamonds, gold, phosphates, tin and manganese; there are productive projects in oil exploration; marine microbes may prove valuable for the chemical and drug industries.

Daniel J. Haughton, president of the Lockheed Aircraft Corp., put the aerospace industry's interest in oceanography in focus when his firm opened a marine laboratory at San Diego:

He said: "In general, the whole field of the oceans — oceanography, ocean systems, ocean exploration, economic uses, and so on — is becoming increasingly attractive. We have had occasion to notice that technological developments seem to come in waves. In the 30s and early 40s it was the airplane. In the 40s and 50s we added the ballistic missile. In the late 50s and now in the 60s we added space. In the 70s we believe we will add the oceans. This doesn't mean there will be a lessening of effort on airplanes, missiles and space. Far from it. We will continue to press forward in all of these fields. There is a bright future ahead for them all."

Poverty program. The aerospace industry is in the front lines of the war on poverty. Approximately 15 aerospace firms have made proposals or are under contract to the Office of Economic Opportunity, principally for the operation of Job Corps Centers. Industry has proven its capability in managing the centers where young men and women, usually school dropouts, are trained in a great variety of skills.

Sargeant Shriver, director of the Office of Economic Opportunity, recently told members of Congress his impressions of industry running the Job Corps Centers. "They know how to run things. They are good managers. They know what kind of employees they need. They train people in realities. The kids know they're dealing with reality. Take Camp Kilmer. The management knows what a body repair shop is. It has had experience. There is no play-acting."

The Job Corps Center at Camp Kilmer, N. J., is operated by the Federal Electric Corp., a subsidiary of the International Telephone and Telegraph Corp. Harold S. Geneen, chairman and president of ITT, speaking at the dedication of the Kilmer Center, stated: "Some of you may wonder why a major, profit-making corporation like ITT wants to join the war on poverty.

"The answer is threefold:

"We, in industry, owe it to our society to use our resources to cure a social ill that has been with us too long.

"We, in industry, must maintain for ourselves and the nation a trained labor force.

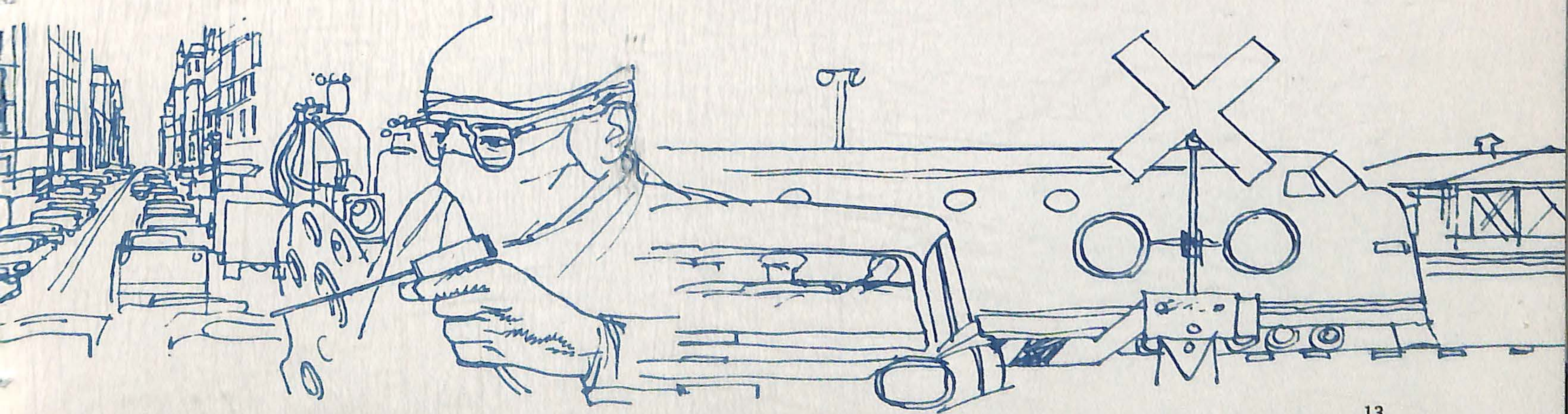
"We, in industry, have the capital, the manpower, the skills, the technology, and the desire to get the job done."

The Philco Corp., Packard-Bell Electronics Corp., Litton Industries, Westinghouse and other companies have similar roles in the program. OEO officials report that industry has contributed training aids to the centers, supplied advice on curriculums and assisted in placing many of the Job Corps Center graduates in jobs.

Other fields. Aerojet-General, a major designer and producer of rocket engines, is active in fields far removed from the pads at Cape Kennedy and Vandenberg Air Force Base. Aerojet's Industrial Systems Division today is heavily engaged in automated materials handling and distribution. The division is supplying Woolworth's in Chicago with a system for quickly supplying merchandise to 1,000 of its stores, and is helping to revitalize the receiving operation of Macy's in New York. The equipment not only moves material from place to place, but accurately and quickly selects merchandise in warehouses to fill specific orders, and then consolidates them for shipment.

Stress cells developed for Aerojet for space projects today are monitoring the stress behavior of Oroville Dam in northern California, the world's highest earthfill dam. The 1,000-pound cells constantly check the static stresses within the dam and dynamic stresses imposed by earthquakes or movements that could produce structural disturbances. California's Water Resources Director William E. Warne calls the system an unprecedented forward step in embankment dams engineering that will develop new information for use in the design of future dams.

Aerojet's work with a Freon coolant technique to chill sensors in a military infrared detection system has led to the development of a cryogenic (freezing temperature) surgical brain probe. Cryogenic surgery uses deep cold to freeze sections of living tissue. Precise



controls supply temperatures to the tip of the probe in a range from 98.6 degrees Fahrenheit to minus 115 degrees F. The probe is small, simple and light. It is six inches long and weighs only a few ounces. A compact console, about the size of a portable typewriter case, contains the controls and the coolant. It is desirable for treating such conditions as Parkinson's disease, brain and pituitary gland tumors, detached retinas, cataracts, even tonsil removal.

Sperry Gyroscope Company and the Univac Division of Sperry Rand Corp. have combined on a project that will provide electronic control for New York City traffic. Simply, the system will permit the traffic flow to control the traffic lights rather than vice versa. The Sperry Rand system incorporates sensors, detectors, controllers, data processors, control consoles and displays. Many defense and space systems combine these elements. The system will permit traffic on a heavily traveled southbound lane to have fewer stops by red lights than a sparsely traveled northbound lane. The New York Traffic Department estimates that a trip across Manhattan from the East River to the Hudson will require only 15 minutes when the system goes into effect. This compares with a trip time today of up to 45 minutes. A modular approach to the equipment design permits a city to acquire the electronic control a step at a time. A city could install sensors and controllers, and later add a data processor.

North American's Space and Information Division has an experiment, which grew out of a study to develop food for lunar colonists, that aims at reclaiming sewage water while growing algae for animal feed. Sixty-six chickens have thrived on the experimental diet of high protein algae supplement. The experimental facility in four weeks harvested 150 pounds of algae from 60,000 gallons of sewage waste water which in turn was pumped back into the desert where the experimental facility is located.

The Garrett Corp. builds many vital components of aircraft and space systems. Their development of a small gas turbine gave them experience in "hot wheels" and high temperature materials. This led the firm into designing, developing and manufacturing a commercial turbocharger. The turbocharger, by forcing air into the cylinder of an internal combustion engine, provides increased engine power without an increase in size. Early this year, Garrett reported that 3,000 of the turbochargers are being manufactured each month.

Garrett has also developed a fundamentally new concept for military field hospitals. Applying its knowledge of systems management, it devised an inflatable field hospital that is mobile, requires a short set-up time (30 minutes), has a controlled environment, contains its own power sources, and can function under any weather conditions.

A Garrett gas turbine engine provides power for refrigeration, air heating and circulation, water heating and pumping, air pressure for inflation and compressed air. The hospital is built as a unit system and can be enlarged depending on requirements. An expandable element, one utility and two air inflatable element containers can be transported on one truck.

These installations are expected to have other military, government and industrial application.

Lear Jet Corp. three years ago broke ground for a facility in Wichita, Kansas, to build a business jet aircraft. Today the firm is producing aircraft, and has diversified into the production of eight-track stereophonic tape player units for the home and automobile.

The Marquardt Corp., designers and builders of ramjet engines and now developing the reaction control engines for the Apollo service module, has utilized its technical knowledge to produce a grade crossing predictor for railroads. Heart of the predictor systems is an analog controller. The predictor operates crossing warning devices at a predetermined time prior to the arrival of the train regardless of train speed.

Douglas Aircraft Company, Inc., one of the pioneer aircraft companies, has not only broadened its product line, but also recently entered the atomic energy field in contract to operate, with another firm, the Atomic Energy Commission's reactor and fuel fabrication facilities at the Hanford (Washington) Plant. Another department of Douglas Aircraft recently turned out its millionth piston for automotive use.

The Boeing Company, which has produced a lengthy series of military and commercial aircraft, missiles and is working in space exploration projects, is also carrying forward hydrofoil research involving the use of wholly submerged wing-like foils for these unique boats.

Grumman Aircraft Engineering Corp. is a major aircraft producer and is the prime contractor for the Lunar Excursion Module. However, since 1931, two years after the founding of the company, Grumman has produced aluminum truck bodies widely used by trucking lines. Since 1945 Grumman has built a long line of aluminum and fiberglass canoes, cruisers and sail boats.

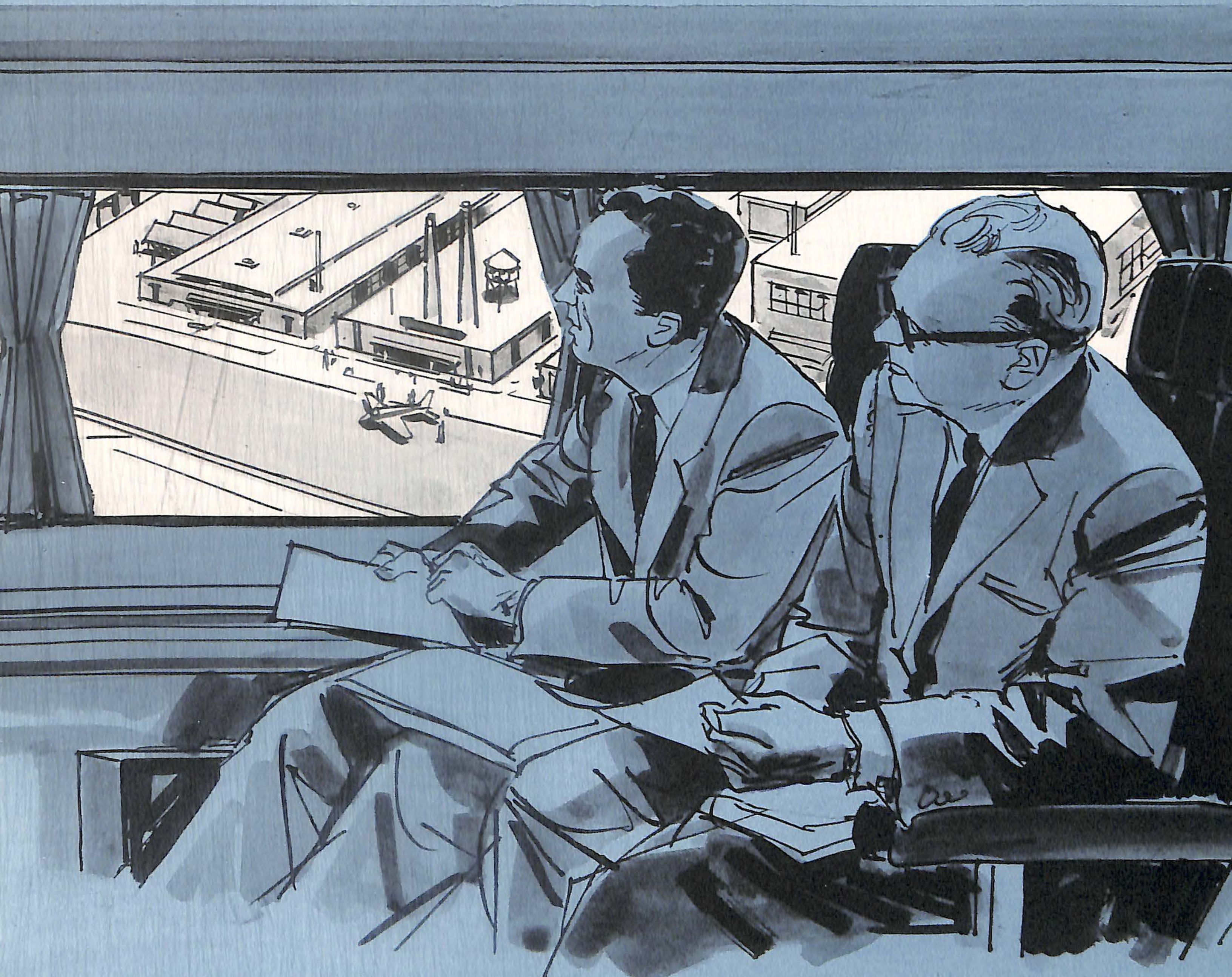
General Precision, Inc., is expanding its position in the field of education. The firm is now selling to schools audio-visual equipment, including motion picture projectors and slide films, television equipment and auto-driver trainers.

TRW Inc. has developed the world's fastest camera which is being widely used in medical and laser research, and has contributed significantly to cancer study. The camera can capture such split-second happenings as lightning, plasma pinches, and laser beam bursts. It can capture natural and man-made phenomena that occur in five-billionths of a second. That is about 5,000 times faster than one can blink an eye.

The new product list is lengthy; every aerospace company has made direct and indirect contributions. The prospect for the future, like outer space, has no horizion. But the task is far from simple. Dr. Ruben F. Mettler, executive vice president of TRW Inc., says: "The fallout from research and development is elusive; and even after it has been caught and processed it is slippery and difficult to funnel into a bottle that you can put a label on and sell."

Virtually every aerospace firm has a planning department that constantly seeks ways and means to translate industry technology into new and existing fields.

General Aviation:
GENERATOR TO THE ECONOMY



Every one thousand dollars of tax money invested in general aviation facilities by one Midwestern city produces business in excess of two million dollars a year.

This statement by George J. Vavoulis, Mayor of St. Paul, Minnesota, was quoted recently at a conference-briefing conducted by the Aerospace Industries Association's Utility Airplane Council on the position and potential of general aviation.

During the discussion on "The Economic Impact of General Aviation," this and other examples were given of how individual communities in the U.S., as well as the national economy, derive benefit from proper *total* air transportation facilities.

At Islip, Long Island, industries attracted to the area because of the facilities of MacArthur Airport have produced 2,855 new jobs resulting in $12 million more personal income and $470,000 yearly tax revenue.

In another part of the nation, an airstrip in the small western Oklahoma town of Alva became the foundation for several businesses and one of the largest payrolls in the county. Noting what general aviation has meant to Alva, its Mayor said: "Our town testifies to the impact general aviation can have on the economic well-being of a modern community that becomes an active part of this vigorous and fabulous age of business flying."

In broad terms, general aviation benefits the total population and the economic structure of the nation in four ways:

- General aviation creates jobs — not only in the manufacture, service, and utilization of aircraft, but in business and industry which use airplanes as a tool of operation.
- General aviation is a consumer of products and services.
- General aviation improves individual well-being.
- General aviation is a stand-by weapon for national defense.

As a tool of business, there are between 35,000 and 40,000 general aviation airplanes operated by corporations and individuals solely for business purposes. Studies by member companies of the Utility Airplane Council of the Aerospace Industries Association indicate that there are about 390,000 potential customers in the business use alone.

Last year the industry produced 9,336 new aircraft, and production during 1965 is running more than 20 percent ahead of 1964. The current annual retail value of these sales is approximately $325 million. To produce these airplanes, the seven companies belonging to the Utility Airplane Council spend more than $500 thousand daily for goods and materials. In addition, the salaries to employees bring strong economic benefits to the areas where these plants are located.

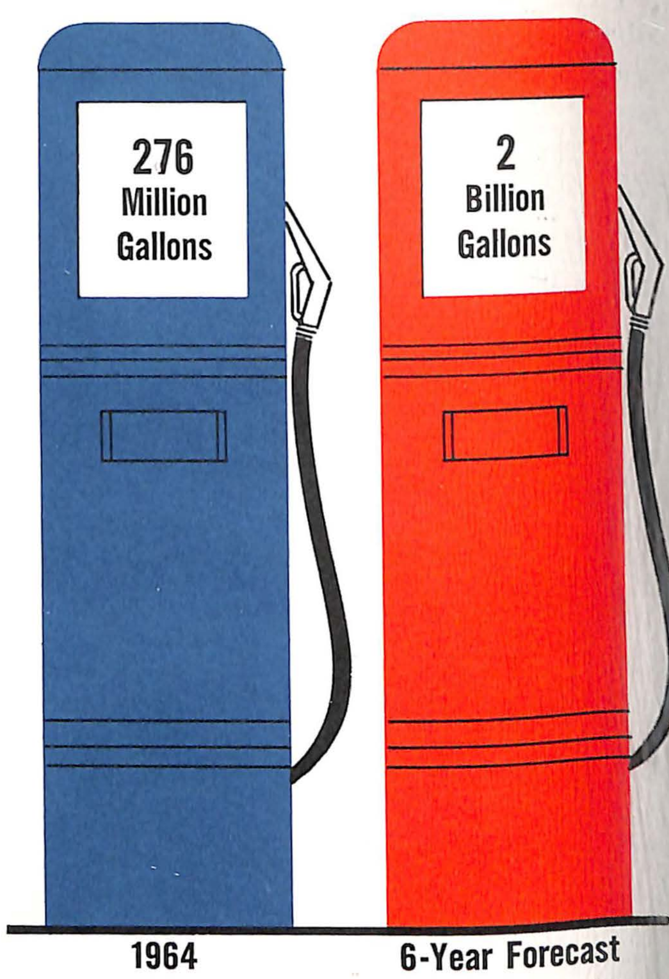
The money spent in the production of the completed airplane and engine, however, is but a small part of the total. There is a further benefit to the economy in the large payrolls of the many companies that produce and supply the radios, instruments, aluminum and steel, tires and tubes, propellers, wheels, brakes, and petroleum needed by general aviation.

The Federal Aviation Agency has estimated that general aviation airplanes used 276 million gallons of fuel in 1964, with an approximate value of $110 million. By 1969 these figures are expected to rise to 380 million gallons with a value of $150 million. In this six-year period, general aviation airplanes will consume approximately two billion gallons for which their owners will pay $800 million.

General aviation aircraft also create a demand for special services, for they require a base of operations, daily service, and periodic maintenance. At present, there are about 3,500 service centers operating on a full-time basis and thousands more at airports operating on a part-time basis.

The impact of general aviation upon local economies

FUEL CONSUMPTION BY GENERAL AVIATION



has been well documented. One of the most interesting studies in this field was conducted by the Michigan Department of Aeronautics in 1962. In its report, the Department concluded that general aviation accounted for 91.4 percent of the airplane movements in the state. Of more than six and one-half million air travelers, general aviation carried 46 percent while the scheduled airlines carried 54 percent. The money these general aviation pilots and passengers deposited in the communities they visited — exclusive of pure airplane services — totaled $110 million during the year.

In addition to its economic impact upon individual communities in Michigan and the other 49 states, general aviation provides further economic impact through its exports. Last year exports of general aviation aircraft and powerplants accounted for about 20 percent of the industry's production.

Not only do these exports represent important "people-to-people" dollars and aid the U. S. balance of payments position, but they provide numerous aids to the people and countries receiving them. For example, in the developing nations, general aviation aircraft imported from the U. S. provide vital communication and transportation links that would otherwise be impossible without massive expenditures in time, money and manpower to build roads across deserts, mountains and jungles.

The ways in which general aviation improves individual well-being, both abroad and in our own country, are numerous. General aviation flying includes aircraft for personnel and cargo transportation by business; personal and pleasure air travel in one's own aircraft; forest, power, and pipeline patrol; instruction, charter and air-taxi flying; ambulance, rescue and emergency service; law enforcement and agricultural application.

In this last category alone, each American benefits, both in savings and in health, from the use of general aviation airplanes to spray and dust crops throughout the land. Airplanes are used to treat one out of every six tillable acres in the U. S. with some 140 million gallons of spray chemicals and more than 700 million pounds of dry chemicals.

The nation also benefits from general aviation's contribution to national security.

Although the companies producing general aviation airplanes are commercial entities, their facilities are ready and adequate to meet the government's requirements to produce defense materiel.

Last year the Federal Aviation Agency stressed the role of general aviation in time of emergency through its launching of the State and Regional Defense Airlift Planning. In its report, the FAA stated that in time of emergency one of the nation's most important resources is its stand-by fleet of general aviation airplanes and competent general aviation pilots.

"General aviation," the report stated, "has become an integral part of industry and agriculture to such an extent that without the use of general aviation aircraft many of these activities would be seriously hampered. In terms of volume, general aviation activity is much greater than that of the air carrier.

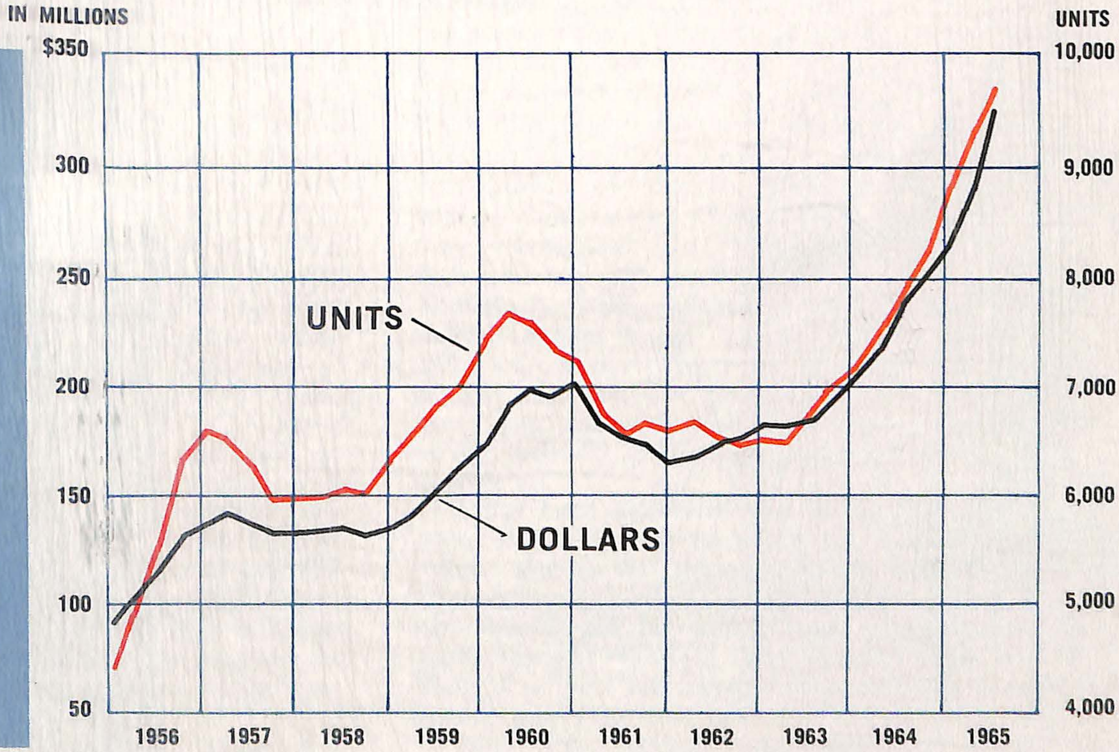
"The general aviation resources provide such a significant capability in national emergency that every effort must be made to provide for its continued use in civil and military defense, survival, and industrial and agricultural recovery efforts. Loss of the use of these resources even for a short period would result in serious impairment of the efficiency of industrial and agricultural operations. From the viewpoint of moving passengers and/or cargo, the capability of the general aviation fleet to perform airlift approximates that of the air carriers, although the general aviation fleet is approximately 42 times as large as that of the air carriers."

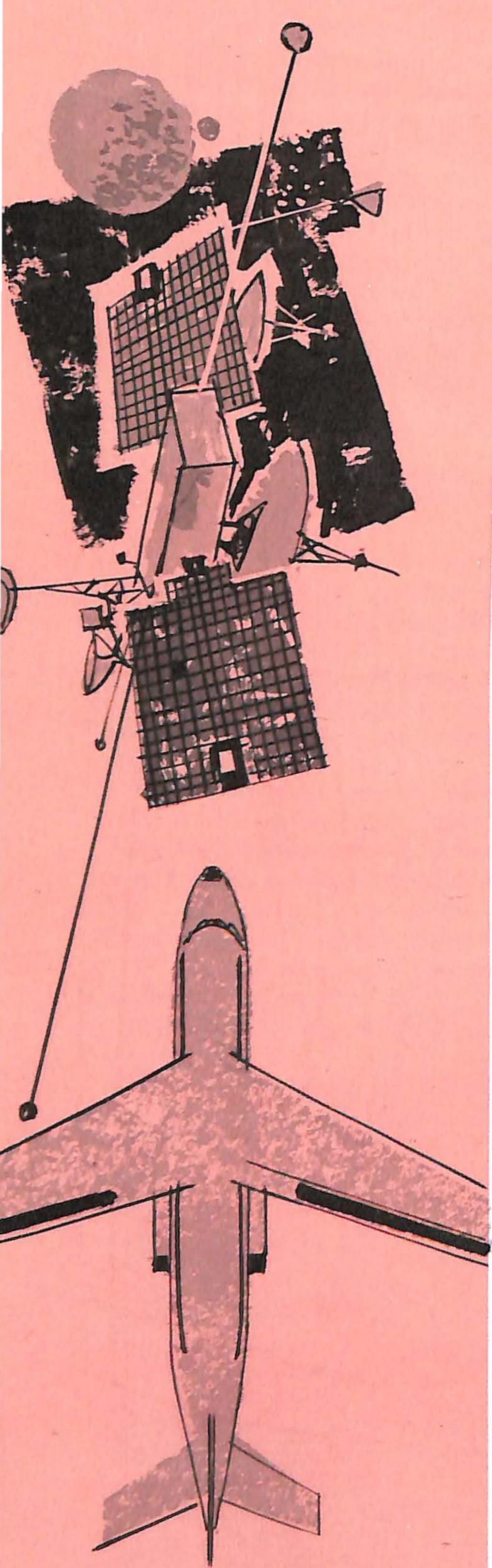
The reasons for this importance in the event of an emergency are equally sound for economic, political, and social advances.

General aviation aircraft serve more than 9,000 airport communities across the nation. With more than 90,000 airplanes currently active and with some 400,000 active pilots, general aviation immediately connects any community with an airport to the jet age of transportation and communication.

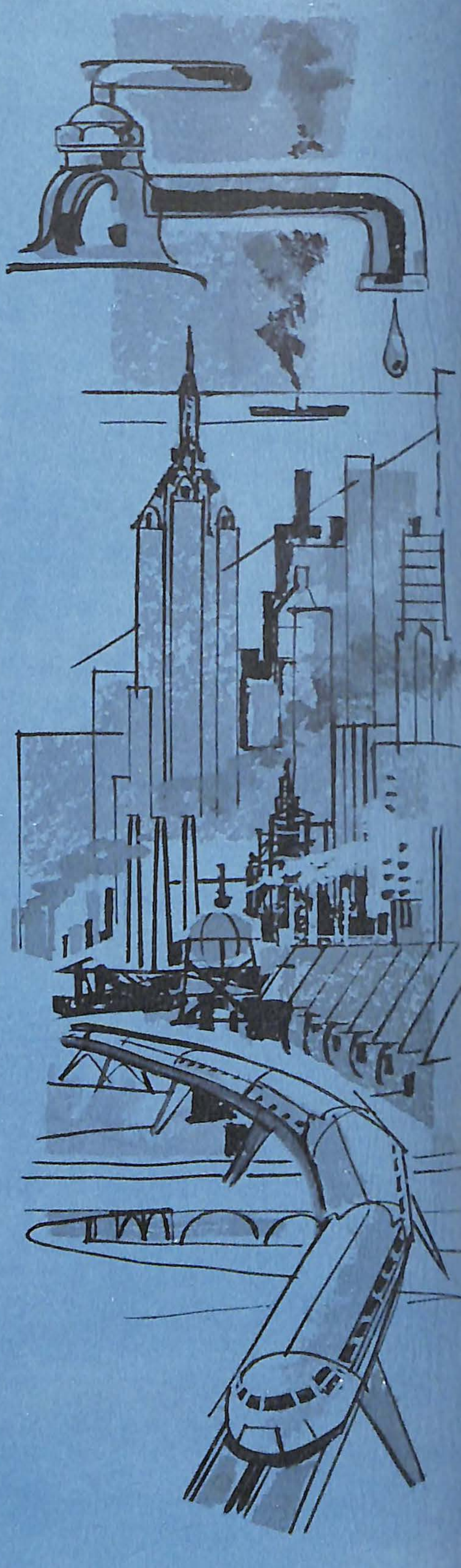
Not too many years ago this type of flying was called "private aviation." As it developed and grew through the technological advancements made by the industry and through the fulfillment of a myriad of needs of the user, its name has been broadened to "general aviation." The industry is proud of its promotion from private to general.

GENERAL AVIATION DELIVERIES





EXPERIMENT IN TOMORROW



Speaking before the Commonwealth Club of San Francisco, Karl G. Harr, Jr., president of the Aerospace Industries Association, delineated the fundamentals of the government-industry aerospace relationship and the direction it is providing in the relationship of the government to U. S. industry for other requirements. Excerpts from this major policy speech are reprinted here.

We stand now at approximately the 20th anniversary of the end of World War II. And in these past two decades the aerospace industry, together with the government, has evolved the form, the capabilities and the working relationships which will shape its future.

To convey an accurate picture of the nature of this industry is sometimes difficult, but the statistical facts can be simply stated. It is the nation's largest manufacturing employer and is second only to the automotive industry in annual sales. It is an extremely technically oriented industry, embracing more than one-fifth of the nation's scientists and engineers. It is the nation's leading exporter of manufactured goods, accounting for well over a billion dollars of exports for each of the last five years. It is a low-profit industry, averaging a net profit on sales after taxes of approximately half the national average. And it is a highly competitive industry, a producer of a highly varied product line, and an industry that must operate under the closest public scrutiny.

Finally, although it produces all of the nation's private and commercial aircraft, helicopters, and many other commercial products, approximately 85 percent of its products and services are sold to the government.

Perhaps it is this last statistic, coupled with the technical complexity of most aerospace products and the fact that some of them are secret, which produces the aura of mystery that tends to pervade public understanding of the nature of the industry. People find it hard to accept the fact that today's highly complex hardware items, whether for military or space or even commercial applications, are produced by free private industry, just as are standard consumer goods — that such things as fighters, bombers, intercontinental missiles and spacecraft are produced by private companies having stockholders, boards of directors, profit-and-loss statements, indebtedness to the bank, and all the other normal concomitants of any private industry.

Although there are differences in some of the ways of doing business when the government constitutes so large a proportion of the market, the fundamentals remain the same. The managerial responsibilities and the economic disciplines that are essential to the successful operation of any industry are equally essential to the successful operation of the aerospace industry.

Recognizing this is fundamental not only to understand the nature of this industry but also to grasp the implications of its peculiar position vis-a-vis the government.

The aerospace industry is not a captive industry nor is it a "tamed" one, if these terms convey any idea of relinquishment of managerial or fiscal responsibility. Nor is this industry an element of any sinister military-industrial cabal. It is merely that segment of American private industry which, because its experience made it an obvious choice to be the keystone of the nation's defense and space program, has had to learn to live in a close working relationship with government. As such, it has been something of an industrial guinea pig over the past 15 or 20 years. And the experiences it has undergone in that capacity have broad implications for all American industry.

The great significance of the experiment involving the aerospace industry, viewed at this moment of time, lies in pointing up the philosophical crossroads at which this nation, as well as its major regions, stand in terms of the future relationship between government and industry as they both approach the problems and opportunities that now face us and will face us to a greater extent in the future.

It seems reasonably certain that along with the defense and space challenges, many of today's and tomorrow's other major challenges, such as transportation, pollution, water supply, urban congestion, and the like, cannot be met or even seriously approached without some major public involvement at one level of government or another.

The demands of mere population growth alone, not to mention the heightened appetites that will inevitably accompany the unfolding of a whole new range of opportunities afforded by advancing technology, will require combinations of public and private effort for their satisfaction. By 1985 our population will be approximately 265 million; and it will be an overwhelmingly urban population. We will have to make radical changes in our manner of transporting people and goods, in providing water, heat, light and clean air so that men can live productively and with dignity. Municipal, state and federal participation along with private industry, in varying combinations, will often be necessary.

It has been estimated that in another five years, water programs may be where our space program is today. During that period federally sponsored water research is expected to double. To take another example, federal aid for urban mass transportation has grown from $194,000 in 1964, to $48 million in 1966. Federal support for transportation research alone has grown from $1 million in fiscal 1964 to $12½ million in fiscal 1966. Whereas it may ultimately take several billions to develop a supersonic transport, it may also take several billions to find a way to conquer air pollution. Thus, as we view the challenges of even the immediate future, it is apparent that we are not talking about projects which private industry, a municipality, a state or even the federal government can readily tackle alone.

If this be true, the experience of that industry which has been so directly involved over recent years in the nation's largest enduring peacetime experiment in government/industry collaboration becomes of considerable importance to each of us.

Inferentially, two questions were posed when the government chose private industry to be the instrument to produce the hardware necessary for the achievement of national goals in defense and space.

First, could private industry do the technical and managerial job efficiently and effectively?

Second, could satisfactory working relationships between government and industry be developed that would preserve all vital elements of each in the national interest?

On the first count, of course, industry rather quickly proved its point. It could and did respond in impressive fashion to the increasingly difficult and complex demands occasioned by the nation's defense and space requirements. As the major industrial component of such an effort, the aerospace industry takes great pride in the technical and systems management capabilities which it has developed. Although we can hardly take exclusive credit for having reached such an advanced state of capability, since government requirements played a major part in both forcing us to and enabling us to develop it, the fact remains that, in the key respects essential to the development and production of technically complex systems, the aerospace industry has advanced far beyond anything this nation has seen before. Certainly, therefore, positive affirmation of the first proposition, at least, has been irrefutably established. No one of significance in government today talks seriously of a return to an arsenal concept. In fact, the trend in thinking in this connection is running strongly the other way.

Furthermore, the second question also can already be answered solidly in the affirmative. Although a refined determination of the exact parameters between industry and government in such major undertakings is far from being established, it has already been demonstrated that an effective system of working relationships can be developed which will preserve all vital public and private interests.

In the case of the aerospace industry and the government, such relationships have not been achieved without great strain on both sides. They have evolved slowly. They are far from perfect. They require constant pragmatic experimentation if the proper balance is to be maintained. And they require constant reaffirmation both within government and within industry of the realities of our times and the basic principles which must be preserved if the *total* national interest is to be protected.

Any fair and objective observer would have to conclude that there has evolved a general understanding and a general system of working relationships which is conducive to the perpetuation of these national interests. Industries such as the aerospace industry, and the principal government procuring agencies, will continue to contend vigorously with each other as to the specifics and the degree of governmental control, issues of risk-taking versus profit, and the like. But there exists now within government a widespread recognition of both the merits and the needs of industry's having the freedom and the incentive to do its proper job, and there is a widespread recognition within industry of the need for government controls adequate to protect the public interest.

The conclusion that inescapably emerges is that a major segment of American industry *can* function effectively in a close, large-scale working relationship of indefinite duration with the government and still remain independent and free standing. This is not limited to *big* industry. Industrial teams that are involved in aerospace programs run the gamut from the major prime contractors to the smallest suppliers of components.

It is true, of course, that all such concerns must learn the distinct art of living with the peculiarities of a government, as distinguished from a commercial customer — the special vocabularies, the special ways of doing business, the special rules, the special controls, and the like. Learning this art often appears difficult. Sometimes it even overwhelms the newcomer and leads him to believe that participation entails some sacrifice of his essential managerial responsibilities. The aerospace industry's experience, however, indicates that, though constant vigilance is required, such clearly need not be the case.

The implications of this fact are significant. If tomorrow's problems and tomorrow's opportunities include among them many of such a complexity and such a magnitude — and, of course, they do — that they can only be approached through close cooperation between one level or another of government and major segments of private industry; if it has been demonstrated that private industry provides the best technical instrument to exploit the rapidly unfolding technological revolution; if it has been demonstrated that effective working relationships on an enduring and mutually beneficial basis can be established between government and private industry; and if it has been demonstrated that private industry of all sizes and at all levels can engage in such a relationship over a protracted period of time and still remain healthy and free standing as private enterprise; then, there is an important formula for the future.

Today, by virtue of the past two decades of national requirements for increasingly complex defense and space hardware, and by virtue of the technological revolution in commercial aviation, the aerospace industry possesses a unique capability to address itself to the solution of the most complex technological problems. This is a considerable national asset; it is an asset which has potential applications far beyond the confines of military or space hardware. It should not be inferred that the aerospace industry has a monopoly on the technical brainpower or managerial skills essential to complex systems management. Such an assertion would be as untrue as it would be beside the point. One point *is*, however, that by virtue of our nation's recent history this industry has had the advantage of having had to reach out into such areas much farther than industries paced solely to consumer demands. Another point is that in a future in which we can look for big government, big problems, and big opportunities as a virtual certainty, it behooves all of American industry, big and small, realistically to analyze the implications of these facts if they would play a major role in helping advance our society.

Advance or die is applicable to industry, or any given industry, as much as it is to any other element of life. And, for industry in the present context, advancing entails learning to live constructively with the formidable challenges and hard realities of the times.

And this means that today and tomorrow we require the rugged individualist as much as, if not more than, ever before. We need the man with the courage to deal with what is before us today and yet live with the discipline of tomorrow's requirements; who is willing to risk; who looks for answers and solutions; who seeks to lead and not merely carp; who learns how to manage large and complex institutions and combinations of institutions rather than be frightened by their sheer size or complexity; and who accepts adventure as the natural state of man.

We need men like this both in industry and in government. Underlying the whole American concept of the democratic society is this belief in the responsible but bold action and attitude of the individual. The premium on such action and such attitude grows apace with the size and complexity of the problems our society faces.

In order to bring our technological gifts and skills to bear on our many problems — problems larger than those we have yet had to face and different from those we have yet had to face — we must encourage and honor a new breed of rugged individualists, for upon their shoulders will fall the task. We must, in addition, hold out to our youth the prospect of a vigorous participation in meeting these challenges, and prepare for them as well as we can a fruitful working place in a democratic society of free men and women devoted to that task.

Just what the future forms and structures will be that will provide our youth with this opportunity cannot be firmly predicted. In any case, such forms will undergo constant evolution.

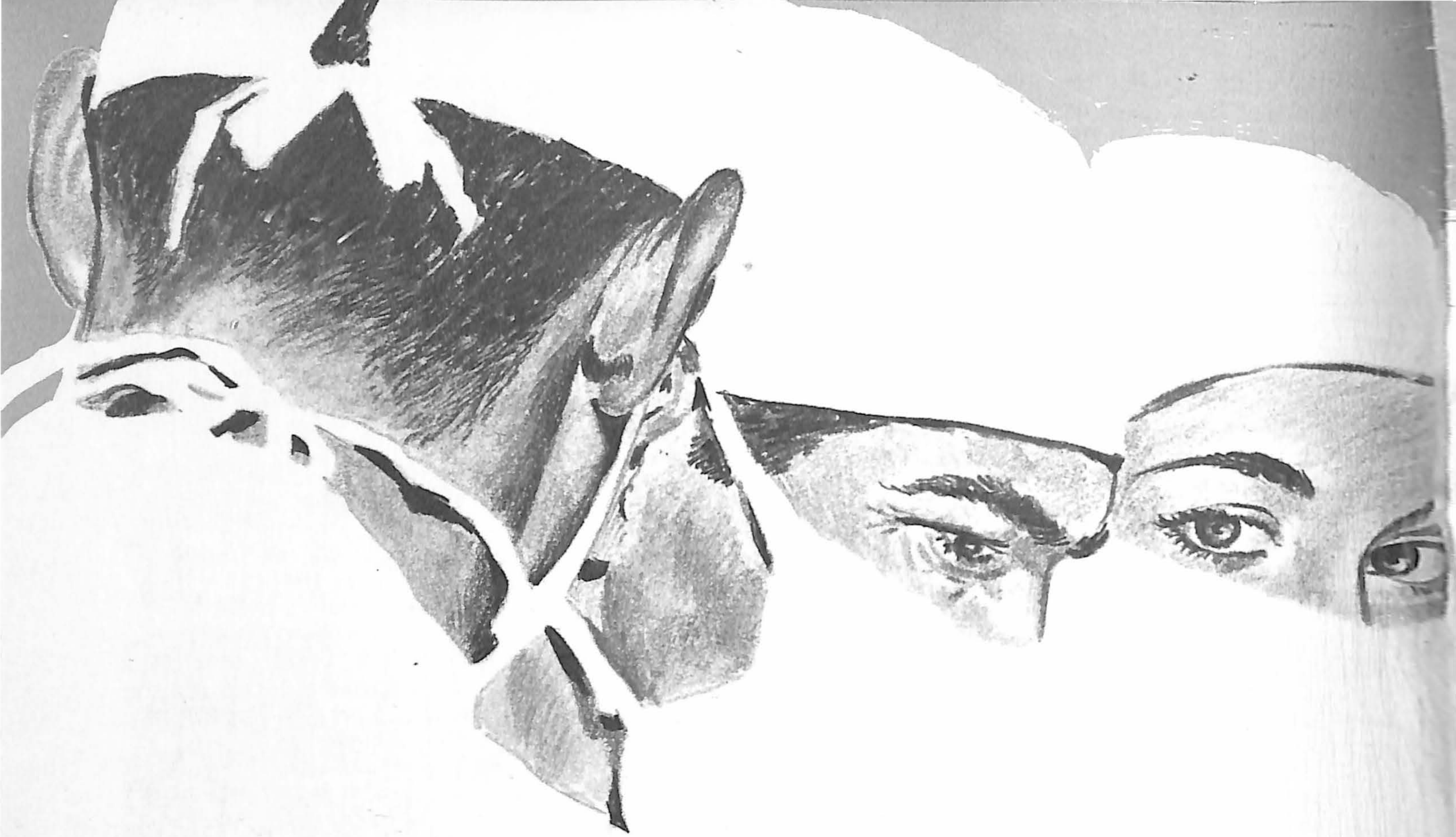
We have already seen firm evidence that there will be many further types of experimentation in developing formulae for industry/government cooperation toward the achievement of national or regional goals. A system of procurement of military and space hardware — that is, the direct government procurement of products for direct government use — is merely the simplest formula. Other more complicated ones are already emerging, such as the formula for the development of the supersonic transport and the formula for the development of the communications satellite system.

Does the formula of working relationships provide the continued dynamic parallelism of governmental and free enterprise institutions? Such a dynamic parallelism is the key to fulfilling man's wants without destroying the principles of free men in a free society.

In the case of our aerospace experiment over the past two decades, the swift changing demands of national security would permit neither a static industry nor a stultifying bureaucracy. Both the government segment and the industrial segment involved had to achieve and sustain this dynamic parallelism in terms of technological competence, managerial skill, constant searching for new and better ways to work together, and relentless vigilance directed at protecting the essential elements of their respective institutions.

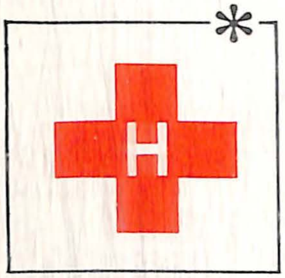
Defense is and will continue to be a *big* challenge which requires the best efforts of industry and government. The same is true of space. These are the two vital national problems which have provided us with experience as to how government/industry can best work together.

New *big* problems are already emerging to confront us and such problems will both grow in size and become more numerous as our population expands and as advancing technology affords opportunities for better fulfilling man's needs. Transportation congestion, water and air pollution, the need for greater water resources, the need for better crime control are but the known advance guard of the big problems which will face us in the future. Only if this situation is fully grasped, only if the experience in coping with such problems which are already at hand is analyzed and applied, and only if the total potential for addressing these problems is positively exploited, will future managers both in government and out have the tools with which to marry technological advances with a society of free men and free institutions.



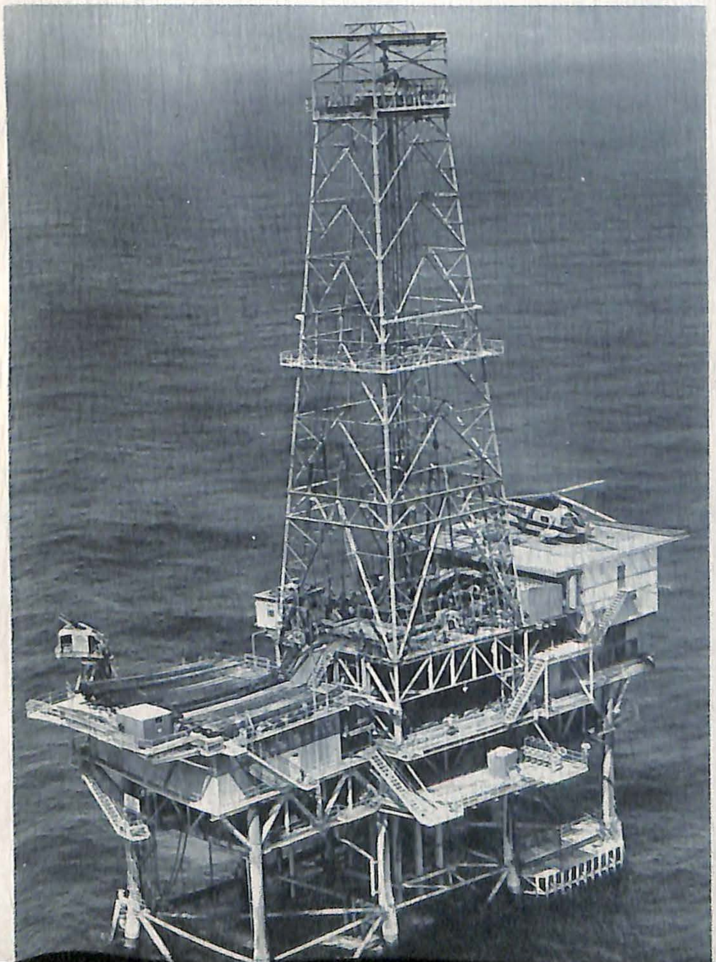
Firemen help transfer pa- tient in helicopter litter t a hospital stretcher at th Methodist Hospital o Southern California, Arca dia, Calif. This heliport i 50 feet by 50 feet and ha an asphalt cement surfac lighting and a wind soc Initial cost was $1,500.

H — Helicopters, Heliports and Hospitals



The helicopter, heliport and hospital combine to provide prompt medical attention in emergencies and save lives. Today there are nearly 40 hospitals in the U. S. with helicopter landing facilities, costing from $100 at a private hospital to $30,000 at a government-owned hospital. All have demonstrated their value. A survey conducted by the Vertical Lift Aircraft Council of the Aerospace Industries Association revealed that the hospital heliports range in size from 25 feet by 25 feet on a hospital rooftop to ground sites 100 feet to 200 feet square. The VLAC offered this "prescription" for hospitals wishing to build a heliport: Review local ordinances regarding helicopter operations; consult with a helicopter operator regarding possible sites; request the Federal Aviation Agency to test the proposed sites for air safety; select a site with an unobstructed approach-departure path; then add a fence, heliport marker, fire extinguisher and a wind sock. There are many refinements that can be added, such as telephones, paving and lighting, but the simple "prescription" above will result in an adequate ground-level heliport. Photos in this article show the wide variety of heliports at U. S. hospitals.

* This is the forty-foot square hospital heliport marker recommended by the Federal Aviation Agency. Sections of the cross are 10 feet on each side.

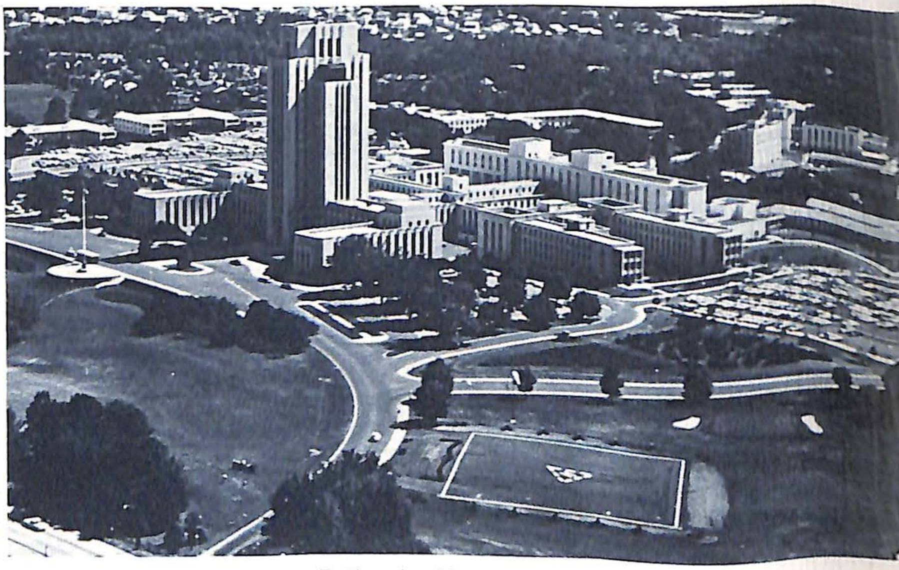


There are more than 100 of these off-shore oil rig heliports (left and top). Rig heliport at left is 60 feet by 60 feet and oak planks are used for the surface. The heliport is marked to aid the helicopter in lining up for the approach. Alton Oschner Medical Foundation in New Orleans established this heliport (bottom) in 1954. Patients are often flown here from the off-shore oil rigs.

This huge helicopter can transport 67 passengers in the attached pod. The pod could be equipped as an emergency hospital and transported quickly to disaster areas.

An Army helicopter lands a patient at Arizona's Tucson Medical Center close to the door of the emergency entrance.

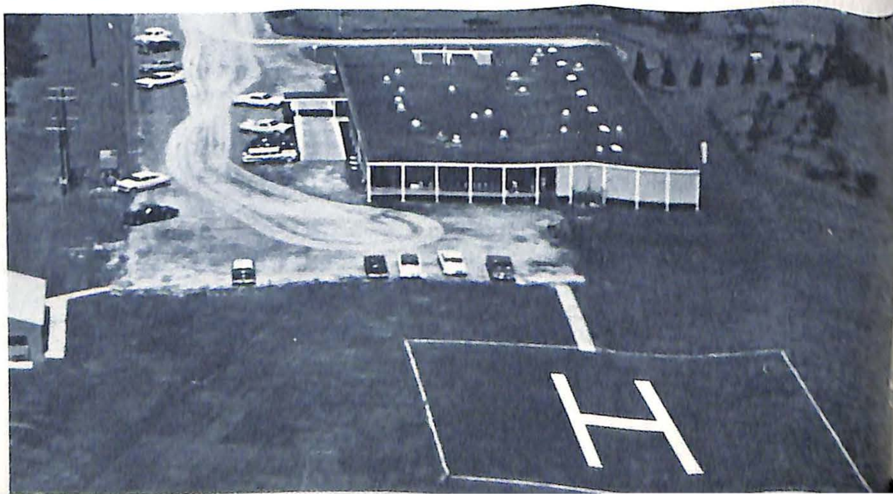
California's Santa Monica Hospital has a typical minimum rooftop heliport. This is one of the first rooftop hospital heliports built in the U. S.



The Naval Medical Center, Bethesda, Maryland, has a thoroughly equipped heliport. The asphalt-covered 150-foot by 150-foot facility cost $30,000.

Hospital rooftop can be an emergency heliport.

Lady of the Sea General Hospital at Galliano, Louisiana, has a minimum, sod surface heliport. About 50 patients a year arrive here by helicopter.

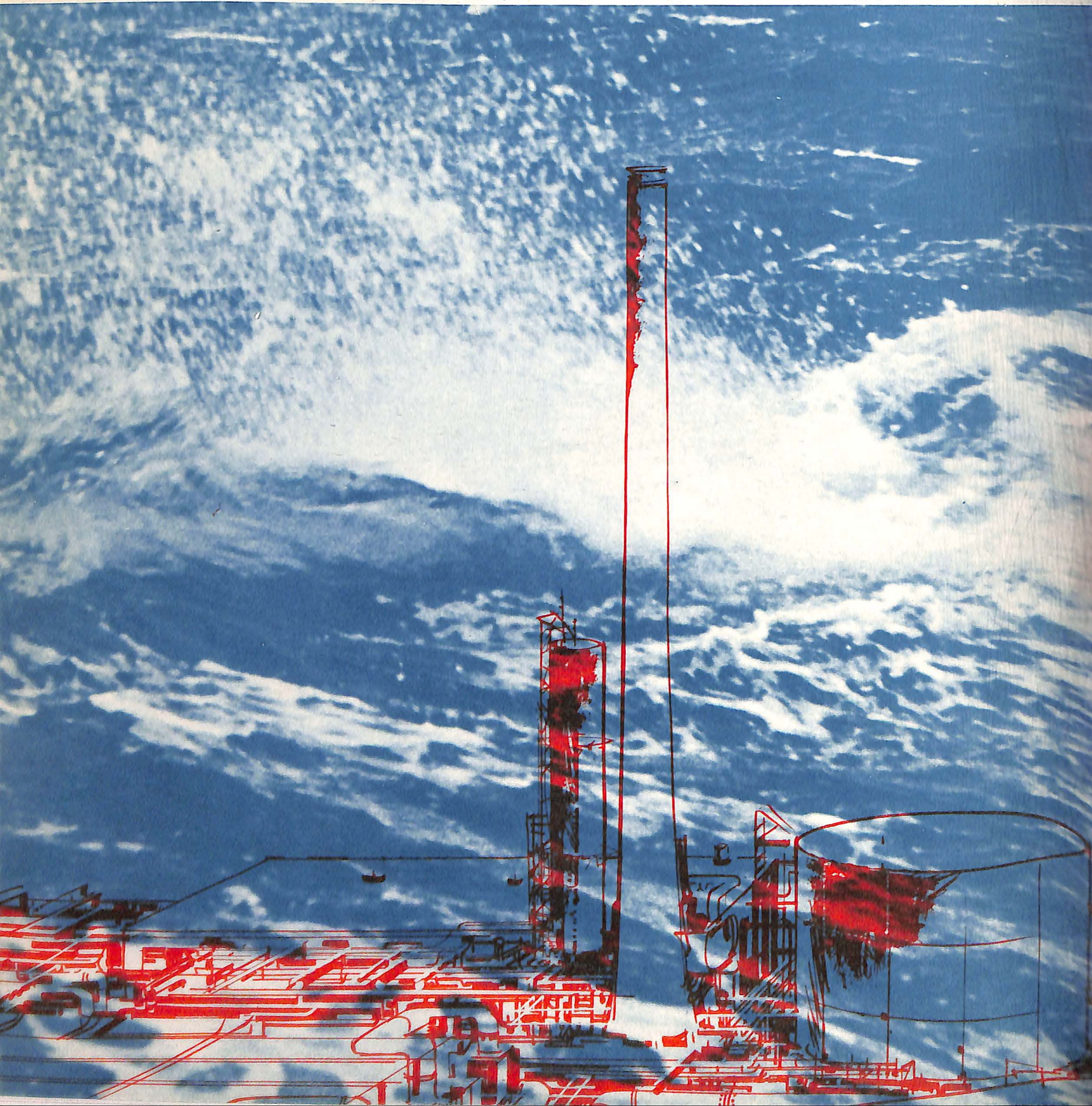


AIA MANUFACTURING MEMBERS

Aero Commander Div.
  Rockwell-Standard Corp.
Aerodex, Inc.
Aerojet-General Corporation
Aeronca Manufacturing Corporation
Aeronutronic Division, Philco
  Corporation
Aluminum Company of America
American Brake Shoe Company
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
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 Powder Company
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 Corporation
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Company
McDonnell Aircraft Corporation
Menasco Manufacturing Company
North American Aviation, Inc.
Northrop Corporation
Pacific Airmotive Corporation
Piper Aircraft Corporation
PneumoDynamics Corporation
Radio Corporation of America
  Defense Electronic Products
Rohr Corporation
The Ryan Aeronautical Company
Solar, Division of International
  Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company Division
  Sperry Phoenix Company Division
  Sperry Utah Company Division
  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

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

Several aerospace firms are engaged in water desalination projects. (See article, *The Innovation Industry*, page 10).



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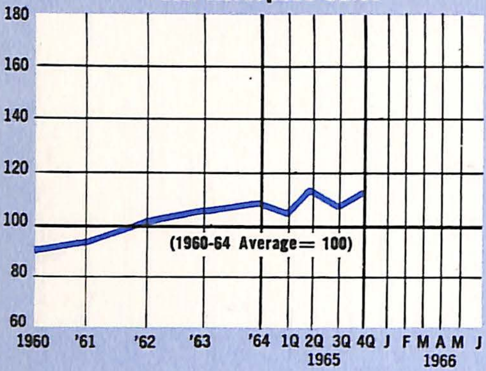
- The Federal Budget and Aerospace
- Zoom at the Top
- Air Traffic Snarl—On the Ground
- Aerospace Economic Indicators

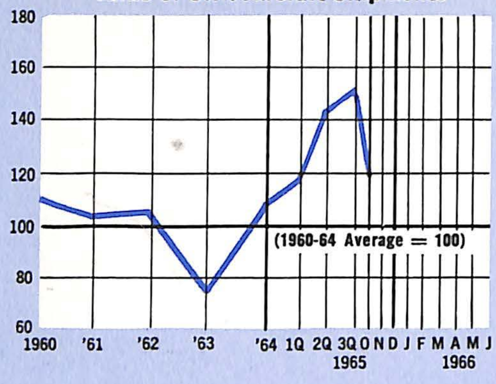
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

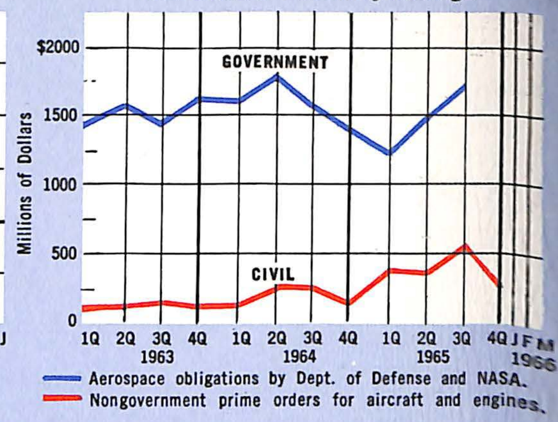


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-64 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.0	Quarter Ending Dec. 30 1965	20.6	20.5	20.9[E]
	Billion $	Quarterly	4.7		4.9	5.1	5.5
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,177	Nov. 1965	841	1,147	741
Aircraft	Million $	Monthly	584	Nov. 1965	556	684	569
Missiles & Space	Million $	Monthly	593	Nov. 1965	285	463	172
Aerospace expenditures: Total	Million $	Monthly	1,098	Nov. 1965	868	833	708
Aircraft	Million $	Monthly	560	Nov. 1965	489	444	357
Missiles & Space	Million $	Monthly	538	Nov. 1965	379	389	351
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	183	Dec. 1965	475	408	357
Expenditures	Million $	Monthly	143	Dec. 1965	317	372	417
GENERAL UTILITY AIRCRAFT SALES							
Units	Number	Monthly	633	Jan. 1966	866	1,111	1,187
Value	Million $	Monthly	13	Jan. 1966	19	38	33
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	14.1#	Quarter Ending Sept. 30 1965	15.4	16.7	18.7
U.S. Government	Billion $	Quarterly	11.1		11.9	11.8	12.7
Nongovernment	Billion $	Quarterly	3.0		3.5	4.9	6.0
EXPORTS							
Total (Including military)	Million $	Monthly	107	Sept. 1965	79	141	122
New Commercial Transports	Million $	Monthly	23	Sept. 1965	8	54	46
New Utility Aircraft	Million $	Monthly	2	Sept. 1965	4	5	8
PROFITS				Quarter Ending Sept. 30 1965			
Aerospace — Based on Sales	Percent	Quarterly	2.1		2.9	3.1	3.6
All Manufacturing — Based on Sales	Percent	Quarterly	4.6		5.1	5.8	5.4
EMPLOYMENT: Total	Thousands	Monthly	1,128	Nov. 1965	1,099	1,181	1,198
Aircraft	Thousands	Monthly	507	Nov. 1965	421	472	480
Missiles & Space	Thousands	Monthly	490	Nov. 1965	531	538	547
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.87	Nov. 1965	3.11	3.21	3.23

E Estimate
* 1960-64 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 1961-64.

AIA

aerospace

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CONTENTS

The purpose of AEROSPACE is to:

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

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

Foster understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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.

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

With this issue, *Aerospace* becomes a monthly publication. A compelling reason for increasing the frequency of publication from a quarterly is to provide current information on the economics of the aerospace industry and an outlook for its future. This is accomplished in the facing page of economic indicators.

Sources for this information are predominantly government agencies, including the Department of Defense, National Aeronautics and Space Administration, Department of Commerce, Department of Labor, and the Securities and Exchange Commission. The data are refined and then supplemented by reports from the member companies of the Aerospace Industries Association. The dynamic economics of the aerospace industry, a major U. S. industrial force, and the dominant technological force, will be detailed on a regular and comprehensive basis.

Today the industry stands at a peak of activity. Karl G. Harr, Jr., president of the Aerospace Industries Association, recently stated highlights of the industry's record for 1965.

- Sales reached a record of $20.9 billion. This was also the third successive year that sales have exceeded $20 billion.
- Earnings, as a percentage of sales were 3.1 percent, the highest in recent years; however, this is still well below the average of 5.5 percent for other manufacturing industries.
- Backlog of orders at the end of the third quarter in 1965 was $18.7 billion, more than $3 billion higher than in 1964.
- Exports amounted to $1.4 billion, a near record, and about 16 percent higher than in 1964.
- Employment was about 1,200,000 persons at the end of 1965. Scientists, engineers and technicians accounted for a substantial part of a gain of 64,000 over the same period a year ago.

In nearly every major economic indicator category, the year ahead will exceed 1965. Orders generated by U. S. operations in Vietnam are a contributing factor. But the aerospace industry base today is far broader than its responsibilities in defense and space exploration.

Commercial aircraft orders for turbine-powered transports and a wide variety of utility aircraft are at an all-time high. Other areas of commercial products and services are developing and expanding. The industry is energetically responding to the burgeoning civil problems of the nation ranging from traffic control to air and water purification, confident of an ingenuity that has put man in space and aircraft across continents in time-confounding speed. The prospects and results of industry's imaginative solutions will be reported in *Aerospace*.

THE FEDERAL BUDGET AN

AEROSPACE

Approximately $20 billion in orders for the aerospace industry is indicated by the Fiscal Year 1967 budget and the supplemental appropriation request for FY 1966, an increase of more than $5 billion compared with FY 1965.

These orders, coupled with programs underway and an increasing level of activity in commercial aircraft projects, place a very high degree of challenge and responsibility on the aerospace industry to meet urgent national requirements.

Federal funds will provide the equipment to carry on operations in Vietnam, make valuable improvements in weaponry ranging from tactical weapons to strategic missiles and aircraft, move ahead in a comprehensive program of space exploration, and pursue such programs as the supersonic transport, high speed ground transportation, oceanography, environmental sciences, desalination of water, and air and water pollution.

Dollar amounts in this article, whenever possible, are for obligations — *orders* — as opposed to expenditures — *payment for orders* — in order to reflect the future activities of the aerospace industry. Charts on Pages 4 and 5 show the major aerospace expenditures of the Department of Defense and the National Aeronautics and Space Administration for FY 1960 through estimates for FY 1966-67.

In major aerospace categories, Department of Defense estimates direct obligations for aircraft procurement at $7.3 billion in the FY 1967 request and missile obligations at $1.9 billion. Research, Development, Test and Evaluation (RDT&E) obligations for defense programs in FY 1967 will be approximately $6.9 billion.

National Aeronautics and Space Administration has requested $5 billion in FY 1967 obligational authority. About two-thirds of this sum is for the Apollo program, which is aimed at putting man on the moon by the end of this decade.

Funds for aircraft and missile procurement and RDT&E comprise a substantial portion of the supplemental FY 1966 request. Funds to purchase 2,000 helicopters and 900 fixed-wing aircraft amount to $3.15 billion. USAF requested $1.58 billion; the Army, $825 million; the Navy and Marine Corps, $738 million. For the procurement of 4,800 missiles, mostly Hawk (surface-to-air) and Bullpup (air-to-surface) types, $181 million has been requested. The Army is asking for $64 million, the Air Force $63.7 million, the Marine Corps $27.5 million and the Navy $26.2 million.

Total RDT&E funds in the supplemental FY 1966 "for accelerated research and development efforts related to Vietnam" amounts to $152 million.

Several other government agencies seek varying sums in their FY 1967 requests for projects involving the aerospace industry. Specific programs of some of these agencies will be discussed later.

Department of Defense

Vietnam dominates the military budget. Military expenditures for FY 1967 are based on Vietnam operations continuing at approximately the present level. An increase in Vietnam action means a greater requirement for funds. Conversely, a lessening in operations is not expected to reduce military spending significantly because substantial troop commitments to keep the peace and improve the capabilities of South Vietnamese forces would still be required. Modernizing and expanding weapon inventories would continue, involving substantial aircraft purchases.

Aircraft

Total new money for aircraft requested in FY 1967, by services, are: USAF, $4.7 billion; Navy, $1.9 billion and $700 million for the Army.

More than 1,000 fixed-wing aircraft are scheduled to be procured. The major programs include orders for the FB-111 and the A-7 for the Air Force. The FB-111 is being ordered in quantity (210 units) to keep the manned bomber force modern in the 1970s. Secretary of Defense Robert S. McNamara explained the decision to procure the FB-111, equipped with the Short Range Attack Missile (SRAM), this way:

"Against the current Soviet anti-bomber defense, we have measured the cost to hedge with bombers in terms of B-52s armed with gravity bombs since the FB-111/SRAM would be a more expensive alternative. Conversely, against an improved Soviet anti-bomber defense, we have used the FB-111/SRAM since it would provide a less expensive hedge than the B-52 armed with either gravity bombs or SRAM."

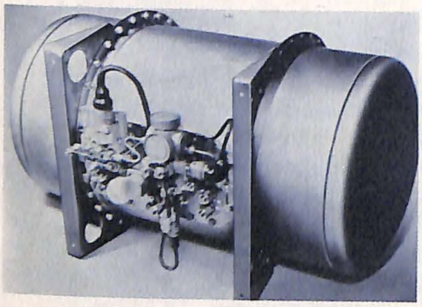
AEROSPACE NOTES

Air-Space Museum Receives Gemini Fuel Cell Unit

The National Air and Space Museum has been presented a fuel-cell unit for permanent display.

Identical to those used on the 14-day Gemini VII mission, the presentation was made to Sidney R. Galler, assistant secretary of the Smithsonian Institution, by George L. Haller, vice president of the General Electric Co., producers of the fuel cell.

Although fuel cells were invented more than a century ago, their first practical performance was achieved during the eight-day Gemini V flight last August. Their importance to space flight lies in the fact they are lighter than conventional batteries where there is a heavy electrical load for flights greater than three or four days.



New Calibration Techniques Produce $400,000 Savings

General Dynamics' San Diego Electronics operation expects that reappraisal of calibration requirements for test equipment will produce savings of nearly $400,000 by the end of this year.

Three cost reduction proposals led to the adoption of the new procedures. Although each has specific functions designated, they can generally be described as restricting calibration efforts to realistic requirements of each instrument's intended use instead of calibrating all instruments to the same accuracy and on the same time schedule.

A fourth proposal, which concerns adapting or borrowing test equipment, when possible, rather than purchasing new instruments, is expected to achieve an additional $260,000 savings.

Electron Beam Welds 5-Inch Stainless Steel in One Pass

Hamilton Standard, a division of United Aircraft Corp., has developed and produced the most powerful electron beam welder with the highest penetration capability now in use in the metal-working industry.

The high voltage machine can weld five-inch stainless steel in a single pass and join heavy sections of aluminum, titanium and other metals from four-to-six inches in thickness.

The 20-kilowatt welder will be utilized by Lockheed-Georgia in its manufacturing development work on the C-5A heavy logistics transport.

Hydroclave Tests Submarine

Rohr's Space Products Division achieved an unexpected dividend in current operation of its hydroclaves.

Designed and installed to serve as a curing and densification facility for large non-metallic rocket nozzle components, the unit recently performed tests for a two-man submarine.

The largest hydroclave is capable of producing a maximum pressure of 1,000 pounds per square inch — thus simulating some 2,300 feet of ocean depth. When a group of California scientists, who had developed a small, two-man submarine, proposed to test their vessel in the hydroclave, Rohr agreed to try the facility. The tests were so successful, Rohr now believes the hydroclaves may be utilized as a means of testing a wide range of other oceanographic and undersea equipment.

Helicopter Spray System Covers 14 Acres in Minute

Textron's Bell Helicopter Co. has developed a new chemical application system which allows a helicopter, flying at 60 miles per hour and allowing for ten-second turns, to spray up to 14.4 acres per minute.

Dubbed the AgMASTER, the system was designed for Bell's new Ag-5 helicopter but can be used as a separate unit and installed on any Bell Model 47G series.

Electron Microscope Takes Small View of Things

Radio Corporation of America has introduced a new electron microscope capable of distinguishing objects as small as 1/30 millionth of an inch in diameter.

In addition, a new photographic facility in the microscope holds 18 photographic plates and allows for removal of partial loads without breaking the instrument's vacuum. Thus, exposed plates become immediately accessible, measurably improving the microscope's productivity.

Experience has shown that the instrument can magnify objects to as many as 200,000 times their size. As one user put it, "If an aspirin tablet could be seen in its entirety under this instrument, it would appear as a powdery hill, a mile in diameter."

CH-54 Copters Retrieve 47 Aircraft Downed in Vietnam

In three months of operation by the U. S. Army in Vietnam, four Sikorsky CH-54A Skycrane heavy-lift helicopters have saved almost twice their original cost by retrieving aircraft downed in combat areas.

The four helicopters have recovered a Douglas A-1E Skyraider fighter-bomber, a deHavilland CV-2 Caribou transport, and 45 helicopters, ranging in size from the 2,000-pound Bell OH-13 to the Vertol CH-47, weighing about nine tons. Total value of the recovered aircraft is about $15 million.

Foam Fired Through Gun Provides Instant Packaging

Several years ago, foam became a standard ingredient in fighting fires and smoothing runways for disabled aircraft landings. General Dynamics Fort Worth Division now has found another use for a slightly altered form of foam—instant packaging.

Packaging specialists are using a foam-in-place machine for packing aircraft parts for shipment. The part is suspended in any standard container and foam is applied from a gun in from 10 to 30 seconds. Hardening takes about three minutes and securely locks the part to be shipped.

The gun consists of two 500-pound containers and a nitrogen and air supply. One container uses a resin and the other a frosting compound. Equal amounts are forced into the gun and mixed, and they emerge as a frosty suds. Consistency of the foam can range from spongy to hard, depending upon the mixture of the compounds.

Microfilm File of Vendors Contains 10,000 Companies

Establishment of a vendor selection microfilm file at the Lockheed-California Co., has expanded and centralized procurement source selection for Lockheed suppliers.

The file contains information on more than 10,000 aerospace suppliers, largely small business firms, and is indexed by product and by company name. For each supplier there is either a five-page capability report or a one-page profile of information.

The index lists all products manufactured by each supplier. Photo reproductions of the requested information may be made in seconds by the touch of a button.

TV Camera Photographs 'Invisible' Rocket Flames

Test engineers at Rocketdyne, a division of North American Aviation, Inc., photograph "invisible" rocket hydrogen flames with a television camera which sees things the operator cannot.

The unique single camera setup, developed by Rocketdyne, is being used to "spy" on tests of the J-2 hydrogen fueled engine. The camera modification was devised as a part of the J-2 research and development program because burning hydrogen is not normally visible.

However, infrared radiation is emitted by water molecules which are produced when hydrogen burns with air or pure oxygen. Consequently, the spy-camera employs a pick-up tube, which is installed in a TV camera in place of its standard tube, and photographs infrared light rays through its special filters. Through this method, test engineers track down leak sources as they occur.

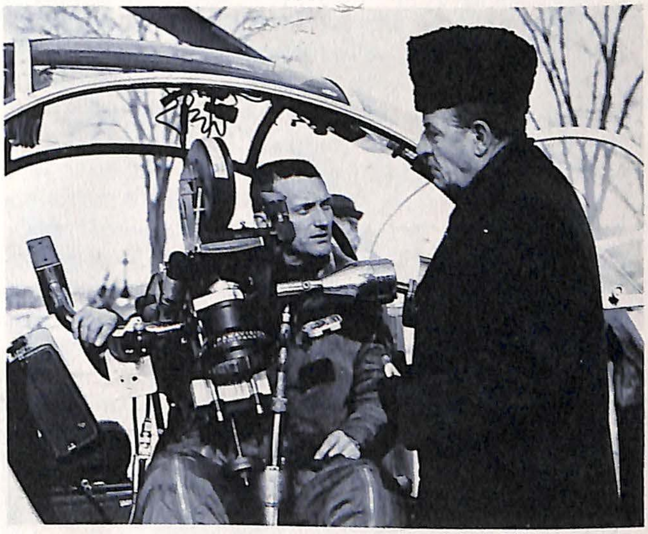
Suggestion on Turboprop Part Saves $64,000 in Year

A suggestion that the turbine inlet case for turboprop engines be purchased as a rolled and expanded seamless ring has resulted in annual savings of $64,000 at the Allison Division, General Motors Corp.

The suggestion was submitted by an engineer, who recommended the new method replace the more costly closed die forging previously used.

In addition to reducing material costs, use of the new method will also save time. Consequently, Allison officials say, the savings will be passed on to the government customer through the price charged for the end product.

ZOOM AT THE TOP



It is time for that inevitable break in any television program which is known as the commercial, the period that allows the firm paying the bills to display its wares. This particular program is sponsored by an automobile manufacturer.

As the announcer describes the virtues of the model, the viewer is given first a bird's-eye view of a typical automobile testing track. Then as the test car roars around the area, the viewer is brought immediately closer to the auto until he can see the distinctive features in its styling.

Then comes another commercial, sponsored by a wine company. The picture shows a solitary sailboat in a rolling body of water. Again the camera zeroes in gradually to show, from an altitude of about 50 feet, an appropriately handsome couple sampling the sponsor's products.

Commercials such as these are viewed daily by millions of TV watchers across the nation.

The vehicle for enabling advertisers to present this kind of pictorial commercial?

The incredibly versatile helicopter.

It was not always so. Although movie makers and commercial cinema-photographers for years have yearned for higher cranes from which to suspend their cameras, they believed the helicopter to be too susceptible to the winds and whims of atmospheric conditions to be the base for acceptable filming.

The Los Angeles cameraman-pilot partnership of Nelson Tyler and Peter Pascal helped solve the problem. Their company, Helicopter Camera Systems, designed a camera mount that effectively and mechanically compensated for the conditions which had adversely affected films shot from a helicopter.

The first outside agency to take advantage of their research was the National Film Board of Canada, one of the world's largest producers and distributors of motion pictures.

The Board decided that the mount would be useful in carrying out two major assignments: filming the Labyrinth project for Expo '67 (Montreal's celebration of Canada's 100th birthday), and filming Canadian scenes under a working title of "Helicopter View of Canada" by commission of the Centennial of Canadian Confederation 1967.

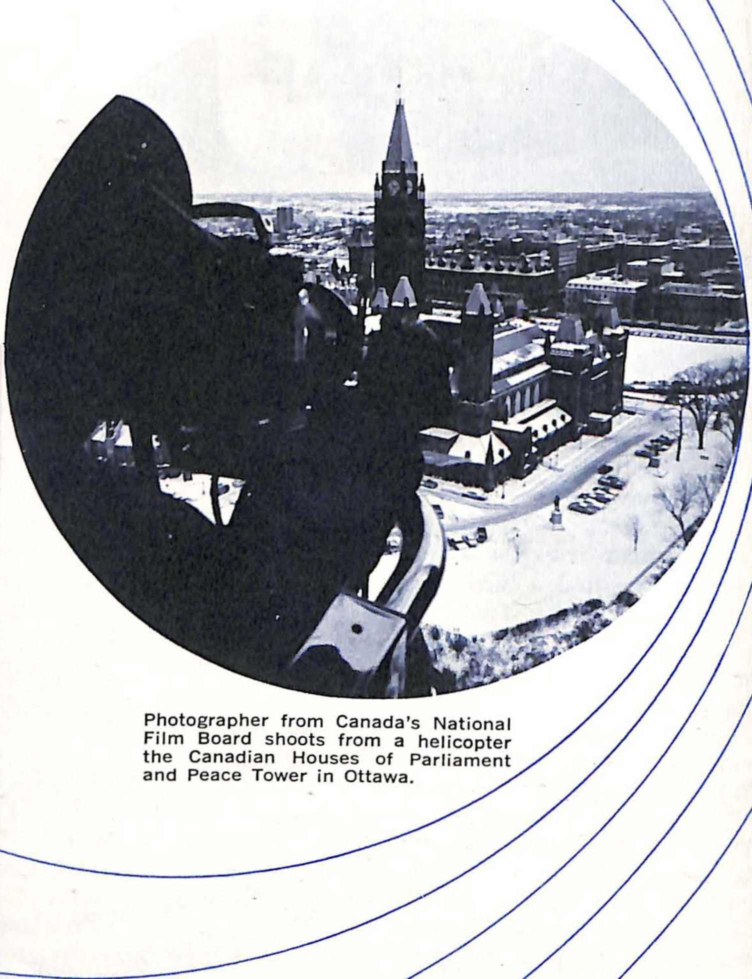
The Labyrinth project theme is "Man and His World." The Film Board, in its Labyrinth films, plans to modernize the ancient Greek legend of the Minotaur — the half-man, half-bull who lived in a labyrinth — to portray modern man's discovery of his planet.

To enhance the films' effectiveness, the Board has designed a large horizontal screen to be placed below the audience; at one end will be a slender vertical screen. The movie will be viewed from three horseshoe-shaped tiers or galleries surrounding the two screens. The result will be to give the viewer a realistic view of earth as seen from a high altitude.

The films range geographically from the concrete canyons of Manhattan to the Rocky Mountains, from Crete and Greece in the Eastern Mediterranean to Ethiopia and Cambodia.

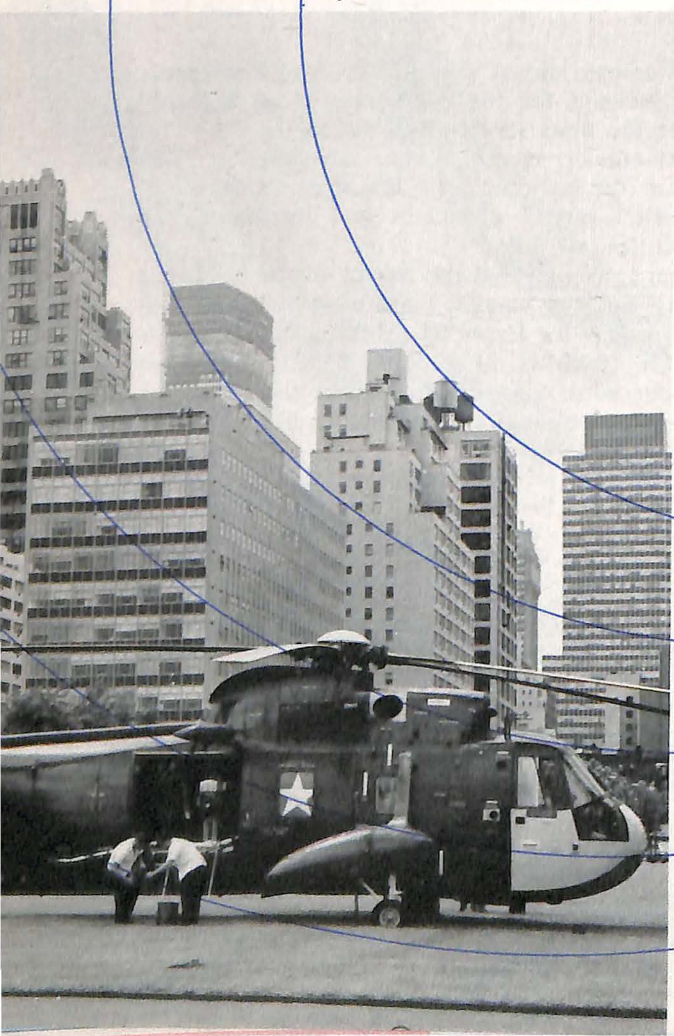
The movie took four months and 250 hours of flying

This apparatus dampens vibration to permit steady views of a harbor. Cameraman uses several view-finders.



Photographer from Canada's National Film Board shoots from a helicopter the Canadian Houses of Parliament and Peace Tower in Ottawa.

TV cameras aboard this helicopter, ready to lift off, caught the United Nations Building and the New York skyline for a Telstar broadcast.



time to complete. Airplanes as well as helicopters were used.

The project had to overcome many complications — legal, technical, and atmospheric.

For example, flight crews in the Western Hemisphere had to comply strictly with the regulations of the Federal Aviation Agency and the Canadian Department of Transport. This made operations in metropolitan areas such as New York City and Montreal especially challenging.

Then, too, the cameras aboard the chartered Sikorsky S-55C could not be reloaded in flight, and it was necessary to land after the 500-foot magazines were exposed. This permitted only about five minutes of actual shooting per flight.

Another complicating factor was the weather. Film often had to be shot in freezing temperatures, which thickened the camera lubricants and numbed the fingers of the cameraman.

Despite these and other problems, officials of the Film Board are enthusiastic about the use of helicopters in their film work, so much so that they have constructed a small heliport at their Montreal headquarters.

For the filming of "Helicopter View of Canada," the Film Board again used a helicopter.

"Helicopter View of Canada" is intended eventually for distribution as a feature film for projection on conventional wide-screen panavision or cinemascope.

Even when not used in filming, the helicopter proved useful in the Canadian projects. During the filming of Labyrinth, for example, the camera crew wished to shoot an ancient monastery, largely populated by mummies, which was situated inside a cave atop a high plateau in Ethiopia.

It would have taken a day's ride by mule train — the only available surface transportation — to haul the camera rig to the site. A helicopter which could accommodate the rig made the trip in eight minutes.

Grant McLean, the National Film Board's Director of Production, says that the Board's success with the airborne cameras will lead to even more extensive use of helicopters and other aircraft in future movie-making. The results are spectacular. Audiences are delighted with views hitherto reserved for appreciative aviators, McLean, a former Royal Canadian Air Force pilot, reports.

The S-61 helicopter was used for the first live transatlantic television program. It provided the platform for an American Broadcasting Co. television crew to furnish a close look at the United Nations building and New York's East Side as the climax to a Telstar TV program to Europe.

In the filming of TV commercials, the idea of using helicopters comes not only from the advertising agencies or movie makers but also from the client who knows best the nature of his product and the terrain over which it will operate.

A photographer for an automobile manufacture estimates that he shoots nearly 100,000 feet of film a year from a Hiller helicopter, and most of the film is used by the firm's advertising agencies.

It was this photographer, Andrew R. Christenson, who shot the spectacular commercial of an automobile racing around the Chrysler test track.

Christenson and pilot Barney Stutzman of Detroit's Helicopter Airways Service — with the help of a few Chrysler automotive engineers — fashioned their own gyro stabilizing mount from surplus B-17 automatic pilot gyroscopes. This stabilizer allows Christenson vibration-free focus. Weighing only 55 pounds, it can be removed from one Hiller helicopter and mounted on another within 15 minutes.

The device developed by the Los Angeles firm of Helicopter Camera Systems — the one used in the Canadian projects — behaves, in effect, like a cushioned platform. Under a spring mattress anchored to the helicopter's floor is a unit consisting of camera mount and cameraman's chair.

The camera has three dimensional freedom of movement through a geometry of sleeve bearings. The net effect is to dampen out completely the vibration caused by the rotor blades and give the camera a smooth ride. The whole installation, including the cameraman, weighs about 600 pounds.

Robert James, a principal of the Detroit helicopter firm, says that advertising provides a lucrative business for his company.

"Advertising accounts for 200 flight hours a year, mostly for TV commercials," he states. "We also do work for General Motors and Ford Motor Company and have even been used in fashion photography by one of Detroit's leading department stores."

The Los Angeles film-producing firm of Cascade Pictures is one of the foremost users of helicopters for advertising. General Manager Barney Carr explains the development this way:

"Because of the mobility and hovering capability of helicopters, we can achieve dramatic effects that would not be possible otherwise. Our cameramen can now film our clients' products starting from several thousand feet away and zooming in to within 50 or 60 feet, or vice versa."

It was Cascade who made the zero-in shot of the cruising couple sipping the wine.

Rick Helicopters, Inc., San Francisco, is another firm that finds its fleet being used to shoot TV commercials for its clients which include Labatts Beer, Chevrolet, Thunderbird, and Marlboro cigarettes.

Robert Delker, one of Rick's veteran pilots, draws most of the assignments. While they are relatively simple, he found that he had to change some of the flying habits he picked up while working with construction crews in the wilderness. He explains:

"You don't make a normal landing for TV commercials. When I had the brewery's 'Man from Labatts' aboard my Hiller, the producer insisted that I land so that the best side of the actor's face would be shown."

An old problem for actors, with an airborne twist.

AEROSPACE COMMENTS

Congressman Joseph E. Karth
before the National Space Club

"One important contribution of aerospace technology has been general acceptance of the 'total systems approach.' A closely connected idea is the growing awareness that we need to view our world environment as a whole. And I have a hunch that in retrospect, historians will consider this concept as one of the truly significant ideas of our century.

"As part of our environment, the sea is not independent — it is greatly affected by outside forces: the rotation of the earth and the movements of the sun and moon result in events we all can observe every time we go to the beach. Less apparent are the effects of the direct income and outgo of radiant solar energy — and the vital interchange between sea and atmosphere and land.

"This suggests that, as in the broad field of space, hardly any aspect of the sea is capable of adequate analysis without coordination of all the fundamental natural sciences and engineering. In this sense, as with the study of space, oceanography is not a science in itself. Rather, it is a combination of various sciences and fields of engineering to study the sea in all its aspects — including the complex interrelationships with our total environment.

"An approach of this kind leads directly to what a number of people are suggesting as specific correlation between space 'know-how' and the problems being faced in oceanography. I'll just mention a few major areas:

- Reliability and efficiency requirements.
- Systems management experience.
- Structures and materials.
- Operating in a hostile environment outside the atmosphere.
- Instrumentation and sensors — especially in standardizing.
- Computer, guidance and power systems.
- Vehicle design and construction.

"Many aerospace firms have already grasped the point. For example:

- North American Aviation has a new Ocean Systems facility which will draw heavily on the firm's space effort. It's no accident that it is located in their Space and Information Systems Division.
- Lockheed has established a Marine Laboratory.
- Nortronics is working on the Navy's Deep Submergence Systems Project.
- The Underseas Division of Westinghouse is now building a new research and test facility.
- General Dynamics' Electric Boat Division has been in the field for a long time.

"Incidentally, I understand that some people have become somewhat disenchanted because certain corporate investments of the early 1960's haven't started to pay off yet. My advice is this: *Stick around for a while;* Small opportunities are often the beginning of great enterprises."

Karl G. Harr, Jr., *President*
Aerospace Industries Association
before the Aviation/Space Writers Association

"The two most important questions concerning the industry are: (1) How secure is the basic market? (2) What are its potentials for growth? The answer to the first of those questions lies in America's continuing need for more effective, more diversified transportation, a stronger defense capability, increasingly effective space vehicles, and improvements on the many other fronts in which the aerospace industry is presently engaged.

"The answer to the second, however, lies elsewhere. One would have to be insensitive, indeed, not to feel that pressure is building up in many corners of the nation for breakthroughs in terms of solutions to a whole range of national problems. The manifestations of this kind of pressure increase daily. They emanate from thoughtful writers, university faculties, the press, congressmen, executive leaders at the federal, state and municipal levels, and from the results of the widely varied research undertaken by industry itself.

"People are saying ways *can* be found to marry the best capabilities of industry, wherever found, with the greatest public needs, wherever found. Moreover, this assertion aways seems to focus on the particular capability of industry to cope with rapidly advancing technology and the increasing complexity of systems.

"The rising frustration you see emanating from many quarters of government, from thoughtful public and private leaders, and from our citizenry in general, is matched by their growing willingness for experimentation. Today's emerging problems demand imagination. The necessary ingredients for solving them are all at hand: technological breakthroughs, systems management capabilities, increasing agreement upon identification of the nation's principal needs and a growing will to try to find a way to cope with them. Finally, there is a reservoir of experience which can be applied to public and private cooperation toward the fulfillment of local regional and national goals."

James E. Webb, *Administrator*
National Aeronautics and Space Administration
before the Young Mens Christian Association

"Interacting with technology has been science and man's concept of the universe. The progress of man's thought has always been one of changing ideas. The difference between today and the past is in the rate of change. Our ideas of reality are undergoing change at a rate undreamed of yesterday. Today we have the ability to use rocket engines to send men and instruments out to explore, to measure, and to observe the universe unhampered by the limitations of our former earth-bound existence.

"Millions of minds all over the world now have been broadened by the emerging concepts of the energy system of our earth's atmosphere because they have seen the pictures taken by our Tiros and Nimbus satellites. We have used this new instrument to rethink our ideas about the workings of the weather, to put it to use as a new method for increased accuracy in forecasting and to achieve reliability and safety in air transportation.

"Our ideas of the size and shape of the world have been drastically altered as a result of space exploration. Improved rapid communications have shrunk the size of the world for all practical purposes. The communications satellite Early Bird now links Europe and North America by word and voice and pictures. This satellite relay station enabled, for example, millions of people in Europe to hear and see Pope Paul at the United Nations as he met President Johnson and spoke so eloquently for peace.

"Basic physical concepts such as that of motion are being better understood than formerly because, for the first time, man can see and hear what is taking place in satellites orbiting the earth, and in deep space probes reaching out to Venus and Mars."

Donald W. Douglas, Sr., *Chairman of the Board*
Douglas Aircraft Co., before the Wings Club

"There is currently a mild frenzy of activity on the problem of urban transport, spurred in part by the spectre of megalopolis tomorrow. We are hearing a lot about high-speed trains and pneumatic tube systems that would move people about like change in a department store. I do not deprecate such efforts; they are a necessary part of our search for solutions to pressing problems. I am not sure, however, that transportation systems involving immense capital investment, and requiring substantial quantities of real estate precisely where it is most valuable, are really the best answer to the transportation challenges of tomorrow. I *am* sure that airborne vehicles, descended in some fashion from today's aircraft, deserve the fullest study as a possible more economic answer.

"While great progress has been made in vertical- and short-takeoff vehicles, the truth is they are still in their infancy. But I see little justification for supposing that their development cannot be carried a great deal further. Particularly if we are willing to accept a short take-off run — perhaps only a couple of football fields worth — it seems to me quite reasonable to expect airborne vehicles that will be economically useful in commuter-type situations."

John S. Foster, Jr., *Director*
Defense Research and Engineering
Department of Defense
before the Military Operations Subcommittee
of the House Government Operations Committee

"I believe that the Military Space Program is responsive to the present and future needs of National Defense. It is a balanced program which, when taken together with the programs of NASA and other government agencies, represents the most vigorous technical and scientific effort ever mounted by the United States or any other nation.

"We will continue to exploit the space environment to accomplish those military missions for which space offers unique military advantages. Space systems will continue to be required to compete with earth based systems for those missions which may be performed in either environment. We believe that we are pursuing the proper development approaches to achieving a definitive increase in our defense posture through the use of space environment that makes both economical and technological sense — always keeping in mind that the objective is to develop and maintain a qualitatively superior military capability as a cornerstone for national security.

"As a corollary, we make our considerable DoD resources of scientific and military manpower and facilities available to NASA and other government agencies in consonance with national policy and national goals. In turn, we expect to exploit the science, technology and hardware development of the other government agencies in related space pursuits."

Air Traffic Snarl —On the Ground

It was nearing dusk when the twin-engine airplane with four businessmen aboard moved into the pattern at Washington National Airport and landed on runway 15. Ground control cleared the airplane to the general aviation terminal. The ground crew directed the pilot to the *last* available parking space at the primary airport serving the nation's capital. Unless one of the several dozen airplanes already on the field departed in the next few moments, the next arriving pilot would not be able to stay at the airport.

This is a typical example of the critical airport problem facing major city areas.

The *Airman's Information Manual,* a Federal Aviation Agency publication of information and instructions for pilots, warns all general aviation pilots that they may not be able to stay in the area because there is no room to park additional airplanes. "Pilots," the manual says, "may be required to proceed to another airport for parking after passenger deplaning."

For the pilot flying his own airplane this reduces the utility of the airport and his airplane by the distance and time required to seek out another field and return to the city by ground transportation. For the scheduled air carrier the traffic is costly in ground and air delays. The Air Transport Association estimates these delays at Washington National cost the airlines in the neighborhood of $4 million in 1965. For the Washington business concerns, it is a threat to transient dollars.

The FAA reports more than 73,300 general aviation operations at Washington National Airport during 1964, the most recent official figures. This represents both landings and take-offs. Studies show an average load of three passengers per general aviation flight, or some 110,000 arrivals. The great majority of these general aviation passengers were executives and other officials of American business enterprises. Quite apart from the basic importance of such travel to the total economy, it also has a direct measurable value just in

the Washington area.

The Washington Board of Trade reported that last year about 9,000,000 visitors to the city spent approximately $400 million, about $44 a person. At this scale, those arriving in the city aboard their own aircraft brought $4,850,000 into the local economy, not counting landing fees, fuel or other services for the airplanes which brought them. (This does not count the amount of business brought through the half dozen general aviation airports in the area.)

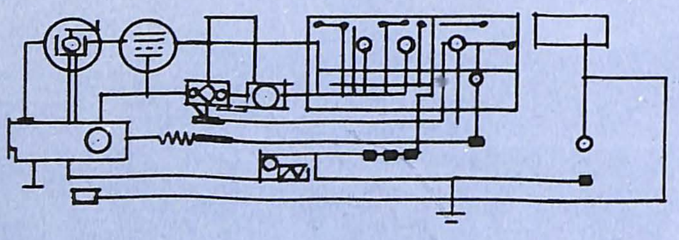
Los Angeles, New York, Chicago, San Francisco—all of the nation's hubs are finding the growth in general aviation catching them with their windsocks down.

With more than 95,000 general aviation airplanes flying today, the fleet is growing at approximately twice the rate forecast by the FAA. Last year the industry produced 11,852 new airplanes, 27 percent more than in 1964. Production this year is expected to top 14,000. In January of this year, the FAA predicted that production in 1971 would be 13,900 airplanes. The number of flight hours originally forecast for 1965—15,000,000—was actually reached in 1962.

In Los Angeles, unless additional airports are created, by 1970 no individual or business will be able to purchase an airplane because there will be no place to base it in the immediate area.

Industry, pilots, airlines, the FAA and progressive municipal leaders are working to prevent parking snarls and costly take-off and landing delays, either or both of which will reflect sharply on conduct of business in these areas.

Today's aircraft have the range and speed to take a businessman or vacationer to a place where he *can* land if he must pass up a place where he *wants* to land. Thus, unless communities provide additional airports, more facilities on existing airports, and ample parking areas, the dollars that flow into a community from the air will literally fly past the area.



An extended Department of Defense-industry program on aerospace electronic design specifications, which is already producing cost-avoidance savings in excess of $3 million annually, is taking another significant step.

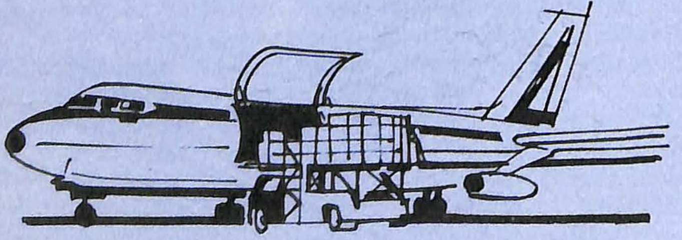
The program involves rewriting design specifications in which a concerted effort is being made to pull together the varied requirements of twelve different Defense agencies into acceptable single specifications for 84 different practices.

Basis of the rewrite program is to take conflicting engineering practices and mold them into standard specifications where commonality exists while, at the same time, retaining the specific requirements of each of twelve using agencies.

Rewriting of twenty-three of the eighty-four practices has been completed, accepted by the services and published. The DoD review board is considering an additional thirteen. Another thirteen are being reviewed for comment by the military services.

The overall program, which was initiated in 1960 at the request of the Defense Department, was scheduled for completion by 1972. However, the success which has been achieved has generated swifter action and government-industry engineers are now aiming for March 1968 as the completion date for the eighty-four identified areas.

Engineering specialists from AIA and the Electronic Industries Association have each accepted thirty-two specifications for action and military departments are handling the remaining twenty requirements. When the program is completed, it is estimated that annual savings will amount to approximately $12 million.



Members of the AIA Traffic Committee are assisting the Civil Aeronautics Board in the planning and coordination of a series of air cargo workshops, scheduled for the fall of 1966.

Tentatively, the 5 regional workshops have been scheduled for the following dates and places: September 20-21 in Seattle, Washington; October 24-25 in Miami, Florida; October 27-28 in New York City; October 31-November 1 in Chicago, Illinois; and November 3-4 in Los Angeles, California.

The workshops are designed to provide a forum for shippers to discuss their problems and needs with air carriers and the CAB.

Format of the meetings will provide for an opening day of simultaneous roundtable discussions, each covering various aspects of air cargo. The prime aim of these sessions will be to provide an informal atmosphere in which air carrier representatives will answer questions and explore shipper needs on a face-to-face basis.

On the second day, plans call for a review of the highlights of each roundtable session before all workshop attendees. A field trip to a nearby air cargo facility is scheduled as a closing event.

The Council of Defense and Space Industry Associations (CODSIA) has accepted applications for membership from three more national associations.

The applicants are the National Association of Manufacturers, the Shipbuilders Council of America, and the Scientific Apparatus Makers Association.

Formal acceptance, which now awaits the signing of CODSIA's Articles of Agreement, will bring the membership to nine. In addition to the new organizations, present membership includes the Aerospace Industries Association, Electronic Industries Association, the National Security Industrial Association (the founding groups), the Automobile Manufacturers Association, the Atomic Industrial Forum, and the Western Electric Manufacturers Association.

The Council was formed on June 30, 1964 "to provide a central channel of communication in order to simplify, expedite and improve industry-wide consideration of the many policies, regulations, problems and questions of broad application involved in the supplier-purchaser relationship between industry, acting through its associations, and the Department of Defense, National Aeronautics and Space Administration or other procuring agencies of the government."

During its first twenty months of operation, CODSIA has accepted more than sixty projects for consideration. Nearly fifty have been or are being acted upon.

AIA MANUFACTURING MEMBERS

Aerodex, Inc.
Aerojet-General Corporation
Aeronca Manufacturing Corporation
Aeronutronic Division, Philco Corporation
Aluminum Company of America
American Brake Shoe Company
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

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 Powder Company
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 Corporation
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Company
McDonnell Aircraft Corporation
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. Aviation Divisions
Rohr Corporation
The Ryan Aeronautical Company
Solar, Division of International Harvester Co.
Sperry Rand Corporation
- Sperry Gyroscope Company Division
- Sperry Phoenix Company Division
- Vickers, Inc.

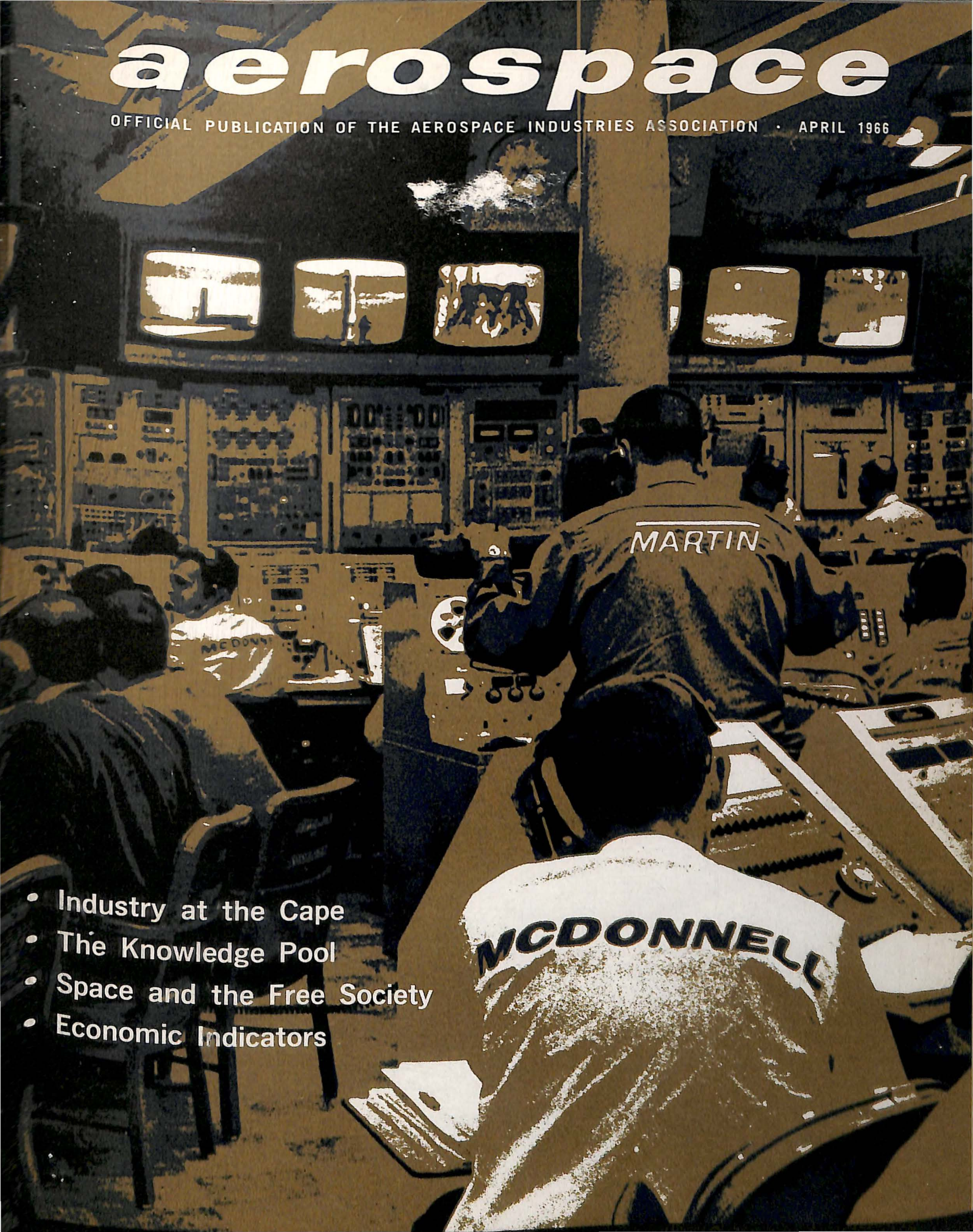
Sundstrand Aviation, Division of Sundstrand Corporation
Thiokol Chemical Corporation
TRW Inc.
United Aircraft Corporation
Westinghouse Electric Corporation
- Aerospace Electrical Division
- Aerospace Division
- Astronuclear Laboratory

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

Canadian National Film Board photographer obtains a new view from a helicopter of a familiar lady — the Statue of Liberty. (See article, *Zoom at the Top*, Page 8).

aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · APRIL 1966

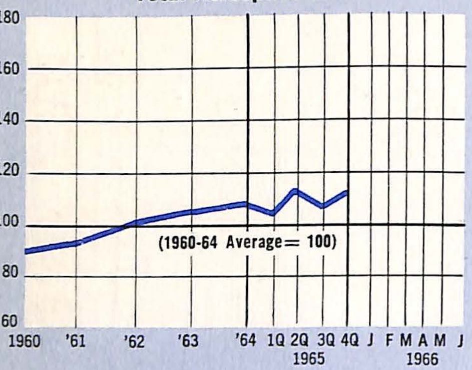


- Industry at the Cape
- The Knowledge Pool
- Space and the Free Society
- Economic Indicators

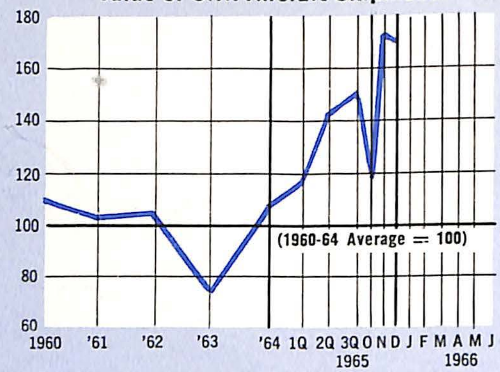
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

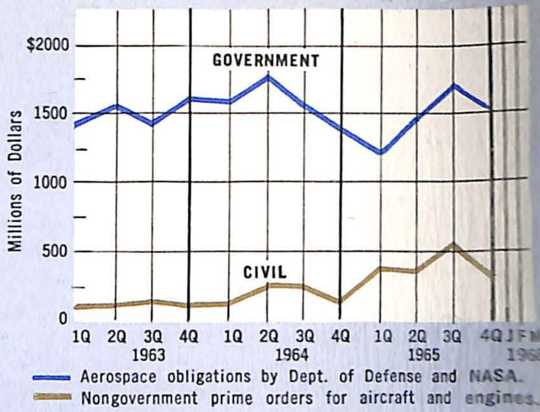


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-64 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.0	Quarter Ending Dec. 30 1965	20.6	20.5	20.9 E
	Billion $	Quarterly	4.7		4.9	5.1	5.5
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,177	Dec. 1965	1,323	776	1,414
Aircraft	Million $	Monthly	584	Dec. 1965	982	569	822
Missiles & Space	Million $	Monthly	593	Dec. 1965	341	207	592
Aerospace expenditures: Total	Million $	Monthly	1,098	Dec. 1965	1,109	820	1,209
Aircraft	Million $	Monthly	560	Dec. 1965	699	469	804
Missiles & Space	Million $	Monthly	538	Dec. 1965	410	351	405
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	183	Jan. 1966	223	357	406
Expenditures	Million $	Monthly	143	Jan. 1966	327	417	378
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	633	Feb. 1966	752	1,187	1,173
Value	Million $	Monthly	13	Feb. 1966	17	33	31
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	14.1 #	Quarter Ending Sept. 30 1965	15.4	16.7	18.7
U.S. Government	Billion $	Quarterly	11.1		11.9	11.8	12.7
Nongovernment	Billion $	Quarterly	3.0		3.5	4.9	6.0
EXPORTS							
Total (Including military)	Million $	Monthly	107	Jan. 1966	90	126	104
New Commercial Transports	Million $	Monthly	23	Jan. 1966	27	36	22
New Utility Aircraft	Million $	Monthly	2	Jan. 1966	2	7	6
PROFITS				Quarter Ending Sept. 30 1965			
Aerospace — Based on Sales	Percent	Quarterly	2.1		2.9	3.1	3.6
All Manufacturing — Based on Sales	Percent	Quarterly	4.6		5.1	5.8	5.4
EMPLOYMENT: Total	Thousands	Monthly	1,128	Dec. 1965	1,126	1,200	1,218 E
Aircraft	Thousands	Monthly	507	Dec. 1965	444	483	493
Missiles & Space	Thousands	Monthly	490	Dec. 1965	513	547	554
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.87	Dec. 1965	3.12	3.23	3.26 E

E Estimate
* 1960-64 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 1961-64.

AIA

aerospace

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PUBLISHER • Glen Bayless

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CONTENTS

The purpose of AEROSPACE is to:

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

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

Foster understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Employment in the aerospace industry — a prime barometer of activity — is expected to increase to 1,266,000 by June, a gain of 48,000 over employment reported at the end of 1965. All employment estimates are based on a survey of 57 major aerospace companies made by the Aerospace Industries Association.

The bulk of the employment increase — 46,000 workers — is in the aircraft category. Non-aerospace employment is expected to show a significant increase of 6,000 from 49,000 at year's end to 55,000 in June 1966. Missile and space employment will decrease from 504,000 to 500,000 during the same period.

Increase in employment in the non-aerospace field is a positive indicator of the industry's increasing involvement in such fields as oceanography, water and air pollution control, surface transportation and a variety of social and economic areas where the industry's systems management and technological capabilities are proving invaluable.

An increase of scientists and engineers from 203,000 in December 1965 to 215,000 in June 1966 is predicted. Approximately 8,000 of the increase will be in aircraft-related employment. By June, scientists and engineers in this category — 104,000 — will exceed those in missiles and space jobs.

Technicians are forecast to increase from 77,000 in December 1965 to 83,000 in June 1966. Aircraft activities will account for 4,000 of the increase in technician employment.

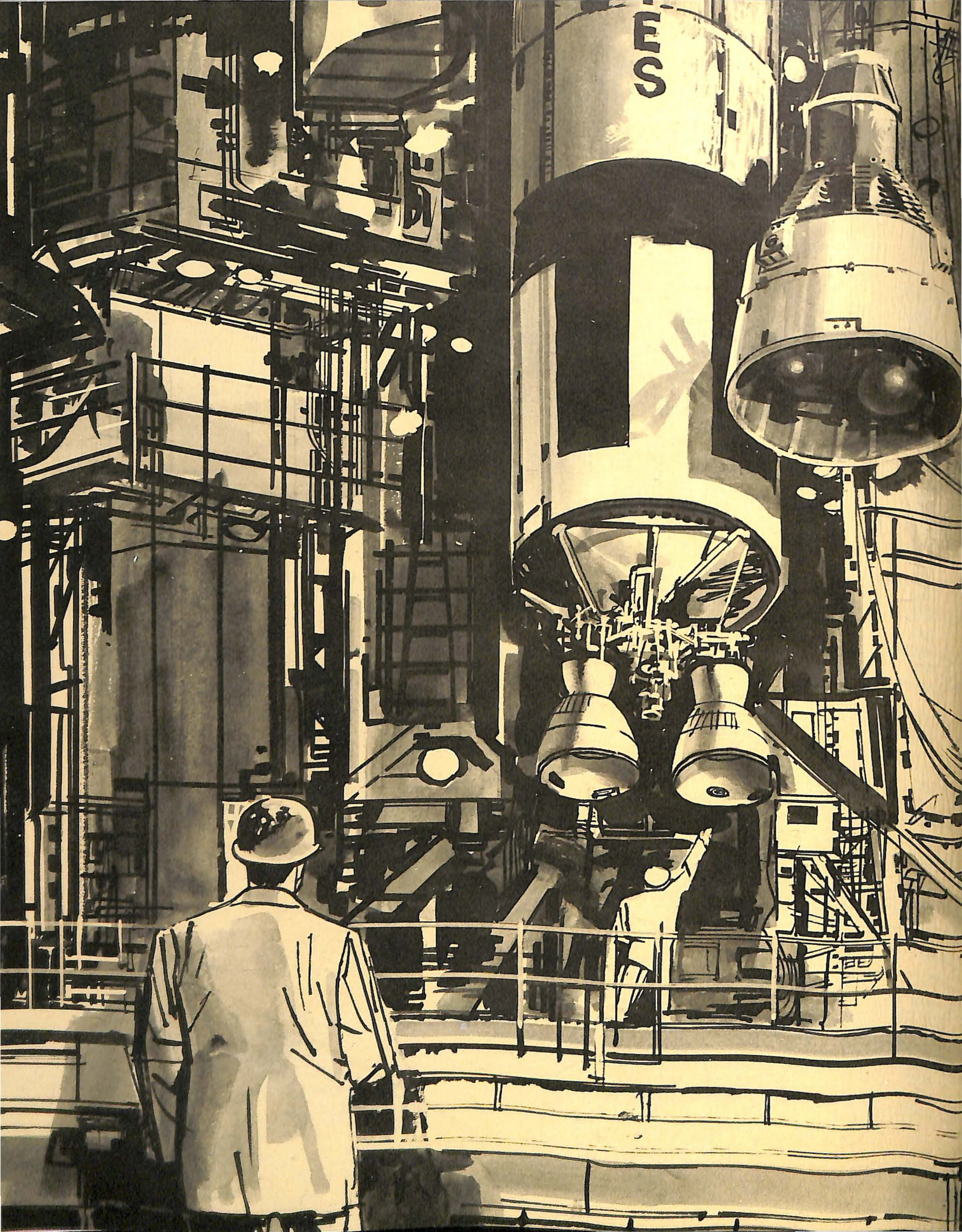
Growth of aircraft activity is clearly evident in the commercial field. Employment in transport aircraft is expected to rise from 75,423 in December 1965 to 90,800 in June 1966. Commercial air transportation is increasing at a more rapid rate than the rest of the economy, and this growth pattern is expected to continue.

Utility aircraft employment is expected to increase from 26,668 to 28,290 in the December 1965-June 1966 period.

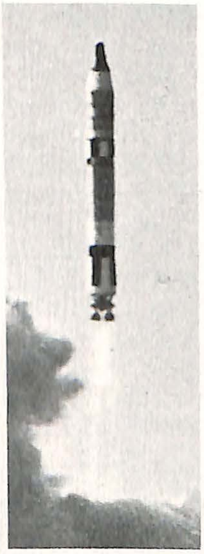
Helicopter employment, largely due to the demands of Vietnam operations, is estimated to increase from 29,032 to 31,508 during the same period.

The forecast for increases in aircraft activity is further evident from figures in the facing page of Economic Indicators. Defense Department expenditures for aircraft in December 1965 amounted to $804 million compared with $469 million in November 1965; obligations (new orders) for aircraft by the Department of Defense in December were $822 million compared with $569 million in November.

In an accompanying survey by AIA, sales in the aerospace industry are estimated to reach an adjusted annual rate of $22.3 billion by June 1966. This compares with annual sales of $20.9 billion in 1965.



INDUSTRY AT THE CAPE



A Gemini manned space flight mission requires a vast variety of skills — and dedication. The teams of scientists, engineers and technicians from the National Aeronautics and Space Administration, the U. S. Air Force and industry work together with great efficiency toward a single goal: the successful launch, tracking and recovery of the Gemini crew and capsule.

The aerospace industry team plays a substantial and vital role in Gemini missions. From the moment the spacecraft arrives by air at Cape Kennedy, Fla., a 600-man McDonnell Aircraft Company crew swings into action on a three shift basis, twenty-four hours a day, seven days a week until the Gemini is launched, flight completed and the vehicle recovered and returned for post-flight inspection and analysis.

They are highly motivated groups. "I can call up any of my men at 3:30 in the morning, and they will be here," says Tom Turner, superintendent of manufacturing for McDonnell. "They wouldn't have it any other way. They have their jobs at heart."

The majority of the members of the industry's team at Cape Kennedy has been there since the early days of Mercury, the mechanics and electricians averaging about 15 years experience, a fact Turner notes, that builds confidence with the astronauts.

On the current launch cycle, the process of preparing, servicing and testing the spacecraft for flight starts about two months prior to the mission date with one spacecraft usually being delivered before the launch of its predecessor.

As soon as the spacecraft arrives, it undergoes a receiving inspection. In addition to NASA inspectors, McDonnell has 58 people of their own assigned to quality assurance and reliability. "One inspector for every four manufacturing men working on the spacecraft," says Ralph Knox, administrative head of the quality section, who started as an aircraft inspector with McDonnell 14 years ago. Stationed at all key points, they follow the spacecraft every step of the way from the final spacecraft acceptance review at St. Louis, Missouri, through the industrial area to the pad, witnessing, verifying, and documenting every process, until the White Room is cleared of all personnel at T-40 minutes.

Aside from the final engineering modifications which are all carried out at the Merritt Island Launch Area (MILA), the sequence of events is a steady build-up of the spacecraft for pad testing and flight. It is first moved to the Pyrotechnic Installation Building, where a crew, after a 22-day pyro verification firing program, installs some 70 to 75 explosive devices, including ejection equipment, survival kits and parachutes.

Next, there is the option of moving directly to the pad or to the Cryogenics Building for the hypergolic (fuel and oxidizer) servicing of the propulsion system and the servicing of the propulsion system and fuel cells. In the nearby Environmental Control Systems Building, all of the astronauts' "life support" equipment is cleaned, sealed, tested and prepared for spacecraft installation. Each time a spacecraft component is completed, it is tagged with a log card giving the history of its verification steps by date, time and inspectors' initials, and then certified for flight installation.

In the blockhouse monitoring tests are experts representing the major systems subcontractors — IBM, onboard computer; Honeywell, spacecraft guidance system; General Electric, fuel cells; Westinghouse, rendezvous radar; Garrett, environmental control system. Permanently assigned to MILA but not involved in pad tests, are North American Aviation's Rocketdyne Division, propulsion system; and Motorola, the digital command system.

Checkout of the Titan launch vehicle is a far less complicated and time consuming operation, since it is basically an operational Air Force system. But the coordination of range support, test schedules, and pad safety, when power is applied to either vehicle or propellant handling is taking place, requires a great amount of planning and cooperation.

"It takes a lot of team work on everybody's part," Joe Verlander, Martin's director of launch operations, recently pointed out, noting that schedules have to be coordinated with Pan American, which operated the Eastern Test Range for the Air Force, then checked with McDonnell systems test engineers.

Radio Corporation of America supports the range with 2,000 engineers and technicians who maintain and operate the radar, tracking, telemetry, optic and photographic equipment, and communications systems at the Cape, 10,000 miles down range, and onboard two Department of Defense Instrumentation Ships. Similar functions at the NASA-operated tracking stations around the world are performed by 700 employees of the Bendix Corp.

Martin's Canaveral Division maintains about a 300-man Gemini force, half of which makes up the launch operations crew — the test conductors, engineers and technicians who do the work on the "bird." Eighty others, primarily inspectors, are assigned to the quality section; 45 engineers provide technical guidance and are responsible primarily for evaluating test and flight data; and 25 work out of materiel.

In contrast to the spacecraft which has 63,000 different spare parts held in bonded storage, the Titan booster has 70 prime spares — major airborne components — and 800 minor airborne or ground components. Two of every item are checked out, verified and ready to go. The crews work a normal 8-hour day, 5 days a week, on two shifts, until T-3 days when they go on an around-the-clock schedule. Just prior to picking up the count, all key launch personnel are given a written and oral examination covering a simulated countdown and emergency drills. Certification is good for six months "but we do this on every bird," Verlander reports.

Aerojet-General, which supplies the first and second stage engines, has 27 engineers, technicians and inspectors working with the Martin force. They oversee engine checks and monitor the countdown.

Ray Stiff, an Aerojet-General vice president, worked with Dr. Robert H. Goddard, the "father" of modern rocketry. He and his staff at Cape Kennedy are responsible for overseeing engine checks and the monitoring of countdowns.

Martin's director of launch operations, Joe Verlander, is responsible for launch site preparation, erection, checkout, launch and data analysis of the Gemini-Titan II.

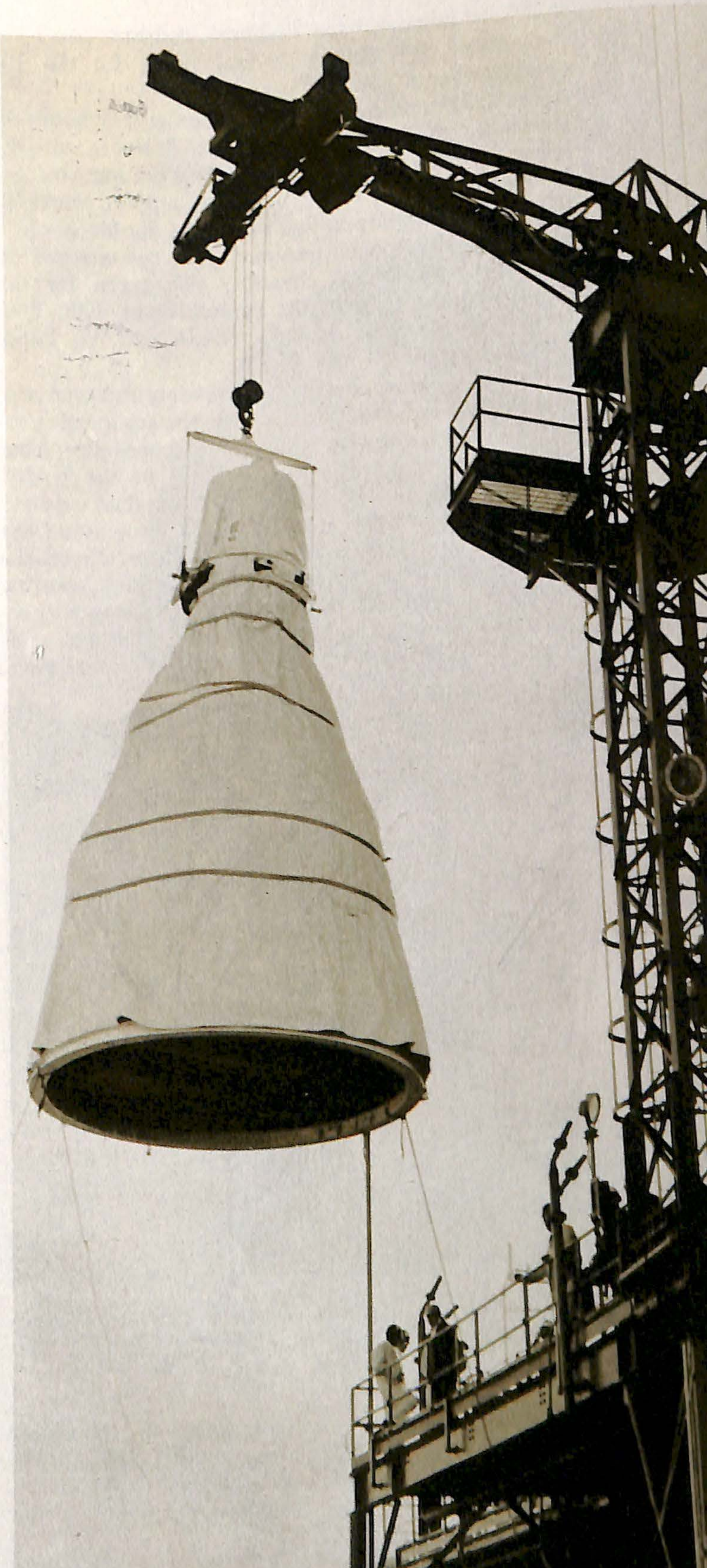
"Our job is not over until the Gemini is flown," Ray Stiff, an Aerojet vice president, emphasizes. "It's our responsibility to make sure our part of it is in proper working order." Stiff has a rather particular personal interest in every launch. His rocketry experience dates back to what he calls the "Buck Rogers days," when he worked with Dr. Robert H. Goddard, the "father" of rocketry. He started development of the engines for the Titan II about 10 years ago. When Gemini came into being, he was charged with man-rating the all-important propulsion system. "We assigned our most competent personnel," he says, "and applied

Ray Post, McDonnell Aircraft, is the chief spacecraft test engineer. He heads the team in the Mission Monitoring Room during the Gemini missions.

to manufacturing what we call 'tender-loving care.' It's the same today."

The detailed checkout of the launch vehicle systems takes 12 days. Like the spacecraft with its McDonnell "manager," the booster is airlifted to the Cape, accompanied by a Martin "chaperone" and an Aerojet engineer who take it "from the cradle to the grave." But unlike the spacecraft, the Titan undergoes very few modifications.

Once the Gemini capsule is raised to the White Room 30 to 40 days before launch, 60 percent of the time is devoted to testing. All of the shingles and doors are stripped off the outside and every system connected by cables to the blockhouse for a complete and thorough checkout. "The entire series of tests requires 600 to 1,000 different hook-ups, with an equal amount of de-cabling," Ed Martin, general foreman of assembly and production personnel, explained. Gradually, as each system becomes certified flight ready, the shingles are replaced and the large cabling list posted on the wall stamped off by inspectors. The spacecraft computer remains cabled up for final checking, until the astronauts board. All the single fittings are precisely tightened, adjusted, and inspected, all scratches repainted, and the exterior washed down and polished. "We're busy cleaning it up and retouching it, right up



McDonnell Aircraft crew directs hoisting of a shrouded Gemini capsule for mating with the Titan booster.

Ed Martin (left), general foreman of assembly and production personnel for McDonnell Aircraft at Cape Kennedy, watches astronaut walk toward pad to enter the Gemini capsule.

until T-40 minutes," Joe Trummel, assistant pad foreman, says. "We want it to look pretty for the TV cameras when it goes off."

The spacecraft countdown resumes at T-5 hours on launch day, the booster an hour later. It is a thoroughly integrated effort, bringing into full play the industry-Air Force-NASA team, with the mutual support gradually shifting responsibility in that order. In the blockhouse, Martin and McDonnell personnel man the complex of color-keyed racks and consoles, pale green for the booster, to the right of the control room, light blue for the spacecraft to the left. NASA and Air Force teams are ready.

As the astronauts become increasingly involved and preparations are made for insertion, the spacecraft portion of the countdown shifts in responsibility from the McDonnell systems test engineer to the NASA spacecraft test conductor, who acts in the dual capacity of launch coordinator. Ken Shipe, Martin assistant test conductor, and as such, pad control officer, directs the activities of the launch vehicle crew at the stand, securing equipment, preparing the erector for lowering and reporting to Mark Goodkind, Martin launch test conductor, who runs the booster phase of the countdown.

Mark Goodkind (left), launch test conductor, is stationed at console for countdown. Kenneth Shipe, assistant test conductor, stands by ready to man the periscope in the blockhouse during the final thirty-five minutes of countdown after the pad has been cleared. Both are with the Martin Company.

At his side in the blockhouse, monitoring the engine checks, is Aerojet's Don Barnes. Both Goodkind and the spacecraft test conductor report to Frank Carey, Martin chief test conductor, overseeing both portions of the countdown.

Carey is directly responsible to the Air Force launch test controller, Lt. Col. John Albert.

Along the range, RCA's instrumentation operations coordinator reports to the Pan American superintendent of range operations, who reports directly to the Air Force. Final authority rests in Mission Control Center,

Frank Carey, Martin's chief test conductor, is on duty at Cape Kennedy's Complex 19 directing the launch vehicle systems test from the blockhouse.

Houston, where NASA Flight Director Christopher Kraft, in communication with Col. Albert throughout the countdown, makes the decision to launch.

"Go" for the spacecraft is given at T-6 minutes. From then on, Frank Carey, responsible for the astronauts' safety and for sending the abort signal, is busy running communications check with the emergency forces — the "beach boss," helicopters, hard-top rescue tanks, and three visual observers — Martin test conductors who are stationed at pads 16, 19 and 20. "They have a clear channel through to me," Carey says. "The rule is, if two of the three give an abort command, it's up to us to throw the switch for the astronauts to get out."

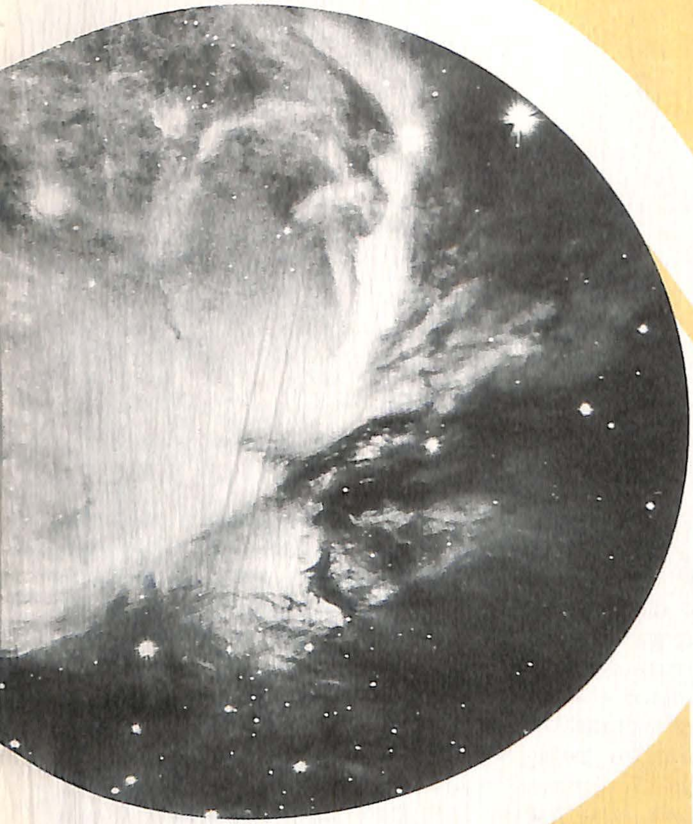
There is always tension in the blockhouse during the final minutes. Describing the launch of Gemini 6 when tension was understandably higher than most, Ken Shipe later claimed he was on the periscope holding his breath from T-6 minutes on down. "There must have been 50 people counting aloud in those last seconds," he continued, "then ZERO — it stopped. Everybody held his breath. The crew was very emotional. Afterwards, out on the pad many of the technicians were actually crying."

On all launches, very strict discipline is maintained in the blockhouse. Everyone stays at his console until insertion at T+6 minutes. "After that," says Carey, "everyone is bouncing. There's lots of backslapping and handshaking." The Martin team's primary job now becomes one of data review. Three hours after launch, they present a report to the Air Force on the performance of the booster, a "quick look," followed two weeks later by an exhaustive evaluation.

As soon as the blockhouse is cleared, McDonnell technicians move in to start the changeover of equipment for the next series of tests on the next spacecraft. "NASA is always pleased with this quick reaction," Tom Turner says.

The McDonnell systems test engineer goes immediately to the Mission Monitoring Room on the top floor of the Manned Spacecraft Operations Building at MILA where he takes over as captain of a team of industry experts who constantly check the performance of the spacecraft, comparing it with the pre-flight data, and with the parameters they have established.

And then the teams get ready for another flight.



Space and the Free Society

The following is an adaptation from an address by Karl G. Harr, Jr., president of the Aerospace Industries Association, before the 1966 national meeting of the American Astronautical Society in San Diego, Calif.

All of the men and women professionally involved in our national space program strive constantly, and with spectacular and meaningful results, to broaden the application of their efforts. In this way, scientists, engineers, businessmen, teachers, government officials and many others seek to fulfill their aggregate role as the human embodiment of the national space effort. They do an excellent job.

I suggest that this is not enough.

I suggest that, in a free society, a man's work is not done unless he has fought for and achieved recognition of the true nature and importance of his work to society as a whole.

As a spokesman for the aerospace industry, I have been able to proclaim "all's well" with respect to most of the key aspects of our national space effort and industry's role in it. The achievements of 1965 certainly have demonstrated the effectiveness in depth of this nation's overall space activities.

But there remains one very disturbing aspect of our space effort: The close relationship between this effort,

with all its ramifications and implications, and our total national growth and posture is almost completely unappreciated by our society.

The responsibility for this lack of understanding must fall primarily on those of us in government, industry and private scientific research who are engaged directly in carrying out the national space programs. For even we who are most closely connected with this effort are often guilty of defensiveness, justification on negative grounds, and an air of apology about our national space commitment.

Such attitudes are wrong. The most important thing we can do is to recognize our responsibility to reverse them. Our national space effort is not a boondoggle, a toy, a gimmick, a camouflaged military venture, a luxury, or anything of the kind. It is, rather, a multifaceted national adventure with great scientific, technological, economic, spiritual and political connotations and components which go to the very core of our national character and posture. The impact permeates all aspects of our society.

Until this fact is popularly recognized and appreciated, our space effort will proceed on a false premise. And we who are most closely connected with it will have failed in our responsibility to our society.

Part of the price of a free society is that its members understand the premises upon which they are called to act. Despite the many successes we have enjoyed in our space program, we cannot count such an *understanding* among them.

By virtue of the technological and scientific advances of recent years and the political and economic strength of our nation, the challenge of space exploration was offered to us on terms within our national reach. The challenge fell on virtually every aspect of our society. No scientific discipline, no capacity for technological innovation, no political institution, and no aspect of our national, regional or local economic life lay wholly beyond its impact. Most were substantially affected. As a result no consideration of this nation's future could be made independently of our national decision as to the nature and scope of our space commitment.

To put it simply, we could choose either to accept the space challenge or to reject it. However, there was no choice about accepting the effects of that decision. Whichever way we decided would to a large degree determine the measure of the greatness of our society in the years ahead. For the decision and its effect were and are inseparable, and were and are essentially a decision as to the dimension of our future.

It follows that no one need be defensive or apologetic about our nation's commitment to the exploration of space. On the other hand, leaders, both governmental and private, would have been hard put to justify a decision *not* to accept this challenge with all of its attendant ramifications. As proof, one should test the attitudes in those national societies which, by choice or necessity, have decided not to be part of the space adventure. For the impact of such an option is as dramatically pervasive as is the impact of assuming the challenge. Rest assured that those nations who have not wanted or been able to accept this challenge are not unaware of what it has cost them in many ways.

Our society cannot remain free and viable by choosing to reject the major challenges with which it is faced; nor can it arbitrarily amputate areas of scientific and technological advance without cauterization of the whole. It cannot turn its back on technological advance, because so many of the solutions and so much of the dynamism available to a great democracy is associated with technology. Technological advance is not separable. You are either in the technological flow of the times or you are not. A great society allocates human and material resources to its space effort commensurate with the challenge, not because the space effort is more, less, or equal to medical research, for example, in importance, but because it believes its chances of improving its research are better if the space effort is undertaken. A great society does not apologize for its space effort as depriving school systems of a measure of resources, but rather proceeds in the strong conviction that its school systems will be better because of the space effort.

The heart of the matter is the inseparability, on the one hand, of advancing where advance beckons and, on the other hand, overall national advance.

It is a narrow and specious contention to justify America's space effort in terms of competition with the Soviet Union or any other nation.

If we were the only nation in the world that had the capability to proceed into this new dimension, we should do it.

We should do it because of the difference it will make in the scope and depth and nature of the opportunities to be afforded our boys and girls ten years from now.

We should do it so that we will be a stronger and richer country in the future in *all* ways.

We should do it to preserve and refresh the spirit of innovation which has been so singular a factor in our national greatness.

We should do it as part of a national renaissance on all fronts; for a great society, like a great university, cannot confine its attention to certain challenges selected under past conditions, but must, to sustain its greatness, move comprehensively to accept the challenges of the future.

Elements of our greatness are interrelated and interdependent. The advance of one helps the advance of every other. The attitude and climate of pursuing advance on all fronts greatly advances the whole. As the huge challenge of space generates and consumes and then regenerates our material and human resources, so does it widen the scope of the environment in which our citizens will exist and make their contribution in the years ahead. We will not have denied the future; we will not have fixed rigid horizons; we will not have tried to call a halt to technological advance; we will not have forfeited serendipity. We will continue to move forward as a free and greater society.

These are the real reasons we should proceed positively and proudly to seize this national opportunity—*not* because of the Soviet space effort, important as that is in some political and perhaps military contests; *not* to climb any mountains just "because they are there"; and *not* to create a Christopher Columbus syndrome. We are heavily involved in the space adventure because it is good for the country across the board.

This means we have a job to do in patiently and carefully establishing this proper perspective about our national space effort.

A free society does not tolerate silence, inattention, or neglect of responsibility in such matters. In a free society, you can't retreat to, or hide behind, your expertise. Just as the national space effort permeates all aspects of our national life, to that same extent does every member of our society have a responsibility toward it. It is everyone's business. But everyone must understand it. In a free society, people are not generous enough to assume your case. That case must be argued and reargued in the marketplace of ideas. And such a function can neither be delegated nor purchased.

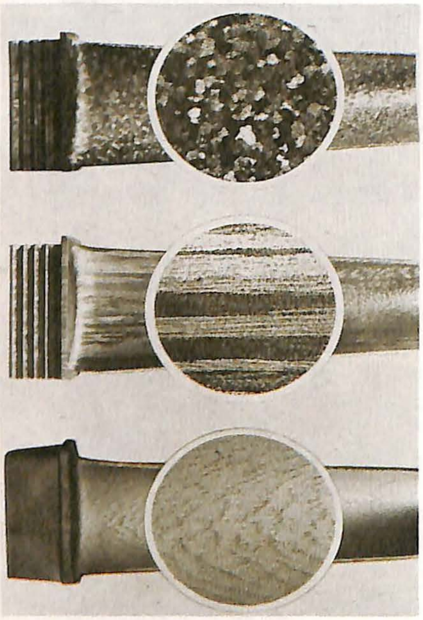
Space is indisputably a key element in our national future. If we are to remain great, we must continue to accept this challenge with a commitment commensurate to its size and nature. If we are to remain free, we must also move ahead in accordance with the tenets of a free society. Thus, engineers, scientists, businessmen, teachers, and government officials, whose aggregate contribution is the national space effort, have not finished their job until they have convinced our free society of the true nature of the great idea and purpose which they represent.

Single Crystal Process Extends Component Life

Pratt & Whitney Aircraft Division of the United Aircraft Corp. has developed a process to produce jet engine components in the form of individual alloy crystals.

The pioneering step, company officials state, could significantly extend the life of military and commercial gas turbine engines. Laboratory tests, for example, indicate the material is four times as durable as conventionally-cast material. Current plans call for testing in jet engines of varying sizes in the near future.

In the process, the grain boundaries have been eliminated. This becomes possible because the material is made of a single crystal which, in turn, is composed of a single grain.



Shotgun Shell Triggers New Mixing Technique

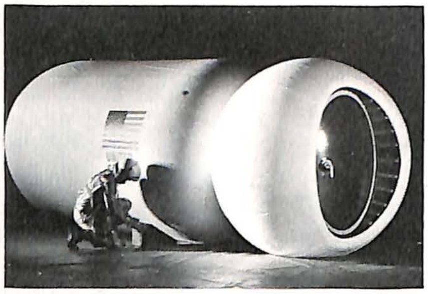
They call it the shotgun treatment; rifle accuracy may be the result.

General Dynamics' Fort Worth Division research scientists are firing 410 gauge shotgun shells into trapped metal powders in quest of materials for tomorrow's hypersonic air and space craft.

The firing takes place in a high-velocity impact device consisting of a firing pin, breech block and gun barrel. Remote triggering of this device sends a small steel projectile — attached to the end of a regular 410 gauge shell — crashing into a die filled with powdered metal combinations at speeds of up to 2,000 feet per second.

The force of the shot compresses the powder into a solid and permits combining of materials that are normally difficult and, in some cases, impossible to mix successfully.

So far, the scientists have worked with such common metals as copper, aluminum, iron, nickle and cobalt and such exotic metals as tantalum, titanium and niobium.



Expandable Shelter Built For Quarters on Moon

Goodyear Aerospace Corp. has delivered a full-scale prototype model of an expandable lunar shelter to the NASA Langley Research Center.

Fabricated of high-strength stainless steel filaments in a composite with other flexible materials, the shelter is called a Stay Time Extension Module (STEM). It is designed for possible use in a three-man post-Apollo moon mission, and would supplement the Lunar Excursion Module (LEM), to provide a stable base of operations for the moon explorers.

The unit is approximately 13 feet long and seven feet in diameter and is designed to maintain a constant temperature of 75 degrees even though the moon's surface temperature may range from a minus 300 to a plus 250 degrees.

'Galloping Garrett' Runs Rugged Testing Program

Halfback Mike Garrett got all the headlines, but the University of Southern California has another Garrett whose contributions in the medical field promise to far outstrip Mike's touchdowns.

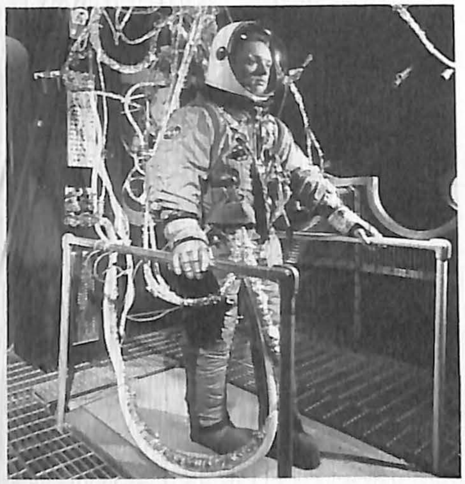
The Garrett Corporation's star is a Human Centrifuge and Space Environmental Facility on the USC campus in which an extensive research program is being conducted for the National Aeronautics and Space Administration's Ames Research Center.

The tests being conducted in Galloping Garrett, as life science specialists have dubbed it, are designed to relate factors of atmospheric composition and pressure as coupled with high acceleration forces. The aim is to help explain the causes and effects of atelectasis — a temporary condition caused by changes of the tiny sacs in the lungs.

The test consists of subjecting a qualified human subject to a controlled atmosphere in a sealed capsule for a three-to-eight hour conditioning period. When the subject is ready, he is centrifuged at a 6-G acceleration for a period of two minutes. He is then removed from the capsule and given X-ray and pulmonary tests to measure changes induced in the lungs.

Apollo Life-Support Pack Passes Simulation Tests

The initial manned simulation test on the life-support pack being designed for use in Project Apollo — aimed at placing man on the moon — has been completed by the Hamilton Standard Division of the United Aircraft Corp.



The test took the volunteer subject to 180,000 feet in a 10 x 10-foot pressure chamber.

A few modifications are expected, but the basic 65-pound pack will remain much as it is now. The pack, which will be worn strapped to the back, is 26 inches high, 17.8 inches wide and 10.5 deep. It is designed to provide future moon explorers with oxygen, purify it for rebreathing, ventilate the suit and helmet while maintaining a constant internal pressure of 3.7 pounds per square inch, pump cooling water through the undergarment, and remove heat and carbon dioxide.

The recent manned test at Windsor Locks, Connecticut, followed more than eight months of rigorous unmanned testing. Officials emphasized that a single test is not enough, and that the pack will undergo dozens of additional probes which will cover the full range of operational modes. The system is expected to go to the Manned Spacecraft Center in Houston, Texas, for NASA testing early in 1967.

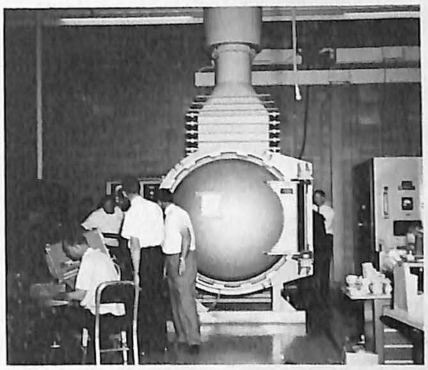
Laser System Is Safe In Airborne Operations

Hughes Aircraft Co. has completed an explosion test of a high-powered airborne laser system.

Purpose of the test was to prove the laser and its supporting circuits, when operating at full power, would not trigger an explosion of the gas mixture in the test chamber by generating a spark, by producing excessive heat, or by any other means.

As a bonus, the system was also checked for radio frequency interference and given a clean bill of health in this area as well.

Successful conduct of the tests, company executives feel, assures the safe use of the laser system in operational aircraft.



Small Business Award Presented to Lockheed

Courtland S. Gross, board chairman of the Lockheed Aircraft Corp. and a member of AIA's Board of Governors, recently accepted on behalf of his company, the Small Business Administration's highest industrial award for the pioneering use of small firms in its defense and space contracting program.

Made in Washington, D. C., by Irving Maness, SBA's Deputy Administrator, the award read, "For outstanding leadership in developing design and procurement programs directed at the maximum utilization of small business firms in meeting the needs of the nation's defense and space programs."

Since 1953, when Lockheed began stressing its small business program, the corporation has placed more than $1.75 billion in subcontracting with 75,000 small suppliers in all 50 states, the District of Columbia and Puerto Rico.

Sensor Gauge Measures Metal Fatigue Damage

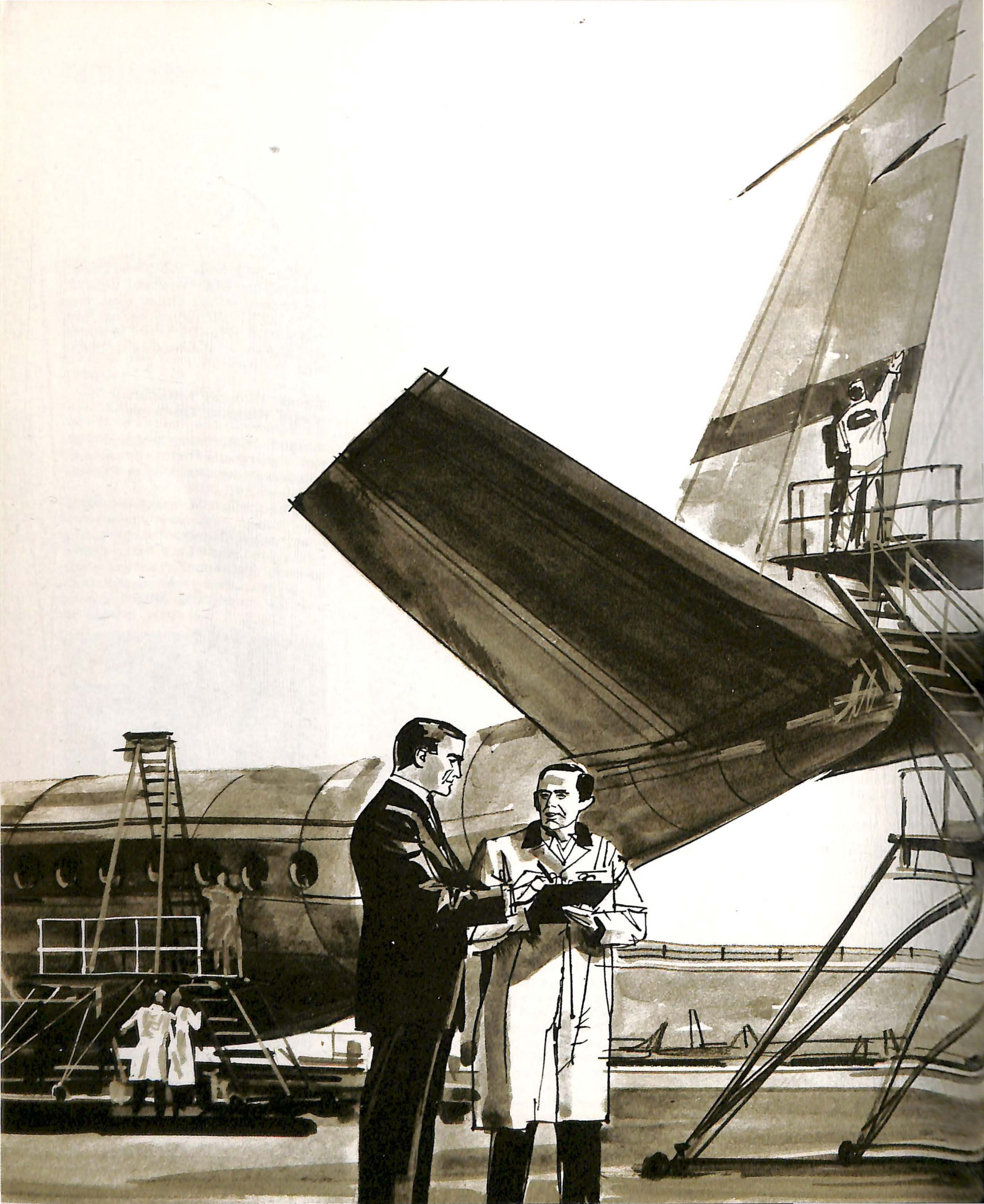
A device which warns when a metal part has become tired and is near failure has been developed by The Boeing Company.

Called a fatigue life gauge, the wafer-sized sensor looks very similar to a strain gauge. However, strain gauges measure the infinitesimal stretches in a structure under specific loads at a particular instant. The new gauge measures the accumulated fatigue damage in a structure over long periods of

time. It reveals this damage as progressively larger changes in electrical resistance of the gauge.

The fatigue life gauge will accumulate information without instruments being attached to it. Technicians simply check the resistance of the gauge periodically to determine the amount of fatigue on that spot on the structure.

Officials at Boeing's structures and environments laboratory caution, however, that it will not solve the problem of variations of structural materials. Consequently, it cannot measure fatigue conditions which occur prior to installation.



TRANSPORT SAFETY–

THE KNOWLEDGE POOL

This article was prepared for *Aerospace* by Robert Blackburn, a British aerospace writer, from the vantage point of London's Heathrow Airport. It describes the philosophy, and reports some examples of the cooperation between a commercial transport manufacturer and its airline customers to make air transportation the safest, as well as the most convenient, form of travel. A description of the efforts of field representatives for other transport aircraft builders would vary only in the name of the manufacturer. Global representatives are also provided by utility aircraft and helicopter manufacturers, aircraft engine and major component firms. The goal for all is common: safety and service.

A modern transport aircraft is a highly complex product, a synthesis of many skills, and an understanding of precisely how and why it works in every respect is difficult for any one person.

The airplane is the meeting point of two great industries — the airlines and the aircraft manufacturers. Both groups are in the aviation business, but in their commercial operations they have little in common except an interest in the airplane.

Airlines are concerned with selling seats by the million for travel between any two airports anywhere in the world; thinking is geared to the mass market. Aircraft manufacturers, on the other hand, produce, relatively speaking, handfuls of airplanes for a small number of highly selective customers — the airlines.

Both airlines and aircraft manufacturers work in highly competitive environments. But when it comes to the operation of airliners there is a sharing of knowledge without precedent in international commerce. On the subject of airliners, there is a huge common pool of information to which the airlines and manufacturers are contributing all the time. The object of this free exchange of commercially valuable knowledge is a simple one — to make air transport as safe and reliable as possible. The airplane thus receives continuous attention from the best engineering brains in the world.

Responsibility for its design and manufacture is one thing; responsibility for operating it is another. Re-

AIA REPORT

Thirteen representatives of Aerospace Industries Association member companies will serve as advisors to the Federal Aviation Agency's Airworthiness Standards Evaluation Committee.

Appointed at the direction of General William McKee, FAA Administrator, the group will conduct an evaluation of the basic principles and concepts underlying the present FAA airworthiness standards and formulate recommendations.

Although the standards have undergone constant change and alteration, the philosophy encompassed is substantially the same as was written in the Commerce Act of 1927.

Now, General McKee believes, the time has come for a review of that philosophy and he has decided that industry and the users should participate in an advisory capacity. As a consequence, in addition to AIA, such agencies and associations as the Department of Defense and the military services, the National Aeronautics and Space Administration, the Civil Aeronautics Board, Air Transport Association, Air Line Pilots Association, Aircraft Owners and Pilots Association, representatives of airlines and the National Business Aircraft Association will be represented.

To assure that all facets of the standards are thoroughly explored, five subcommittees have been established. Each will review a specific area, as follows:

Subcommittee A: Review the categorization and general structure of airworthiness rules to determine the merits and demerits of the existing system and recommend necessary changes.

Subcommittee B.: Determine the approach to be taken to establish regulations for emerging types of aircraft, including the SST, V/STOL, and large types, such as the C-5A.

Subcommittee C: Compare FAA standards with those of the military, the industry, foreign governments and ICAO standards to determine whether FAA standards can be improved, simplified or re-aligned with respect to other standards.

Subcommitte D: Review the standards and procedures relative to responsibilities of the FAA and the manufacturers, including delegation to the manufacturer of certain or all responsibilities for certification to determine the merits of existing procedures and recommend necessary changes.

Subcommittee E: Review the general industry-FAA relationships with regard to promulgation of FAA Airworthiness Standards and recommend necessary changes.

The groups held their initial meetings recently, in Washington, and will work on their recommendations until September. Those recommendations will be edited and printed between that date and October 15, the deadline for submission established by General McKee.

Representing AIA on the various committees are:

Subcommittee A: S. Kleinhans, Vice President, Engineering, Douglas Aircraft Co., Inc.; R. A. Wagner, Manager, Technical Department, Hughes Aircraft Corp.; D. G. Grommesh, Chief Engineer, Lear Jet Corp.; G. N. Cole, Chief, Engine Design, Pratt & Whitney Aircraft Division, United Aircraft Corp.; and E. R. Foxworthy, Director, Commercial Aviation Marketing, The Bendix Corp.

Subcommittee B: J. R. Piselli, Vice President, Engineering, Bell Aerospace Corp., and C. T. Crawford, FAA Engineering Coordinator, Lockheed Aircraft Corp.

Subcommittee C: J. N. Lew, Vice President, Engineering, Beech Aircraft Corp., and R. B. Lightfoot, Chief Engineer, Sikorsky Aircraft Division, United Aircraft Corp.

Subcommittee D: W. C. Jamouneau, Chief Engineer, Piper Aircraft Corp., and B. L. Carter, Chief, Airworthiness, The Boeing Co.

Subcommittee E: K. Van Every, Head, Aeronautical Systems Division, General Dynamics Corp., and O. T. Wells, Executive Engineer, Cessna Aircraft Corp.

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

Field representatives for transport aircraft firms play a key liaison role between the manufacturers and airline operators. Their contributions to safe, economic operations are reported in *Transport Safety—The Knowledge Pool* (see page 12).

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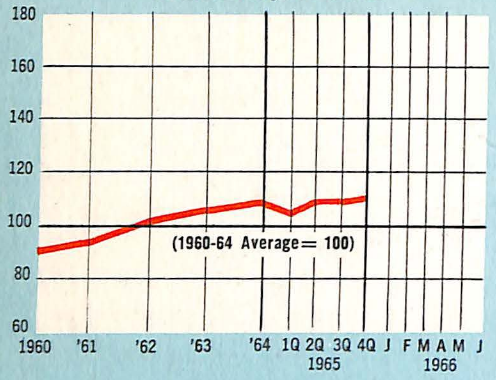
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · MAY 1966

- **VIETNAM—PLANE PROOF**
  By J. S. Butz, Jr.
- **SST—SUPERSONIC AIR TRAVEL**
  By Brig. Gen. J. C. Maxwell

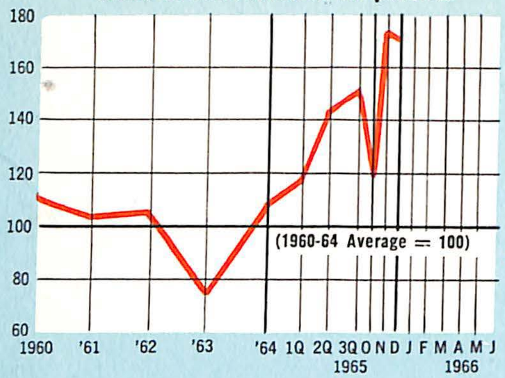
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

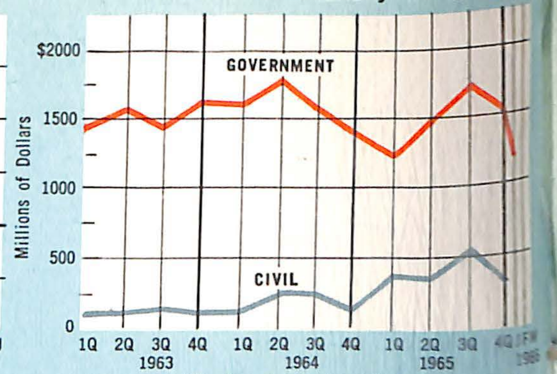


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



Aerospace obligations by Dept. of Defense and NASA
Nongovernment prime orders for aircraft and engines

ITEM	UNIT	PERIOD	1960-64 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.0	Quarter Ending Dec. 31 1965	20.8	20.8	20.9
	Billion $	Quarterly	4.7		4.9	5.2	5.3
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,177	Jan. 1966	939	1,414	862
Aircraft	Million $	Monthly	584	Jan. 1966	533	822	527
Missiles & Space	Million $	Monthly	593	Jan. 1966	406	592	335
Aerospace expenditures: Total	Million $	Monthly	1,098	Jan. 1966	853	1,209	945
Aircraft	Million $	Monthly	560	Jan. 1966	481	804	546
Missiles & Space	Million $	Monthly	538	Jan. 1966	372	405	399
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	183	Feb. 1966	256	406	324
Expenditures	Million $	Monthly	143	Feb. 1966	328	378	367
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	633	March 1966	1,024	1,173	1,495
Value	Million $	Monthly	13	March 1966	26	31	36
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	14.1 #	Quarter Ending Dec. 31 1965	15.2	18.7	20.4
U.S. Government	Billion $	Quarterly	11.1		11.7	12.7	13.7
Nongovernment	Billion $	Quarterly	3.0		3.5	6.0	6.7
EXPORTS							
Total (Including military)	Million $	Monthly	107	Feb. 1966	104	104	154
New Commercial Transports	Million $	Monthly	23	Feb. 1966	12	22	39
New Utility Aircraft	Million $	Monthly	2	Feb. 1966	4	6	6
PROFITS				Quarter Ending Dec. 31 1965			
Aerospace — Based on Sales	Percent	Quarterly	2.1		2.7	3.6	3.5
All Manufacturing — Based on Sales	Percent	Quarterly	4.6		5.4	5.4	5.7
EMPLOYMENT: Total	Thousands	Monthly	1,128	Feb. 1965	1,117	1,215	1,230 E
Aircraft	Thousands	Monthly	507	Feb. 1965	437	504	514
Missiles & Space	Thousands	Monthly	490	Feb. 1965	511	540	545
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.87	Feb. 1965	3.13	3.36	3.35 E

E Estimate
* 1960-64 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 1961-64.

AIA

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CONTENTS

The purpose of AEROSPACE is to:

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

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

Foster understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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.

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RECORD BACKLOG

Backlog of aerospace industry orders increased to the highest point in industry history at the end of 1965, rising to $20.4 billion compared with $15.2 billion at the end of 1964, according to Bureau of the Census reports.

During 1965, the aerospace backlog increased in nearly every category: complete aircraft and parts, aircraft engines and parts, space vehicle systems and non-aerospace products and services. The backlog of orders for complete aircraft and parts rose from $6.3 billion in December 1964 to $8.9 billion at the end of 1965, a 41 percent increase.

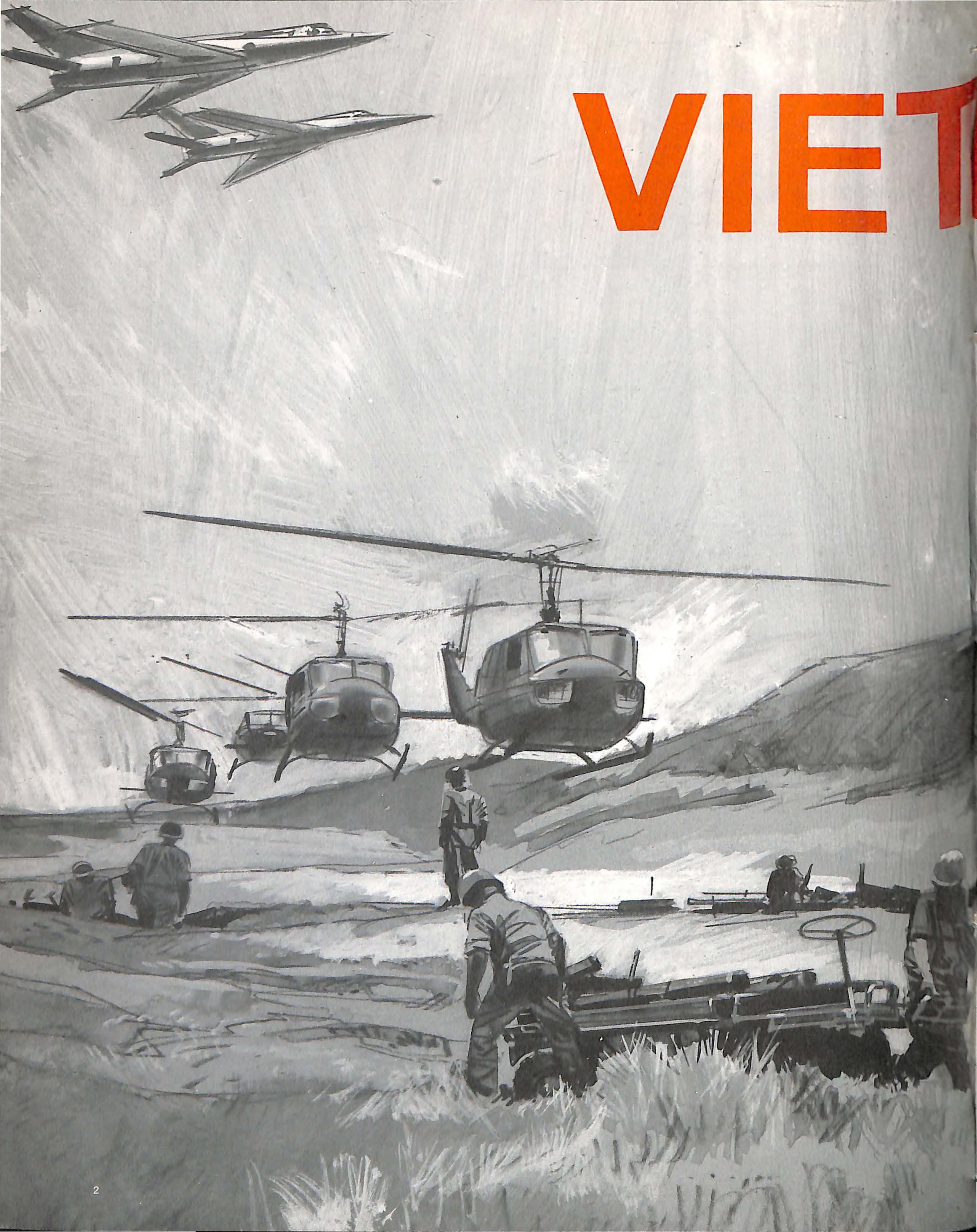
This increase in backlog has been accompanied by a shift in the mix of backlog toward substantially more commercial and less government business. In the period December 31, 1964 to December 31, 1965 the proportion of commercial backlog rose from 23 percent of the total backlog to almost 33 percent.

Commercial backlog during this one year period increased from $3.5 billion in December of 1964 to $6.7 billion in December of 1965, an increase of more than 91 percent. The level of government orders rose from $11.7 billion in December of 1964 to $13.7 billion in December of 1965, a gain of $2 billion.

A substantial portion of the increase in commercial orders is due to the present reequipment cycle which is now moving forward rapidly for commercial transports as well as the increased level of orders for jet utility aircraft. AIA member companies reported that their total backlog on order as of December 31, 1965 for these aircraft was almost $4 billion, scheduled for delivery through 1968 and later. About $1.9 billion of jet utility and transport aircraft are to be delivered in 1966. Foreign orders for these aircraft amount to almost $1 billion with aircraft valued at $420 million scheduled for delivery in 1966.

The present level of backlog indicates that sales for 1966 will rise above $22 billion, primarily as a result of the demand for commercial and utility aircraft as well as the increasing requirements for military aircraft, largely due to Vietnam operations.

VIET



NAM: PLANE PROOF

BY J. S. BUTZ, JR.

J. S. Butz, Jr., an aerospace technical writer, recently spent two and a half months in South Vietnam. This article is a thoughtful analysis of air operations there, and the outstanding performance and utilization rates of U. S. aircraft in a wide variety of missions.

Massive use of air power is the key to U. S. military success in Vietnam operations. Helicopters and fighter aircraft are being used in such large numbers that many basic conceptions about such conflicts are being changed rapidly. One development of extreme importance is that relatively fewer men must fight on the ground since air power has been so successful.

Lieutenant General Andrew J. Goodpaster, U. S. Army, assistant to the chairman of the Joint Chiefs of Staff, explains it this way: "No doubt you have heard statements that an eight-to-one or ten-to-one or twelve-to-one ratio of government troops to guerrillas is required . . . In the case of Vietnam, such ratios lose validity because we are exploiting two weapon systems in a fashion never before undertaken in guerrilla war. The first weapon is the helicopter, in use by the hundreds to transport troops to the scene of combat. . . . The second is the use of tactical fighter bombers in unprecedentedly large numbers to support Vietnamese and American ground troops. They may well have changed the course of the war through swift and heavy air strikes they mount against the Viet Cong wherever they are found. These two weapons — helicopters and fighter bombers — provide the South Vietnamese and U. S. forces an advantage in mobility and firepower greatly exceeding that available to counter insurgency forces in any previous war."

General Goodpaster made these remarks last November, only three or four months after sizeable units of U. S. troops were sent to Vietnam. Time has reinforced his analysis. The great value of helicopters and fighters is even more evident today and their usefulness seems to be growing. No one knows yet just how effective aircraft can become in a guerrilla war, or how large a ground army will be needed to defeat the Viet Cong.

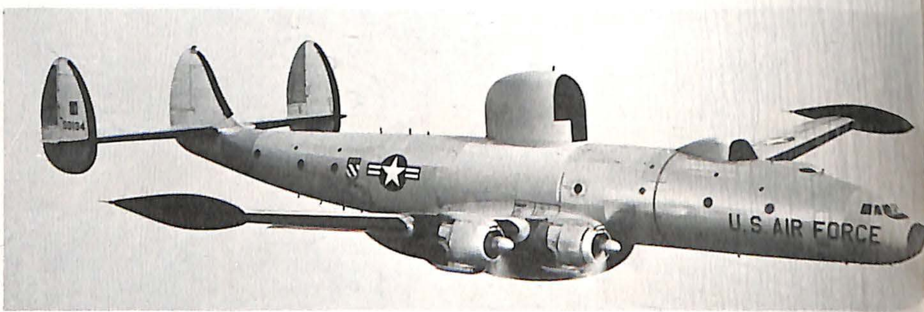
These photos show some of the U.S. aircraft being operated in Vietnam.

Sikorsky CH-54

Ling-Temco-Vought F-8U

Lockheed P2V

Douglas A-4E



Lockheed EC-121

However, the entire military community is convinced that three or four times as many men would be needed if airpower were not being used in massive quantities.

At the beginning of the second quarter of 1966, U. S. air strength in South Vietnam had built up to more than 2,000 helicopters, approximately 700 fighter bombers and 100 transport airplanes. About 300 strike fighters are used in the air campaign against North Vietnam. This compares to a maximum force of about 200 tactical bombers, much less than 50 helicopters, and a handful of transports which supported the French Army when it fought the communists in Indo-China during the late 1940s and early 1950s.

These numbers, important as they are, do not begin to tell the complete story of the U. S. air effort. All of the military services — the Army, Navy, Marine Corps and Air Force — have contributed. All of them can point to major accomplishments. Long years of peacetime training have paid large dividends for both pilots and ground crews. All units have demonstrated a thorough professionalism that has not been so apparent in the past when U. S. forces first entered combat.

The priority task of providing close air support to infantry forces when they are in battle with the Viet Cong has been handled with great efficiency. Ground units have been highly pleased with this support, which was not always the case in Korea or World War II.

The new "air cavalry" concept, in which fighting forces are moved rapidly around a battle area by helicopter, has been thoroughly tested and found to be an important new weapon.

The transport of troops and supplies by fixed wing transports to eliminate the possibility of Viet Cong ambushes on the roads has reached astounding proportions. The airlift now underway inside South Vietnam is larger than any other ever sustained by the U. S. military, including the famous Berlin airlift.

In addition to these more or less traditional tasks of air power, several other large air efforts are well established. Rapid helicopter evacuation of wounded to hospitals has become standard practice. Largely because of this service, only one soldier out of every 100 wounded dies, an unheard of achievement in past wars. Airplanes also are used regularly to drop leaflets and broadcast psychological warfare messages to villages all over South Vietnam; drop flares during the night over small outposts under attack by the Viet Cong; and to kill crops and defoliate forests in VC areas with chemical sprays.

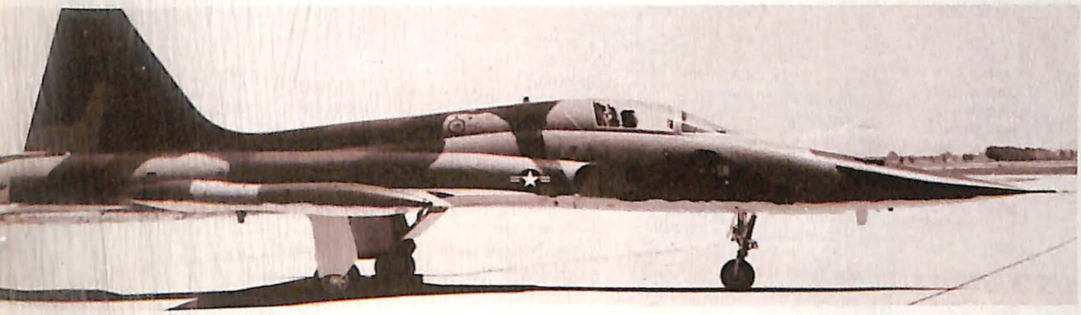
The masses of aircraft and the achievements of the fighting men still are not the complete story of air power

Grumman OV-1


Republic F-105


North American F-100

Cessna O1-E


Northrop F-5


Sikorsky CH-3C

in Vietnam. The individual aircraft have performed splendidly and shown a remarkable sturdiness and serviceability under difficult tropical operating conditions. The aerospace industry, its engineers and factory personnel, can take pride in the aircraft and equipment they have developed and produced.

More than 20 types of aircraft have seen extensive service in Vietnam. Some, such as the McDonnell F-4, Phantom II, holder of many world speed and altitude records, are new and the most advanced hardware available anywhere in the world. Others, such as the Fairchild C-123 transport, are old and a few years ago were due to be phased out of service. In many respects they belong to an earlier technological generation.

All of these aircraft, old and new, have done extremely well. In fact most of them have performed better in Vietnam than they ever did in peacetime service. A case in point is the Republic F-105, Thunderjet. The usage rate for this supersonic strike fighter, which carries a full complement of complex electronic weapon delivery systems, has been about twice as high in Southeast Asia as it was during war games and exercises in the United States. Currently the average F-105 is flown in combat against North Vietnam more than 60 hours each month.

Army helicopters average more than 50 hours a month, well above the flying time that has been possible for military helicopters in the past.

The availability rate is another key factor in judging the efficiency and serviceability of aircraft. It indicates the percentage of aircraft that are ready for combat service on a given day and not down for maintenance and repairs.

It was expected that many aircraft would have maintenance troubles when they were moved from a temperate zone into the tropics and used roughly in combat. There were troubles. Among the troublesome parts were seals for hydraulic systems and pistons in actuators. These and other equipment with close tolerances proved to be sensitive to the high humidity of the rainy season, the fine sand and clay dust that exists in many parts of South Vietnam. The problems were worked out quickly by maintenance men of the military services and the scores of highly skilled engineers from the aerospace industry who accompany all equipment into the field as contractors' representatives.

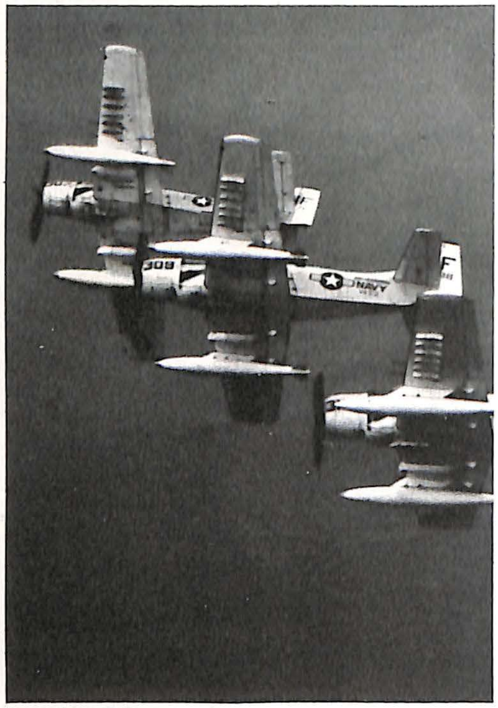
The record of availability rates shows just how efficient this maintenance effort has been. In the first few months that large numbers of aircraft were brought to Vietnam, the availability rate on some helicopters was

Kaman HH-43F

Sikorsky H-34

Fairchild C-123

Boeing/Vertol CH-47



Douglas A-1

Douglas AC-47

Lockheed C-130

about 30 percent. This was a serious matter; no military organization can function effectively if only 30 percent of its aircraft are ready for use each day and 70 percent are down for repairs. However, this situation did not last long and many types of helicopters have availability rates in the high seventies. Even the newest types which are in the process of shaking down are around 60 percent. These figures are exceptionally high for helicopters. Fixed wing aircraft availability rates have been up into the high 80s in some cases, which also is exceptionally high.

The usage and availability rates reveal a great deal about any air operation. When both are high it speaks well for men and machines. In the case of Vietnam where both are very high it means that most of the U. S. armada is in the sky every day, literally covering the whole country, and providing Vietnamese and American troops with a quality of air support that would have been considered impossible only a few years ago.

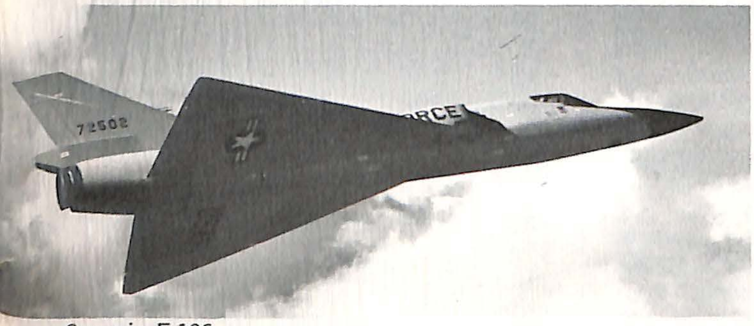
The U. S. Army operates most of the helicopters in South Vietnam. The 1st Cavalry Division (Airmobile), which has nearly 500 helicopters, has been the principal unit testing the new air cavalry concepts against the Viet Cong. However, the value of helicopters for rapid mobility has become so apparent that even such conventional units as the 1st Infantry Division have more than 425 helicopters assigned. The most widely used rotary wing vehicle is the Bell UH-1, the Huey. Its "D" model, or Slick as the soldiers call it, carries troops; the "B" model is the "gun ship" which is equipped with rockets and machine guns to provide an armed escort for the troop carriers. The Boeing/Vertol CH-47 Chinook is much heavier and will carry more than 30 fully armed troops or more than three and a half tons of supplies. It is the heavy workhorse and without its cargo capacity the air cavalry would be seriously restricted in its movement. The champion lifter of the Army's rotary wing family today is the Sikorsky CH-54 Skycrane which is also in service in Vietnam. It will pick-up more than 20,000 pounds and is used for a multitude of jobs including the retrieval of other helicopters which are downed in enemy territory. The Army also uses substantial numbers of four fixed wing aircraft. These are the Grumman OV-1 Mohawk and DeHavilland Beavers, Otters and Caribous. Under a recent agreement between the Air Force and the Army, the Air Force will operate the Mohawks and the Caribous and the Army will take over most of the Air Force's rotary wing aircraft.

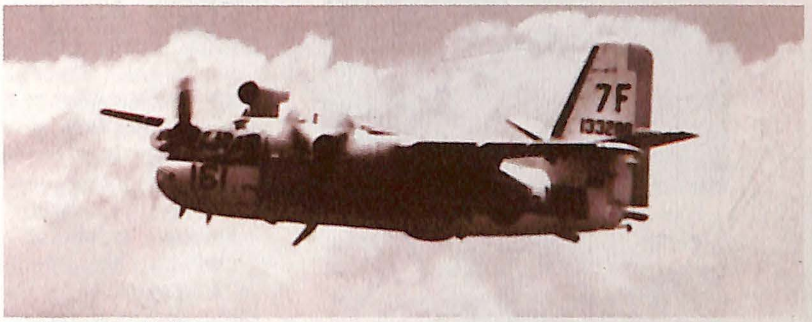
The Navy normally has three carriers in the waters

McDonnell F-4C refueled by Boeing KC-135

North American RA-5C

Grumman A-6A


Convair F-106



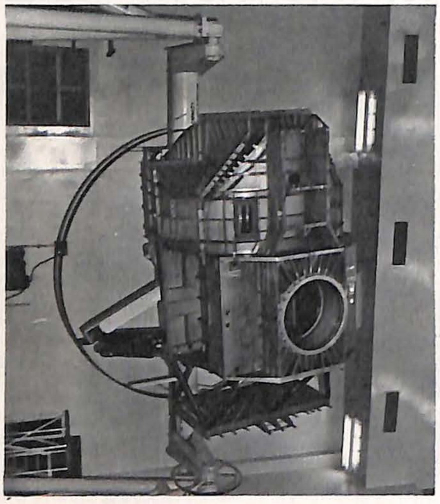
Grumman S-2E

off Vietnam. Two are on *Yankee* station and their aircraft fly against North Vietnam. The major aircraft in these strike operations are the McDonnell F-4 and the Douglas A-4 Skyhawk. The third carrier is on *Dixie* station and its planes are used to support ground troops in South Vietnam. The Douglas A-4 is the principal aircraft in this operation. In addition to its strike aircraft, the Navy also conducts search and rescue, anti-submarine reconnaissance and coastal patrol air operations, and participates in the air defense network. Aircraft that contribute to these operations include: the Douglas A-3, Skywarrior; Lockheed P2V Neptune; Chance Vought F-8; North American RA-5C; Martin P5M; the Grumman S-2E Tracker, A-6A Intruder and E-2A Hawkeye.

Several Marine air groups are ashore in Vietnam. They operate out of bases at DaNang and Chu Lai, primarily. Their principal aircraft are the McDonnell F-4, the Douglas A-4 and the Sikorsky H-34 helicopter. The Marine air groups provide close support and battlefield mobility for Vietnamese troops of the I Corps area as well as Marine infantry.

The Air Force flies from fields in all four of the Corps areas in South Vietnam. On the vital close air support mission, the USAF uses Douglas A-1s, North American F-100s and McDonnell F-4s. Also during the past year twelve Northrop F-5 fighters were evaluated and on the basis of this evaluation more will be sent to Vietnam. Targets are spotted by Forward Air Controllers flying Cessna O1-Es. For its operations against North Vietnam, the Air Force employs McDonnell F-4s and Republic F-105s primarily. They are strongly supported through refueling by Boeing KC-135 tankers. The transports that the USAF depends upon for its airlift inside of South Vietnam are the C-123 and the Lockheed C-130. In its other missions, such as search and rescue, defoliation, reconnaissance and air defense, the USAF uses a wide variety of aircraft. They include: the Douglas C-47 rigged with three General Electric "Gatling" guns for support of ground troops; Convair F-106; Kaman HH-43F Huskie; Grumman HU-16 Albatross amphibian; and the McDonnell RF-101.

One of the key by-products of this massive air effort is experience. This experience is being rapidly put to work by military evaluation teams and in the design offices of the aerospace industry. Shortly, a new generation of fixed wing and rotary wing aircraft can be expected in service which will provide even greater support for American and allied forces.



Grumman Develops Electric Cleaner For NASA's LEM

One of the problems involved in sending man to the moon is wearily familiar — housekeeping. Grumman Aircraft Engineering Corporation has developed a device called LEM Cleaning Positioner for cleaning the Lunar Excursion Module during its final build-up.

Inaccessible corners of the complex structure make removing the unwanted debris a problem. The LEM Cleaning Positioner is a large, electric motor-driven device which tumbles one of the LEM's two sections at nearly any angle to dislodge the hidden debris. The device is then stopped at various positions, and a man with a vacuum cleaner climbs inside and dispatches the exposed dirt.

Grumman builds the Lunar Excursion Module under contract to the National Aeronautics and Space Administration. The LEM will form that section of the Apollo spacecraft which will transport two American astronauts to the moon's surface from lunar orbit.

Lockheed's Big Solid Rocket Welded From Smaller Motors

The case of a 156-inch solid rocket which Lockheed Propulsion Company fired successfully in January was constructed by Rohr Corporation from two rocket motors that had been fired separately last year.

By cutting 10 feet of cylindrical section each from forward and aft closures used in earlier firings and welding the two sections, Rohr produced a 30-foot rocket which developed a million pounds of thrust during a 65-second firing.

Physical properties of 18 percent nickel maraging steel, which permit welding of metal in the hardened condition and local aging of the weld with strip heaters, made the modification possible, Lockheed reports.

The large rocket contained 300,000 pounds of propellant and was fitted with a submerged nozzle and an omnidirectional secondary fluid injection steering system. In the firing position, it stood 34 feet high.

Computer-Designed Circuitry Goal of Norden Project

Norden Division of United Aircraft Corp. has received an Air Force contract to devise a method of designing new, highly complex, integrated microcircuits by computer. Achieving this will reduce the current excessive cost and time required to develop new circuitry.

In awarding the contract recently, the Air Force noted that the time/cost factor has "limited initial application of microcircuitry technology to equipment which requires large numbers of identical circuits."

As a result of Norden's past research and development, the time required to design, manufacture and deliver first production units of a new circuit already have been cut from four months to one.

Hughes Builds Ground Link Terminals for SATCOM

Ground-link terminals for a global communications network which can be pieced together like a child's erector set have been developed by Hughes Aircraft for the U.S. Army's Satellite Communications (SATCOM) Agency. These Mark 1B terminals will be used to receive, amplify and transmit multiple voice and teletype messages for the Department of Defense. They will be capable of transmitting and receiving four voice and four teletype messages at the same time as well as sending facsimile photographs.

Hughes is building the giant-size terminals at its Fullerton, Calif., communications and radar division. When all are delivered to SATCOM and installed at various points around the globe, they will form an integral part of the world's first global satellite communications network.

The Mark 1B is the first specifically designed for military communications and the world's largest terminal that can be transported by air. The terminals can be erected by a station crew and be fully operable within 48 hours.

They are scheduled to go into service when the system's first satellites are

launched later this year. Site preparation for two Mark 1Bs has begun at Helemano, Hawaii, 20 miles north of Honolulu.

Each terminal has a 40-foot-diameter parabolic antenna. Each antenna is housed in a dual-wall inflatable radome 58-feet high which protects it from the elements. Three diesel generators provide power to each installation in addition to other support equipment.

Boeing Simplifies Method To Coat With Fiberglass

Manufacturing development engineers of The Boeing Company have discovered a simplified method of covering surfaces with fiberglass.

In the past, when fiberglass covered panels were needed in production, the task was sensitive to both temperature and timing. The panel had to be cut exactly to size and placed precisely before the resin and catalyst were applied. Then, the latter elements had to be mixed in precise amounts on the spot and the layup procedure done by hand.

Now, Boeing engineers simply precatalyze the fiberglass. Key to the operation is a solvent which is mixed with the catalyst in which the fiberglass is soaked and dried. The solvent spreads a thin layer over the catalyst, preventing it from evaporating when exposed to the air. In this form, it is laid on the surface to be covered, trimmed to size, set in place and the resin applied with a brush. The resin then dissolves the solvent, soaks into the precatalyzed fiberglass, mixes with the catalyst and adheres to the surface below.

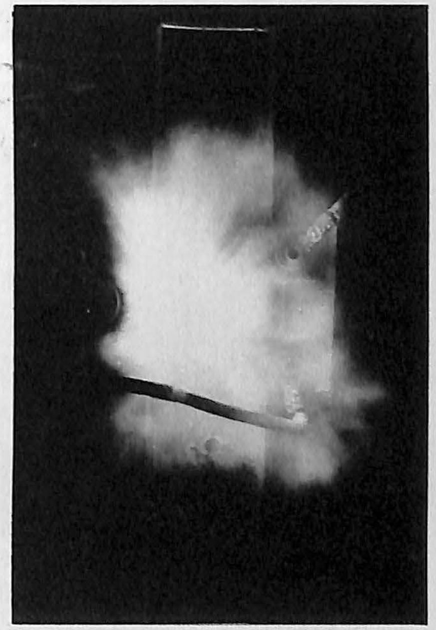
Tests show that fiberglass applied in this manner sets as hard and holds as tight as any applied by the old method.

Compression Tests Explode Aluminum Foil In Simulation

Northrop Nortronics' Applied Research Department is using aluminum foil to simulate high-pressure, short duration shock waves produced by exploding nuclear weapons.

A high-voltage current is passed through a small specimen of foil causing it to vaporize so fast that it actually explodes. This reaction generates high-pressure pulses necessary to determine what kinds of target materials can best withstand pulse radiation or high-speed projectiles. Using this method, Nortronics expects to determine what kind of materials are best suited for hardware such as missile nose cones passing through a nuclear environment.

Results of these tests are recorded on a streak camera that provides data required to compute projectile velocity, the velocity of the shock induced into the target and velocity of the target material. When converted into pressure and density, this information tells researchers how the target material compresses with pressure and temperature



and indicates the conditions under which the material could fail.

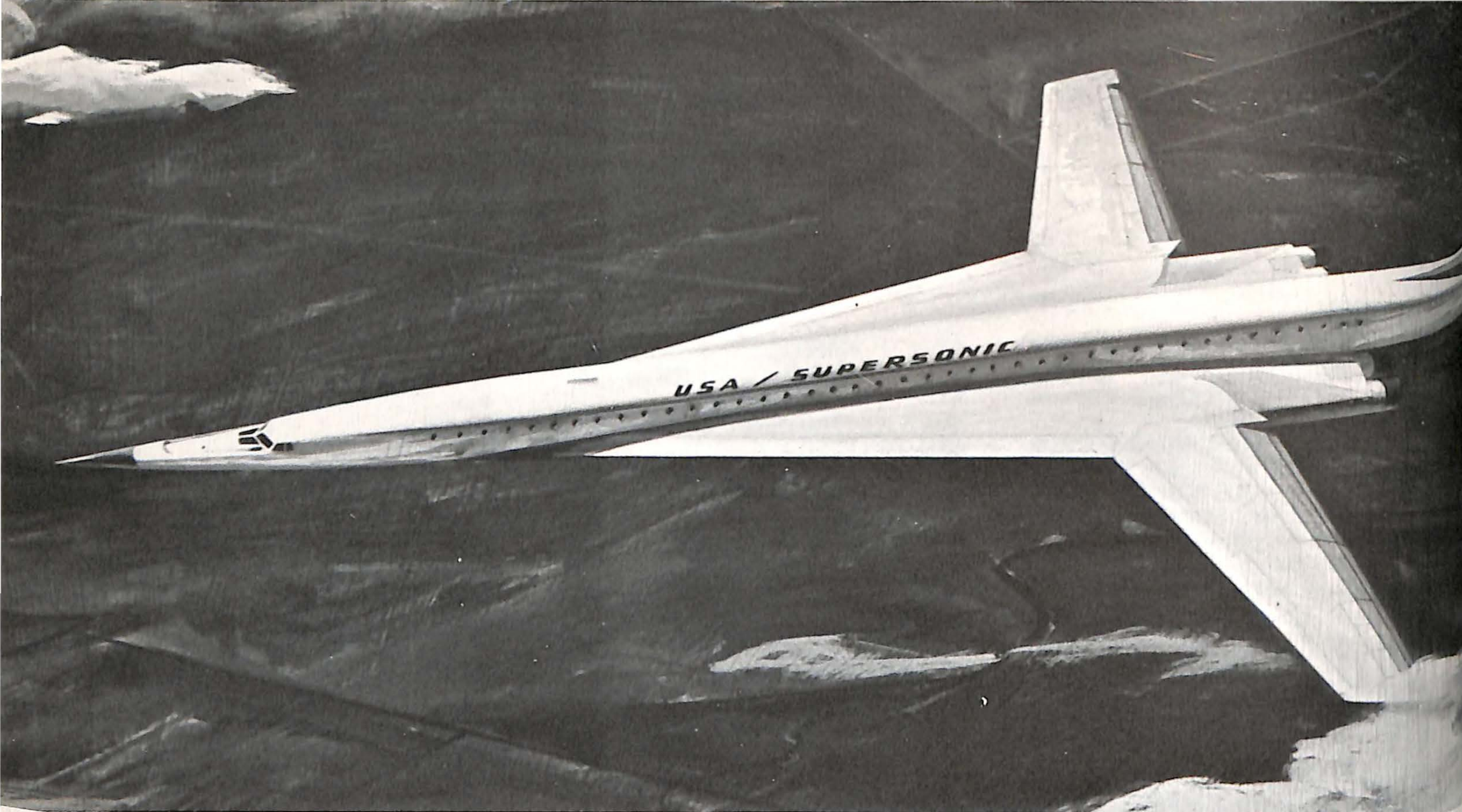
It is believed that the investigation will benefit solid-state research by helping define more accurately how different materials respond to compression.

Army Evaluates Voiceless Code Device for Jungle War

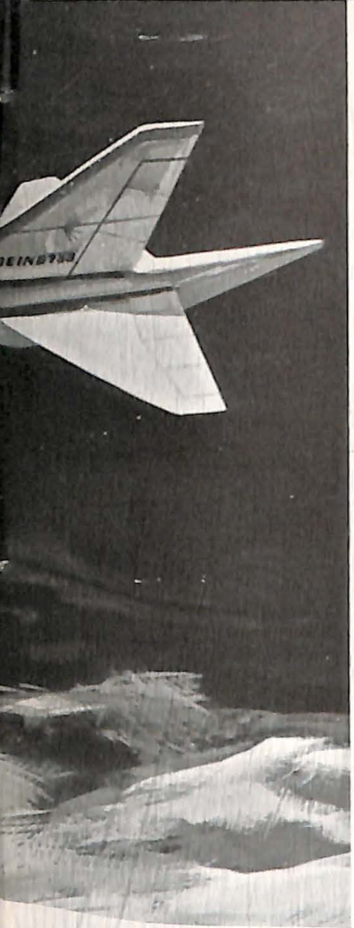
Army Electronics Command is evaluating a new voiceless communications device developed by Radio Corporation of America for the U.S. Army to transmit coded messages between allied jungle combat troops. Known as the Jungle Message Encoder-Decoder, it is self powered, weighs three pounds, and is about the size of a pocket transistor radio.

JMED is to be used with standard Army pack radios to send and receive 32 special five-digit messages. Although it uses digital techniques similar to those used in sophisticated communications equipment, its operation is designed to be simple and quiet.

The device is considered to be particularly effective in situations where allied troops speak different languages. Misinterpretation of messages is impossible since each user has a printed message card which keys the code to pictures, the user's language and international symbols.

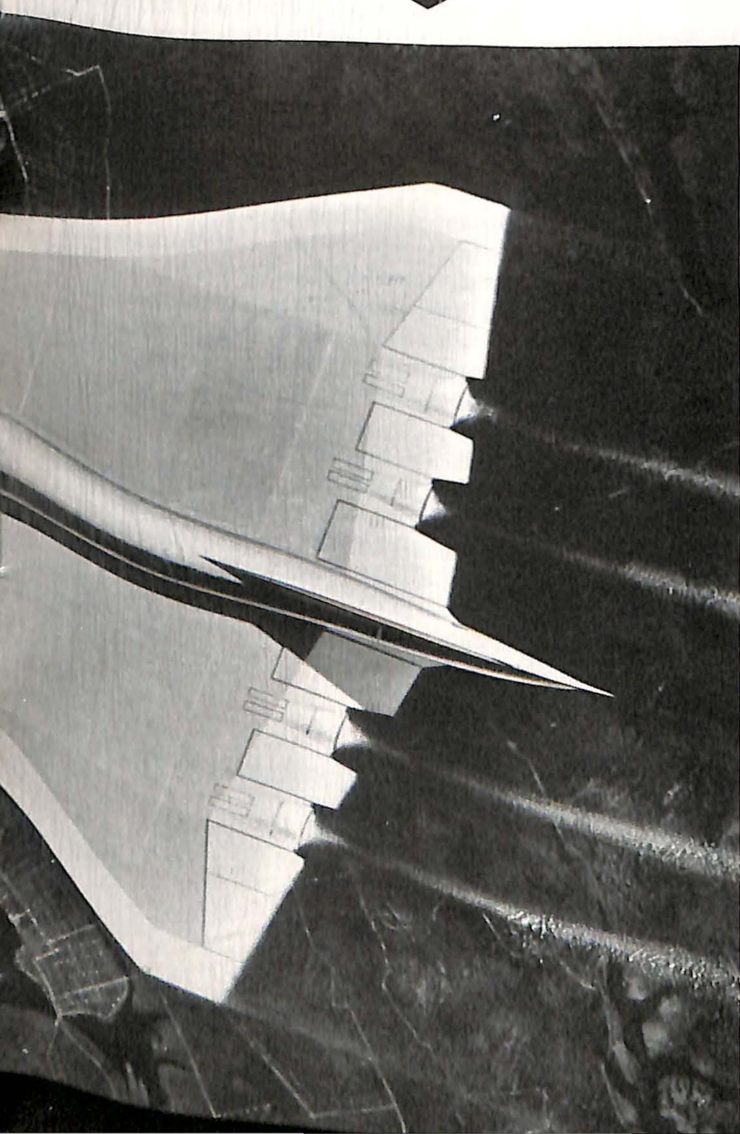


SST
SUPERSONIC AIR TRAVEL



Boeing Company supersonic transport entry features a variable sweep wing.

Lockheed Aircraft Corp. design for a supersonic transport utilizes a double delta wing.



BY BRIG. GEN. JEWELL C. MAXWELL, USAF
Director of Supersonic Transport Development
Federal Aviation Agency

For almost a decade the concept of routine commercial supersonic flight has stirred this country's imagination. Late this year, the U.S. aviation industry will be called upon to bring this dream closer to reality and to prove its long-held contention that a supersonic commercial transport is both technically and economically feasible.

Although the idea of a supersonic transport — SST — may be traced back to early military research efforts in supersonic flight, it did not crystallize into reality until three short years ago. In June 1963, the late President Kennedy, speaking at the Air Force Academy, called for a precedent-setting joint government-industry program to develop such an aircraft. He termed it to be a challenge and a need essential both to this country's future transportation system and national interests.

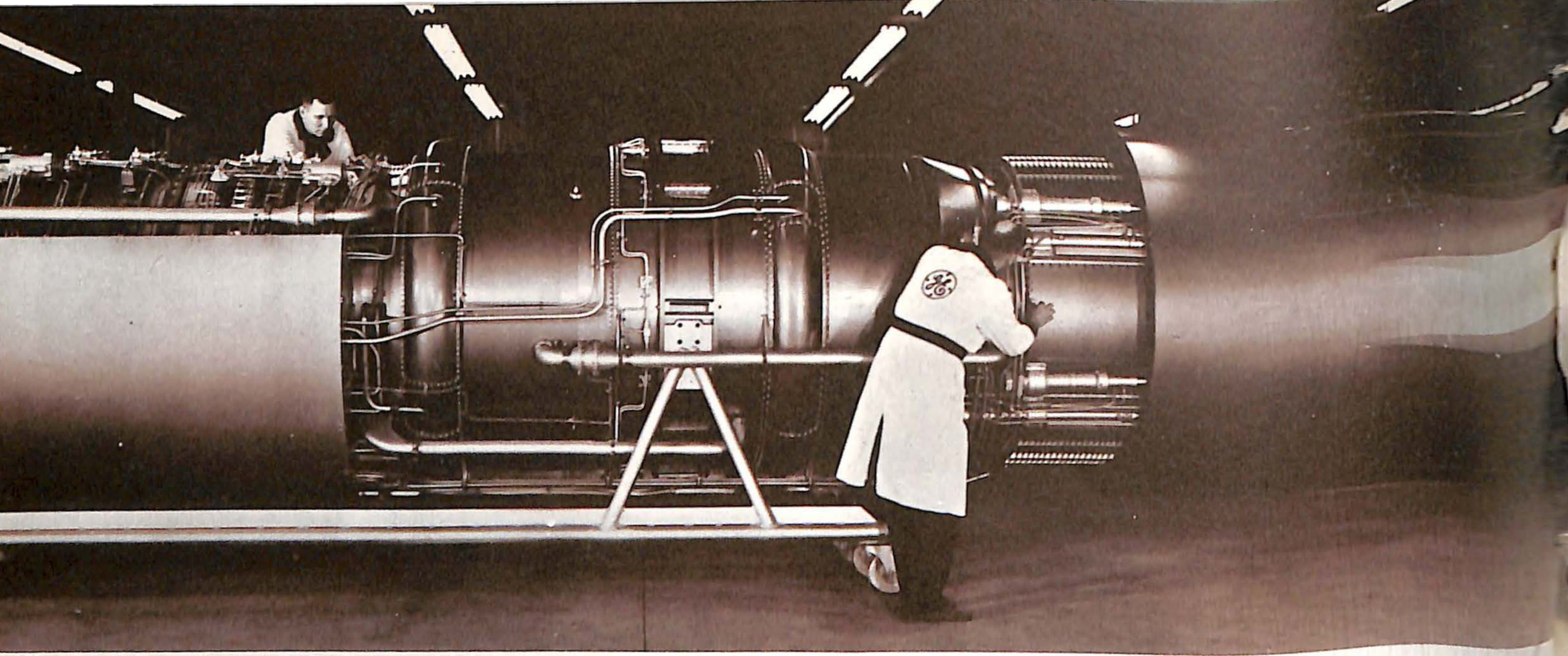
The identification by President Kennedy of the need as it pertained to our national interests was in large part an acknowledgment that further delay by the U.S. would only lead to a loss, by default, in this nation's historically preeminent role in world aviation. A serious challenge to our traditional leadership in this area already had been made.

In November 1962, the British and French governments reached an agreement to develop jointly a Mach 2.2 transport to be called la Concorde or the Concord depending on which side of the English Channel one resided. Work on this aircraft has been going well and the prototype should be flying in the spring of 1968. The production model probably will be certificated and in airline service sometime in 1971 — perhaps three full years ahead of our model.

The British-French consortium, however, isn't our only competitor. The Russians are also working to develop a supersonic commercial aircraft along the same general lines of the Concorde. The prototype is well along and should be flying by 1968. In fact, some well-informed observers even look for the Russians to spring a surprise and fly the aircraft next year.

The fruits of the U.S. decision to create a Mach 2.7 aircraft, a new dimension in flight and capable of growth to yet greater performance and payload, will unquestionably have a far-reaching impact, not only on the economics of transportation, but on the lives, habits, and even tastes of this world's citizenry, the technical growth of this country, and on national prestige.

Taken in reverse order, one need only to review the past contributions of the U.S. to world commercial aviation in order to foretell the benefits to, and the



General Electric turbojet engine is proposed as the powerplant for the SST.

impact on, national prestige that will accrue as a result of worldwide use of U.S.-produced SSTs.

Since the beginnings of international and intercontinental air transport, the reliability of U.S. aviation products has served as a hallmark of excellence and earned for the U.S. world leadership in civil aviation.

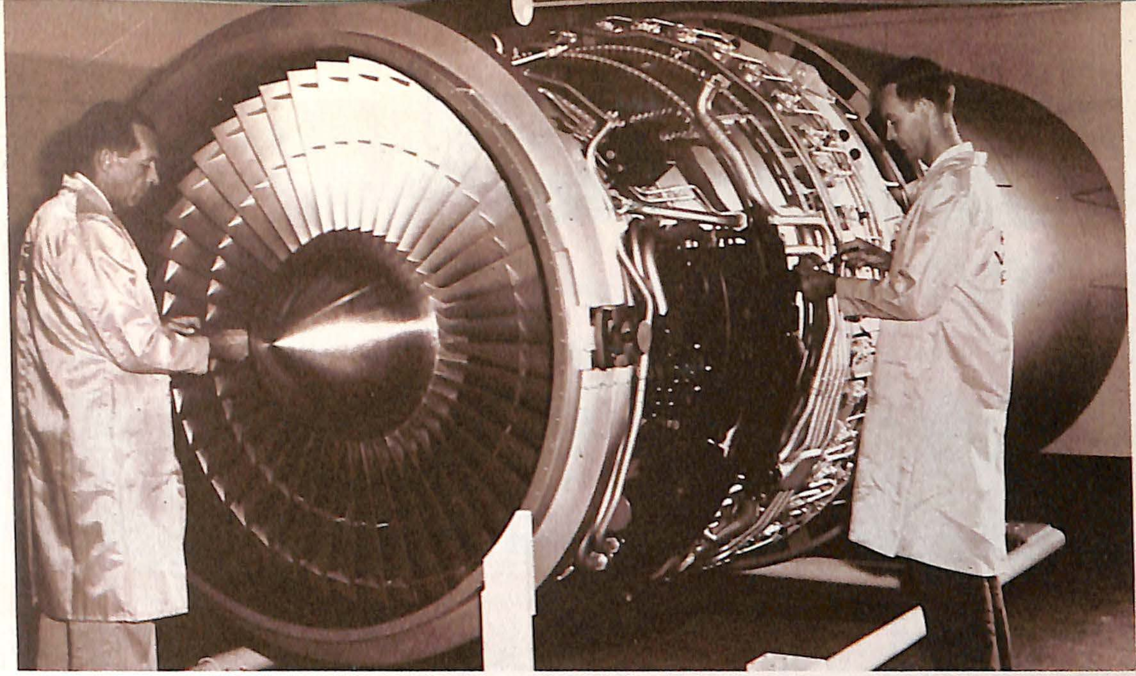
Criticism has frequently been made of a concept that proposes to move travelers at speeds three times that of current jet aircraft. These judgments have generally stemmed from instinct borne of nostalgic memories of the "good old days." The point to be made, however, is that improvements in travel time are not important for speed's sake alone. But increased speed of air travel is important in terms of public necessity and convenience. The SST is not an instrument to manufacture time, rather it is a device to utilize time more effectively. A parallel is found in the computer that solves problems that man has always been capable of solving; the computer simply solves them faster or, in other words, more efficiently and economically. Like the computer, supersonic travel will make the time of the traveler — statesman, businessman or vacationer — more available for his particular goal.

It is in the closely allied areas of economic impact and technology growth that the U. S. development of an SST will be most evident. In a 1963 report to the White House, special Presidential advisors on the SST, Eugene R. Black and Stanley de J. Osborne, succinctly covered this point in concluding that "the economic progress and the security of the nation are closely allied to technological development and achievement, and there is probably no program such as this one which will so challenge the scientific brains of industry and government during the years ahead, and the success of which will produce as much knowledge and as many technical advances, not only for aviation but for the benefits of countless other industries, unconnected with aviation."

The growth of technology resulting from this nation's space program is well known. The national SST program, though small (from a dollar point of view) when compared to the national space program, nevertheless may well have a more immediate impact. The challenge inherent in producing an economically attractive supersonic aircraft has already identified and created demands for improved manufacturing techniques, simple yet reliable electronic and communications equipment, advancements in extrusion and machine tooling techniques, more efficient (and less costly) fuels and lubricants and many other needs. All of these efforts give the promise of by-products that will find application in the manufacture of products unrelated to aeronautics.

The economic aspects are more easily definable.

Concerning the potential market for the SST, varying estimates have been made based on the expected growth of air transportation over the next 20 years and beyond. Even the most conservative is encourag-



Pratt & Whitney supersonic transport turbofan engine mockup.

ing — especially when we remember that just a decade ago the demand for subsonic jets was being grossly under-estimated by many in and outside the aviation business.

Conservatively speaking, we now look for a three-fold increase in long-haul revenue passenger miles flown by the airlines of the world by 1980 and a five-fold increase by 1990. SSTs could carry almost half of this traffic. This could represent a market of approximately 400 aircraft by the 1980s and some 800 aircraft by the 1990s.

In terms of employment, we are talking about at least 50,000 jobs over a period of two decades. Of equal significance is that approximately 60 percent of the value of the production program will be subcontracted and spread across the nation. Eventually some 10,000 subcontractors, suppliers and vendors in 46 states could be involved.

Obviously, the SST program will have a significant impact on the U. S. balance-of-trade position. Based upon past experience along with current encouraging signs, we expect that the export market for a U. S.-made SST will be about half of the total production rate. Over a 20-year period, this could result in a gold inflow approaching $10 billion. Add to this figure another $2 or $3 billion which U. S. airlines might spend for Concordes if a U. S. SST were not available, and the total differential or impact on our balance of trade could be in excess of $12-13 billion.

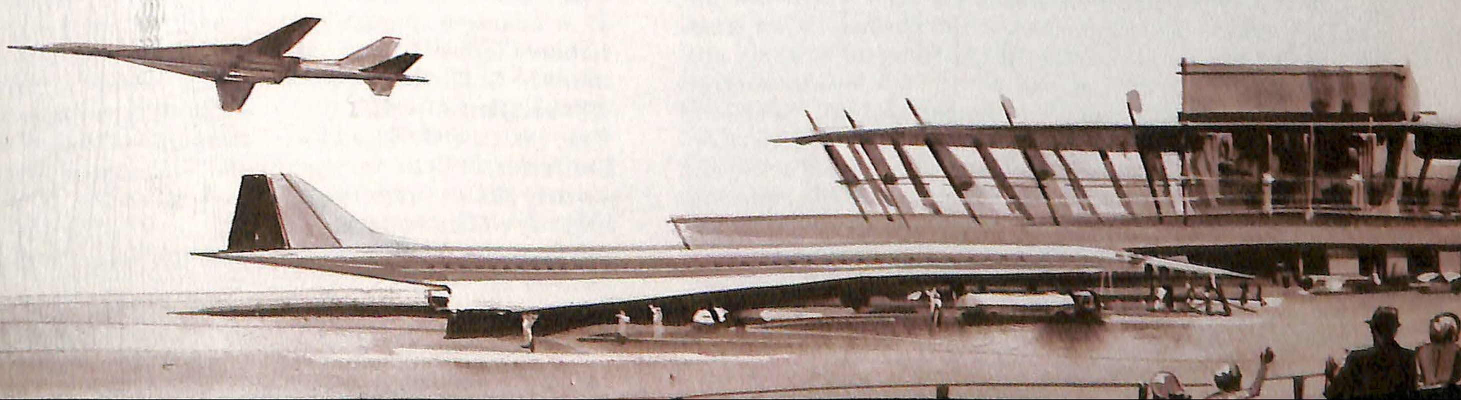
What is the current status of a U. S.-developed supersonic transport? Today, two airframe and two engine manufacturers are participating in this program on a highly competitive basis. The Boeing Company and Lockheed Aircraft Corporation are designing airframes and testing key components. General Electric Company and Pratt & Whitney Division of United Aircraft Corporation are building and testing full-scale prototype engines. All four firms are proceeding under fixed price cost-sharing contracts which run through December 31, 1966.

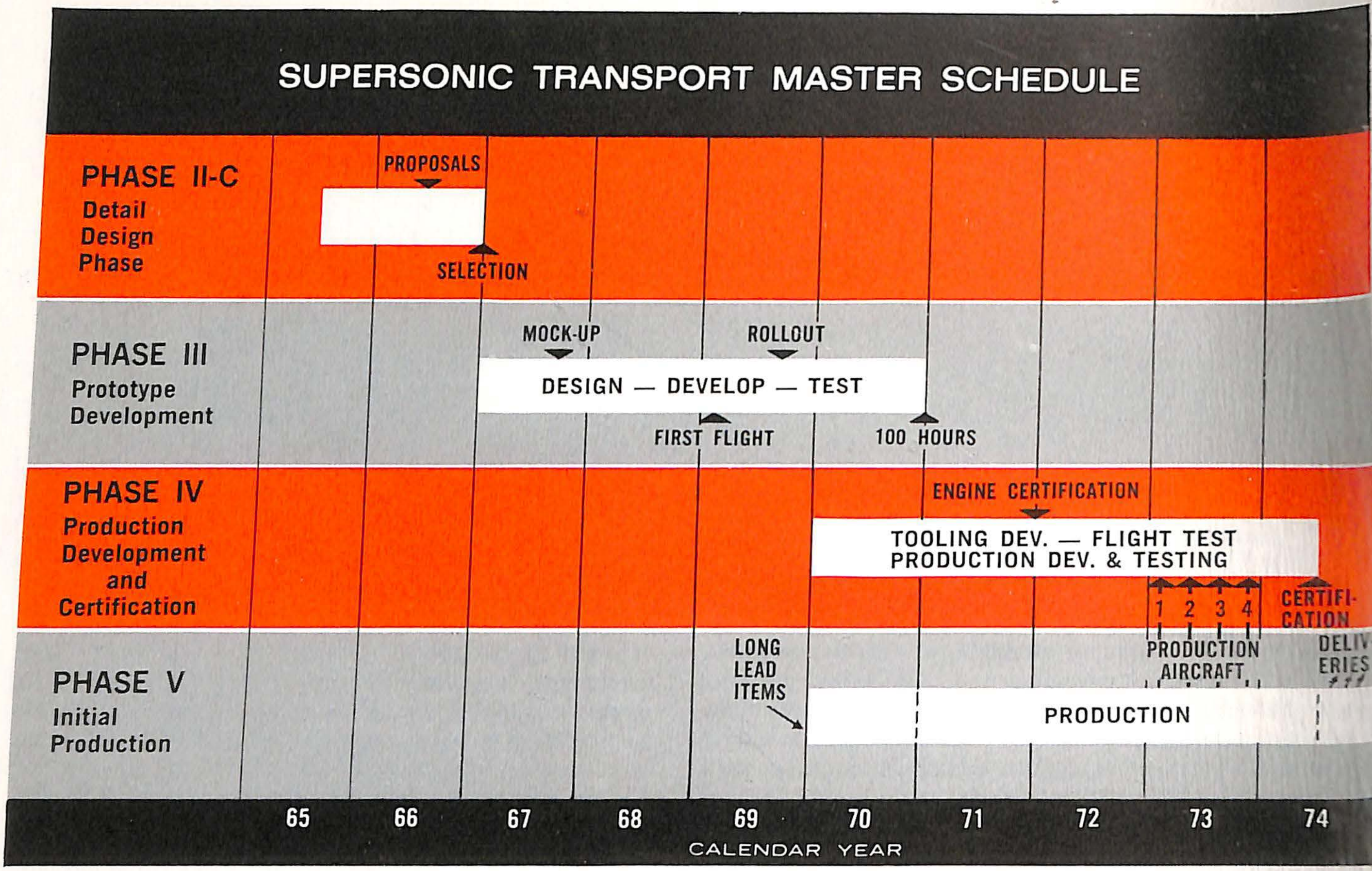
There has been a great deal of misunderstanding concerning the present 18-month detailed design phase. Many have viewed it as a slowdown in program effort.

Actually, there were a variety of sound reasons why a detail design competition phase was a necessary addition. Experience has certainly confirmed the wisdom of the decision.

First, there were technical considerations. One had to do with a more exact definition of prototype configuration which would meet the basic objectives in the areas of payload, performance and profitability. Initial airframe designs fell somewhat short of these objectives and more detail design work was necessary to finalize design of a commercially viable aircraft.

Another technical consideration concerned meeting specification performance criteria for an engine more than twice as powerful as any other commercial engine in the air today yet still retaining the durability re-





quired in commercial service. This is not easy. It was our opinion that the full-scale prototype engines had to be built and tested before a choice of engine manufacturer could be made with the confident expectation of success.

In the financial aspects there was a lot of work to be done before we were ready to start cutting metal. Many fundamental issues had to be resolved before a joint government-industry team could efficiently *share* the cost and responsibility for such a major development program.

Stemming from these studies, a government-proposed plan for financing prototype construction has been submitted to the airframe and engine manufacturers. This proposal is somewhat more flexible than the current 75 per cent government/25 per cent industry cost-share formula. However, terms cannot be discussed until negotiations are completed.

Another significant consideration which made the present phase of the program necessary was the economic environment in which the SST would operate.

Because of the dynamics in the business of air transportation, we have found it necessary to reassess economic impact estimates of a year ago and to contract for studies in the areas of demand analysis, balance of payments effects, and cost studies including development and production costs, airline operations costs, and facility and service requirements. With this information available late in 1966, the necessary decisions can be made based on the best possible foundation of economic knowledge and forecasts.

Final evaluation of the competing airframe and engine designs will begin on September 6, 1966. Signed contracts for prototype construction with the winning manufacturers should be in hand by January 1, 1967.

If all goes well — and the work performed by the airframe and engine manufacturers during the past nine months gives us cause for optimism — the SST prototype will take to the air in late 1969 or early in 1970 to begin an intensive period of testing. At about this time, production development should get underway with the first production model rolling off the line early in 1973 followed by type certification and entry into commercial service by 1974.

It is becoming more and more evident that the SST program is one of the most important the aerospace industry will undertake for some time to come. The program is entirely practical, it is within the state-of-the-art, and it is within the capability of U. S. industry to produce a safe and profitable supersonic transport.

Certainly the opportunity isn't just in profit, although that is not unimportant by any means. The opportunity is in adding to the nation's prestige, in augmenting the nation's industrial capacity and strength and in writing another brilliant chapter of U. S. aviation. It is this combination of challenge — along with an opportunity to break new trails, add new triumphs of ingenuity and industrial skill as well as further the national interest — that has so often in the past fired the U. S. aviation industry to heroic performances.

I have no doubt it will happen again in the development of the SST.

AEROSPACE COMMENTS

Congressman Henry S. Reuss
before the American Institute of Aeronautics and Astronautics

"The space program is a source of immense pride for all Americans. You, the space frontiersmen, have managed, time and again, to do the apparently impossible. You have removed forever the doubts and anxieties we all felt at the time of Sputnik. In less than a decade, you have convinced us that going to Mars is no flight of fantasy but a flight objective we'd better get ready to decide on soon.

"Quite apart from restoring this country's leadership in advanced technology, I believe that you, in the space program, have given us a still unappreciated dividend.

"You have taught us how far we can go when we really harness the Nation's research and development genius to a national goal. In melding the talents and resources of scientists, engineers, industry, and the Government in the space program, you have perfected new ways of thinking through and organizing complicated jobs so that they really get done. The science of systems analysis and management has come of age along with space technology."

Harold Brown
Secretary of the Air Force
before the Air Force Association

"In looking at the future, one cannot be completely confident of very many things. There are a few, however, that seem to me quite certain. I think the world will continue to be full of conflicting interests and that during the next twenty years our own national interests and objectives will have to be supported by military power, as they have been in the past. The security of many other countries, even if some peacekeeping functions should be assumed by international bodies, will depend fundamentally on U. S. military power. So long as our military power is needed, the Air Force will be needed. Twenty years hence, I expect it will be performing new roles, in space and in the atmosphere, as well as functions similar to those of today, though perhaps not in the same way and certainly not with the same equipment.

"Those pessimists who predicted four years ago that the Air Force, as a separate service, was destined to lead the shortest life of any service, or that the airplane was on the way out, have been proven quite wrong. On the contrary, there is every reason to believe that the value and usability of airpower and its missile and space extensions will increase in the years ahead.

"Obviously, we must solve today's problems with what we have. But we must concurrently create the wherewithal for the Air Force — ten, fifteen, and twenty years from now — to support national objectives which in emphasis may be quite different from today. I believe we can do even better in preparing to relate future Air Force capabilities to national objectives than we have done in the past. To do this we need a better model to describe the effectiveness of airpower used in various ways, in various circumstances, and in various amounts."

Senator Vance Hartke
before the International Committee of the Aerospace Industries Association

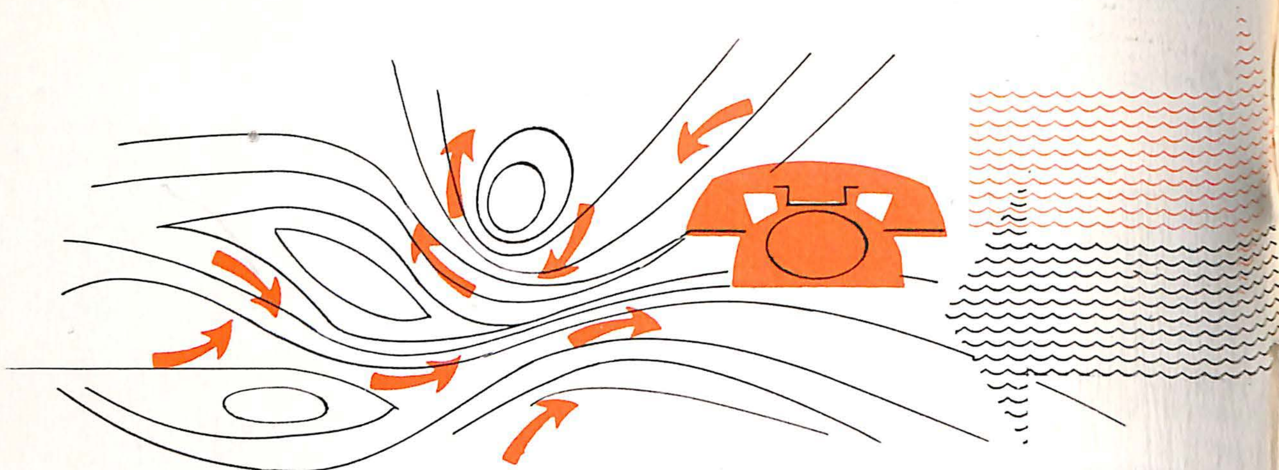
"It is my belief that the primary stumbling block to the promotion of export sales is the lack of available financing. I don't believe there is any industrialized nation in the world, other than the United States, which has failed to develop a rediscount system which permits them to insulate export credit from the gyrations of domestic credit. . . .

"Here in the United States, our export credit rates rise and fall with our domestic rates. When the Federal Reserve Board decides to go it alone on economic policy and increase the rediscount rate, and thereby force up the prime bank lending rates, they increase the cost of every item which must be financed in order to be sold abroad. . . .

"The break between domestic credit and export credit must be made, and it must be complete. I feel it is up to the Congress to provide that break by creating an instrument where an exporter may obtain his export financing totally removed from his domestic banking activities. We must either expand the powers of our own central bank, the Federal Reserve Bank, in this field, or we must create a totally new national export financing institution.

"The type of institution I have in mind would serve as a depository for export paper and would take over the function of issuing export guarantees, which is now being done by the Export-Import Bank and the Agency for International Development. The exporter could bring his export paper to the bank, discount it, and use the funds received to produce the goods to be exported. This would immediately eliminate the long wait between the time the exporter sells his goods and receives payment for them. The exporter benefits because he has immediate cash in hand, and the country benefits because now a Federal institution holds the dollar obligations owed to the United States."

'A Better Life'



Vice President Hubert Humphrey
before the Goddard Memorial Dinner

We must not . . . become so totally fascinated by the wonders of outer space that we neglect the applications of space technology to a better life right here on earth.

I was pleased during my recent visit to the Goddard Space Flight Center to see the successful read-out of the first weather pictures it (ESSA II) sent back. This is a satellite the entire world can tune in on — not only governments but, with a relatively small investment, colleges or even individual citizens.

The time is not distant when we will be able to predict, and predict with accuracy, the weather everywhere on earth. We may even be able to control it —and thus open up many arid portions of the world to cultivation.

Global communication by satellites will become a fact in the very near future. It will be followed by direct broadcast of both voice and TV to home receivers throughout large sections of the world.

In the field of medicine alone, the benefits are already impressive. Improvements in medical instrumentation, resulting from electronic innovations in the space program, are already beginning to revolutionize the equipment of clinics and hospitals. It should be possible to monitor continuously and in detail the condition of hundreds of patients from a single location.

Other direct benefits will come in the form of wideband transoceanic communications, improved forest fire detection, and high accuracy navigation.

We have already made fantastic strides in devising more effective, reliable, and compact electronic equipment with a wide variety of applications. We have developed improved alloys, ceramics, and other materials. And there have been other innovations, such as the accelerated use of liquid oxygen in steelmaking, new coatings for the temperature control of buildings, and filters for detergents.

Our progress in space has already contributed to our national security. The use of communications satellites is backing up our effort in Vietnam.

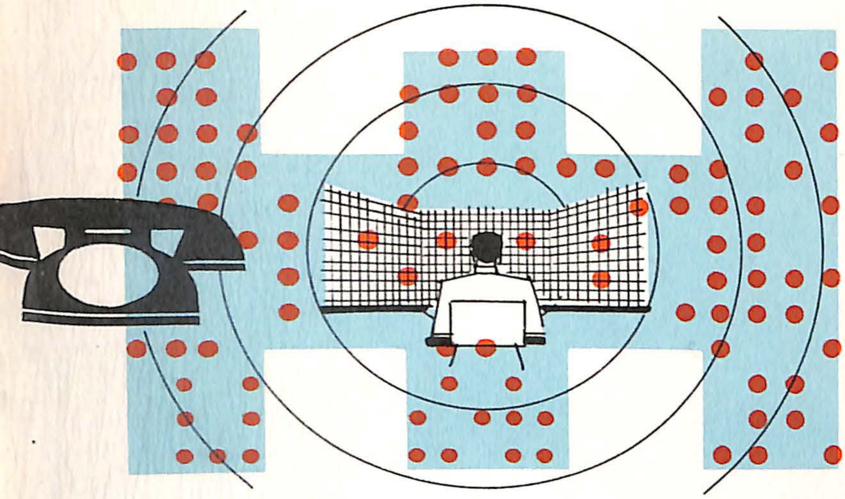
In addition to the support of our armed forces by better communications, our peaceful application of space competence for national security takes many other forms.

Among them are more accurate knowledge of the weather, more effective mapping, earlier warning of impending dangers, and the detection of nuclear explosions in space or in the atmosphere.

There are some who claim, with all sincerity, that the terrestrial relevance of space science and technology has been exaggerated. Concerning this, I would make two comments.

One is to the skeptics outside this hall. I think they have forgotten the fact that this whole field is still only in its infancy. The best is yet to come.

The other is to you. As you constantly enlarge the



horizons of space science and technology, I urge that you be everlastingly alert to recognize those discoveries and innovations which can usefully be applied here on our own planet.

Moreover, it is not only technology that we have developed. Perhaps even more important, we have called into being rich human and intellectual resources — methods, capabilities, insights, and management techniques which can be brought to bear upon problems far removed from space.

In this respect, I want to commend the initiative of private companies and of Governor Brown of California, who have shown the way towards focusing the talents of the aerospace industries on matters as important to our everyday living as traffic congestion and garbage control.

I believe the technique of systems analysis — developed to its highest point so far in the aerospace industries — will be invaluable to us as we face up to the problems of urban life, to the pollution of our waters and our atmosphere, and to many other challenges of today and tomorrow.

I believe those of you here who are in the aerospace industry have a very real obligation to make your capabilities more widely known to state and local officials.

Why you? Because the technical and intellectual capabilities you possess in abundance were made possible by the tax dollars which have supported the space program.

Why you? Because your management and your workers are citizens of many of the communities which will directly benefit from such efforts.

Why you? Because it will be a practical demonstration to the world how democracy and free enterprise function effectively for the common good.

AIA MANUFACTURING MEMBERS

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Aeronca Manufacturing Corporation
Aeronutronic Division, Philco Corporation
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American Brake Shoe Company
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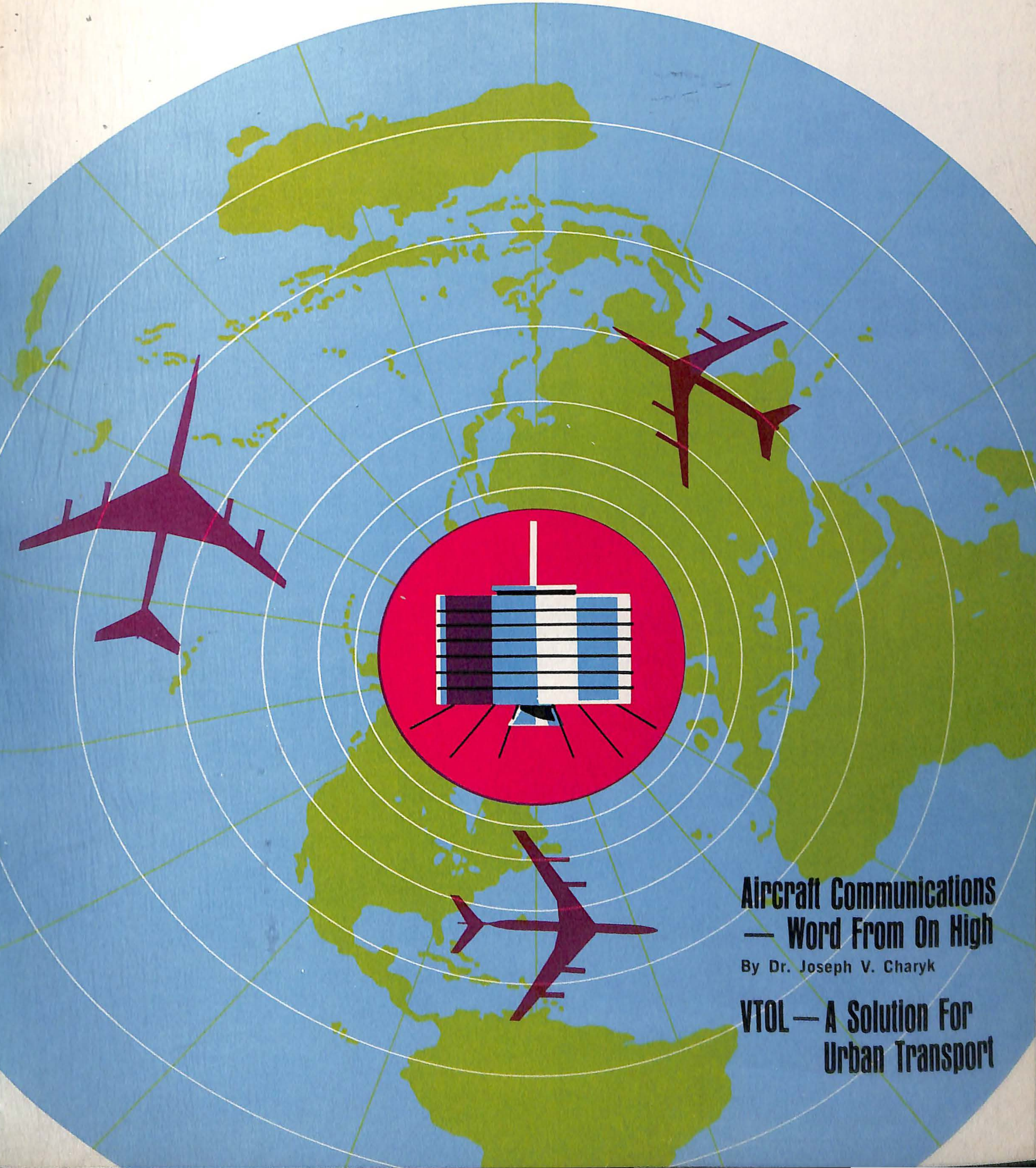
U. S. supersonic transport will create a new dimension of air travel. (See *SST — Supersonic Air Travel,* page 10).

aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION · JUNE 1966



Aircraft Communications — Word From On High

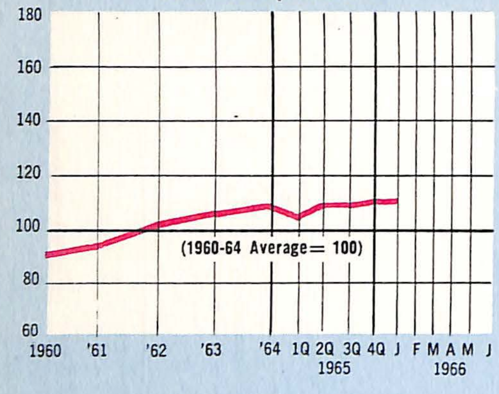
By Dr. Joseph V. Charyk

VTOL — A Solution For Urban Transport

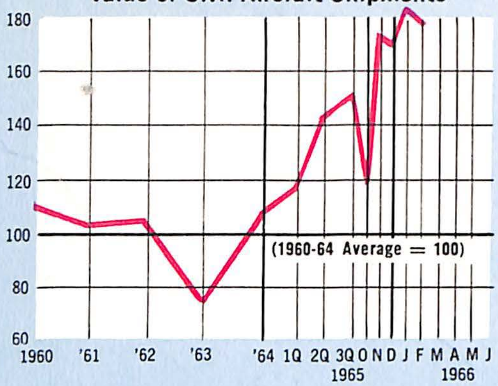
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

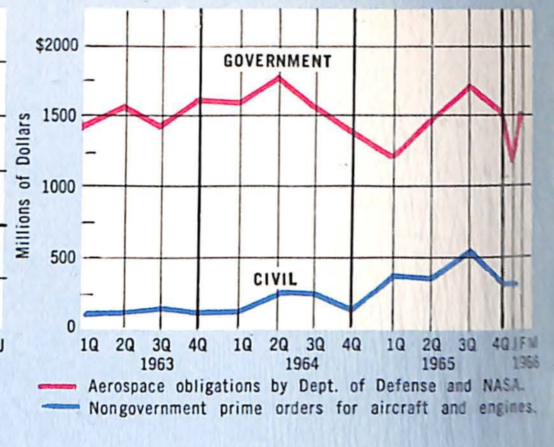


Value of Civil Aircraft Shipments



OUTLOOK

New Orders — Monthly Average



ITEM	UNIT	PERIOD	1960-64 AVERAGE *	LATEST PERIOD SHOWN	SAME PERIOD YEAR AGO	PRECEDING PERIOD †	LATEST PERIOD
AEROSPACE SALES: Total	Billion $	Annual Rate	19.0	Quarter Ending Dec. 31 1965	20.8	20.8	20.9
	Billion $	Quarterly	4.7		4.9	5.2	5.3
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,177	Feb. 1966	664	862	1,172
Aircraft	Million $	Monthly	584	Feb. 1966	390	527	865
Missiles & Space	Million $	Monthly	593	Feb. 1966	274	335	307
Aerospace expenditures: Total	Million $	Monthly	1,098	Feb. 1966	736	945	1,056
Aircraft	Million $	Monthly	560	Feb. 1966	376	546	630
Missiles & Space	Million $	Monthly	538	Feb. 1966	360	399	426
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	183	March 1966	527	324	345
Expenditures	Million $	Monthly	143	March 1966	367	367	428
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	633	Apr. 1966	1,082	1,495	1,385
Value	Million $	Monthly	13	Apr. 1966	27	36	34
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	14.1 #	Quarter Ending Dec. 31 1965	15.2	18.7	20.4
U.S. Government	Billion $	Quarterly	11.1		11.7	12.7	13.7
Nongovernment	Billion $	Quarterly	3.0		3.5	6.0	6.7
EXPORTS							
Total (Including military)	Million $	Monthly	107	March 1966	152	154	139
New Commercial Transports	Million $	Monthly	23	March 1966	49	39	55
New Utility Aircraft	Million $	Monthly	2	March 1966	6	6	9
PROFITS							
Aerospace — Based on Sales	Percent	Quarterly	2.1	Quarter Ending Dec. 31 1965	2.7	3.6	3.5
All Manufacturing — Based on Sales	Percent	Quarterly	4.6		5.4	5.4	5.7
EMPLOYMENT: Total	Thousands	Monthly	1,128	Feb. 1966	1,117	1,215	1,230 E
Aircraft	Thousands	Monthly	507	Feb. 1966	437	504	514
Missiles & Space	Thousands	Monthly	490	Feb. 1966	511	540	545
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.87	Feb. 1966	3.13	3.36	3.35 E

E Estimate
* 1960-64 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 1961-64.

Virtually every aerospace economic indicator is now considerably higher than for the comparable period in 1965. This trend supports predictions for a substantial increase—more than $1 billion—in industry sales this year over 1965. The key indicators show:

■ Aerospace sales—the economic bellwether—are anticipated to rise to more than $22 billion in 1966 compared with $20.9 billion in 1965. Sales to the Department of Defense are expected to increase to $12 billion, non-government to $3.5 billion, non-aerospace to $2.3 billion, and the National Aeronautics and Space Administration and other government agencies sales to decline to $4.3 billion. A recent survey by the Aerospace Industries Association of selected aerospace companies confirmed these estimates, and there are indications that these sales estimates may be conservative.

■ Aerospace employment in the first two months of 1966 averaged 1,223,000 compared to 1,121,000 in the first two months of 1965, an increase of 102,000. An employment survey made by the Association indicated that aerospace employment should rise to 1,266,000 this month primarily as the result of increasing demand for aircraft and related products.

■ Expenditures by NASA on research and development for the first three months of 1966 totaled $1,173 million, substantially more than the $1,022 million in the first quarter of 1965. However, these expenditures are expected to level off in mid-1966. Funding levels for forthcoming programs indicate that this decline could be brief.

Aircraft shipments for the first two months of 1966 averaged $170.1 million compared to $95.5 million for the same 1965 period. Orders for jet aircraft totaled at the end of 1965 almost $4 billion with $1.9 billion anticipated for delivery in 1966.

■ Utility aircraft shipments for the first four months of 1966 are over 50 percent above the same period in 1965. Utility aircraft shipments in the January-April period during 1965 were $89.1 million whereas in the 1966 period they were $134.4 million. The number of utility aircraft shipped also increased from 3,724 in the first four months of 1965 to 5,240 in the first four months of 1966, an increase of over 40 percent.

These industry indicators, coupled with a record backlog of $20.4 billion at the end of 1965, are positive signs of expansion. The level of aerospace profits, although low in relation to all manufacturing, is up from the 2.7 percent of net profit after taxes in the fourth quarter of 1964 to the 3.5 percent in the fourth quarter of 1965.

The growing level of capital investment currently taking place in the aerospace industry is another indicator of growth. An independent survey showed an anticipated rise in capital investment from $410 million in 1965 to a planned $820 million in 1966 for aerospace companies, a 100 percent increase.

AIA

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CONTENTS

The purpose of AEROSPACE is to:

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

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

Foster understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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.

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AIRCRAFT COMMUNICATIONS

—Word From On High

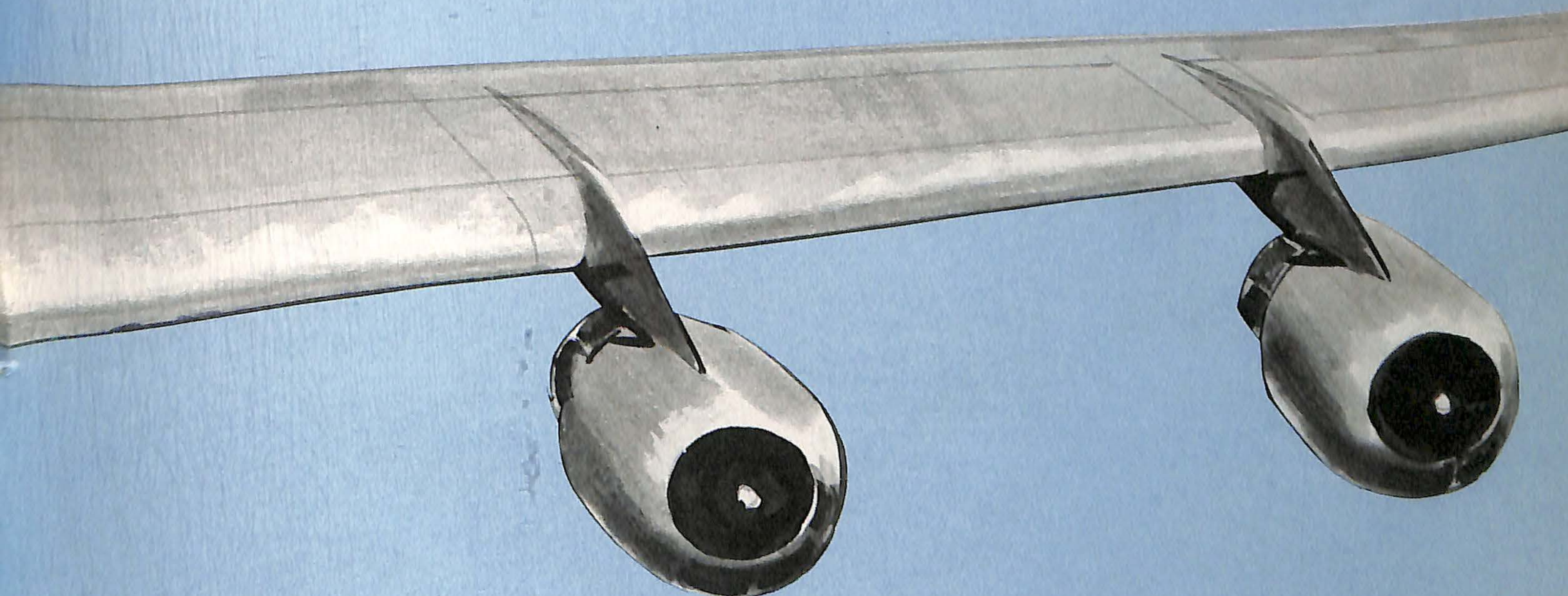
BY DR. JOSEPH V. CHARYK
President
Communications Satellite Corporation

The impact of satellite communications upon the world may well be the most difficult to predict of any development that has occurred in modern times. In less than one year of limited commercial operations, satellite technology and the uses to which it might be applied already exceed what anyone would have predicted a year or so ago.

Our thinking today is unlikely to be able to define with any precision the uses to which communications satellites will be put five years from now.

Some people have the opinion that satellites afford simply another supplementary or complementary means of communications. This is comparable to describing the advent of airplanes as affording simply another supplementary or complementary means of transportation and completely missing the vast civil and military implications that have accompanied the growth of air power.

An instantaneous communications capability for oral, visual and electronic messages on a global scale will,



in due course, have a profound influence on the political, economic and social relationships between the countries of the world.

Who can predict the impact it will have upon a single industry? The aerospace industry is a good example. We are now proposing, for instance, a satellite over the Atlantic to be deployed next year for the purpose of providing high quality voice communications between commercial aircraft flying the heavily-traveled North Atlantic routes and appropriate control centers on both sides of the ocean. About 70 U. S. and overseas aerospace companies were invited to submit proposals for developing the satellite.

Some of the leading international airlines agree that satellites appear to offer the best prospects for solving their communications problems. Pan American World Airways, for example, has installed test equipment on some of its regular jet aircraft and participated in successful satellite communications tests.

The aerospace industry is already moving ahead to coordinate equipment specifications for use with satellites. At the recent Airlines Electronic Engineering Committee meeting, Richard N. White, manager of Trans World Airlines' electronics development office, was named chairman of a subcommittee that will write specifications for the airline industry for the airborne electronics needed for satellite communications. The subcommittee's first meeting is scheduled to be held this month in Washington.

Satellite communications for aircraft is expected to be actively discussed at the International Civil Aviation Organization meeting in Montreal this fall. Hopefully, an internationally-agreed system standards for aircraft satellite communications can be established at this meeting.

Many U. S. airlines, including TWA, Pan American, United Air Lines, Eastern Airlines, American Airlines and Northwest Airlines, are eager to get airborne specifications for equipment written as a companion to the establishment of the system standards. This is the responsibility of the FAA domestically, and ICAO internationally.

The Federal Aviation Agency is currently evaluating our proposal to furnish satellite communications over the Atlantic for traffic control instead of pursuing an intermediate phase that would involve the use of single side band radio. Eventually, it seems certain that aircraft must turn to satellite communications. Nearly two years ago at the Annual Assembly Meeting of the Radio Technical Commission for Aeronautics, the FAA stated, "it appears that the only promising means for adequately achieving the reliability, fast access time, and capacity needed after 1970 is through the addition of a satellite relay."

Using today's state of the art, there seems little question that satellites can immediately provide clear and reliable communications between aircraft and traffic control centers. It is needed; and that need is growing every day as the number of flights increase and aircraft fly faster. There are about 5,000 flights a year over the North Atlantic with this expected to double over the next few years.

The immediate need for aeronautical satellite communications is on the long transoceanic flights, particularly over the North Atlantic. As aircraft fly across the middle sector of this route, atmospheric disturbances often disrupt communications to the point where it sometimes takes twenty to thirty minutes to establish contact between the pilot and the traffic controller. It isn't unusual at all for pilots to hunt over several frequencies before getting a message through.

Improving this situation in itself is highly important. It is vital if data links to aircraft are to be established. Data transmission cannot tolerate the garbled quality of communications.

Obviously, there are many problems to be worked out before aeronautical satellite communications are a reality. But none of them seems too difficult. We are proposing to build a special satellite that will use a microwave link between the ground stations and the satellite. The communications signal will be translated into the very high frequency band in the satellite and transmitted to the aircraft on this frequency. The reverse will occur for aircraft communications back to the earth station. They will be sent from the aircraft to the satellite on the VHF band, then shifted to microwave for transmission to the ground station.

A Pan American transport was utilized in the first series of experiments to prove that two-way communications can be carried on between an aircraft in flight and a ground station via a satellite relay.

Just how much it will cost to outfit aircraft to work with the satellites depends upon the equipment they now have. At the most, it should not run more than $30-40,000, if all new equipment were to be installed. For companies that already have modern equipment in their planes it will be much less.

There are fringe benefits to the system, too. Aircraft, at least initially, are expected to only use the satellite for communication over the ocean areas, then

Future uses of a communications satellite could be commercial telephone operations to ground points while an aircraft is in flight.

shift to their regular tropospheric scatter system as they near their destinations. Because of the more powerful equipment needed for satellite communications, this is expected to improve regular communications when the equipment is used for this purpose, by increasing the range and quality of the transmissions.

Our initial proposal is to put up a satellite in synchronous orbit over the Atlantic with only two to four channels of capacity. A backup satellite would be held in readiness if the primary one should fail. These satellites would be used almost exclusively for air traffic control, with the possibility that some messages of mutual interest to the airlines and traffic controllers would be exchanged. We estimate that, even initially, service could be provided at a cost of about $150 per flight.

After some operating experience has been obtained, there is no reason why the system cannot be expanded to provide many other services. It may be possible to automatically monitor much of an aircraft's performance via computers through satellite communications links, giving companies information on logistics and maintenance requirements long before the aircraft arrives at its terminal.

Flight instructions, weather information, and other data could be transmitted to the pilots by traffic controllers, eliminating the need for pilots to get this information by voice and copy it down as is now the case. These are just a few of the things that satellite to aircraft communications may bring. The airline companies themselves, and the traffic controllers, quite likely envision many other uses.

We may find that it will always be necessary to build special satellites for aircraft communications. At this point, we aren't sure. It is possible that this type of communications service may be included in the huge multipurpose satellites that we are already planning. These will have the capacity for at least 6,000 voice channels. A block of this capacity possibly could be reserved for aircraft use.

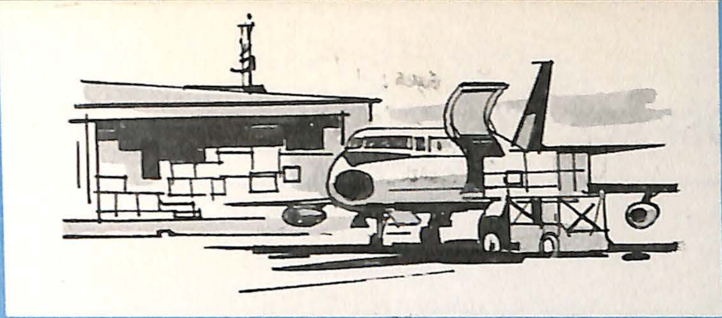
If this should prove desirable, then any of the specially built aircraft communications satellites that were already in orbit could easily be shifted to another area of the world for aircraft use. Syncom II was first orbited over the Atlantic, then moved to the Pacific, and finally shifted over the Indian Ocean.

This flexibility is part of the attractiveness of satellites. As technology improves, new satellites can be built and the old ones moved to other locations and still be used. Similarly, additional satellites can be added over a particular area of the world if additional capacity is needed.

It is our view that we should begin with an aeronautical communications satellite over the Atlantic; then we feel certain such satellites will be added over the Pacific and Indian Ocean. If there is a need for added coverage over polar routes, other orbits would have to be used. For example, if three satellites are placed in a figure 8 pattern that comes with inclining the orbit, at least one satellite would always be in the correct position to provide communications coverage.

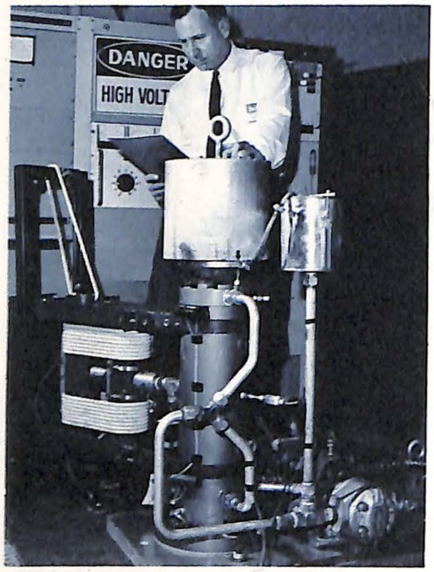
Economics demand that selection of the orbital stations for the aeronautical satellites be done prudently. In the Atlantic, this isn't much of a problem. But in the Pacific if the region between the mainland and Hawaii is adequately served by other means, the Pacific satellite could be moved farther west to encompass the Indian Ocean.

These, however, are merely details. The important point is that satellites can already provide a valuable contribution to aircraft communications. Technological improvements from the aerospace industry are sure to increase their use. We are working on improvements and the National Aeronautics and Space Administration will be making important tests with their ATS-B satellite, particularly in the area of antennas. The combined results are sure to bring revolutionary changes in aircraft communications over the next few years.



AIR CARGO WORKSHOPS

Shippers and air cargo carriers will have their first opportunity to discuss mutual problems in a series of roundtable workshops in five cities of the United States this fall. ■ With air cargo business rising sharply, there is a need for discussions to establish a channel of communications between industrial traffic managers and the airline cargo carriers under the aegis of the Civil Aeronautics Board. ■ Sponsored jointly by CAB and the National Industrial Traffic League, which is the national association of more than 3,000 U.S. shippers, the two-day workshop sessions planned will feature speakers from top industrial management, CAB, and traffic managers from various industries. Everyone attending will have the chance to participate fully in the discussions. Visits to air cargo or air terminal facilities will also be included during the sessions. ■ Roundtable discussions will center around the service requirements of shippers and the capabilities of air carriers to meet them; an analysis of air carrier rate publication procedures, role of the CAB, and shipper participation and contribution to the rate-making process; the economics of air shipping; and an examination of international air shipping services. ■ The first workshop is scheduled for September 20-21 in Seattle, Wash., under the chairmanship of Marvin E. Burke, president of Sportcaster, Inc., of that city. CAB Vice Chairman Robert T. Murphy and William L. Bush, director of transportation for the Weyerhauser Company of Tacoma, Wash., and vice president of NITL, will be the principal speakers. ■ The second workshop will be held in Miami, Fla., October 17-18, under the chairmanship of Roland A. Smith, manager of the Greater Miami Traffic Association. Speakers will be John G. Adams, member of the CAB, and W. L. Murph, Jr., assistant vice president of the Cannon Mills Company, Kannapolis, N.C., and vice president of NITL. ■ The third workshop is to be held October 20-21 in New York City under the chairmanship of R. C. Waehner, general manager of distribution for Lever Brothers Company. Speakers will be G. Joseph Minetti, CAB member, and C. H. Wager, general traffic manager for Shell Oil Company, and NITL president. ■ The fourth workshop is scheduled for October 31-November 1 in Chicago under the chairmanship of H. O. Mathews, vice president, transportation and distribution of Armour and Company, and NITL board chairman. CAB Chairman Charles S. Murphy and Mathews will be the chief speakers. ■ The final workshop in this regional series will be held in Los Angeles November 3-4 under the chairmanship of W. E. Maley, director of distribution for the U.S. Borax and Chemical Corp., and vice president of NITL. Speakers will be Whitney Gillilland, CAB member, and Maley. ■ W. Fletcher Lutz of the CAB is executive chairman of the workshops; Bradford H. Smith of CAB is Logistics Coordinator; Allen J. O'Brien, director of Traffic Service, Aerospace Industries Assn., is program subject coordinator; and Jack Yohe of CAB is information chairman. ■ Registration fee for the workshops is $25. Further registration information will be circulated soon through trade journals, news media and by direct mail.



Boeing's Big Vibrator May Revolutionize Shake Tests

Research engineers at The Boeing Company have developed a simple, reliable hydraulic vibrator which they believe may revolutionize vibration testing throughout industry. By using electric voltage to change the viscosity of hydraulic fluid, this 32-inch long, 155-pound testing apparatus can be employed to shake-test some of the largest components.

The new vibrator has but one moving part, an output shaft. This can be attached either to the part to be tested or to a framework which holds the part. When an electrical field in certain chambers of the vibrator thickens the hydraulic fluid, the shaft moves in one direction. Free flow is stopped and pressure is built up instantly within these chambers. By changing the voltage to the opposite chambers, the original pressure is released and pressure built up anew in the opposite chambers. This change, occurring within a fraction of a millisecond, causes the output shaft to reverse its position.

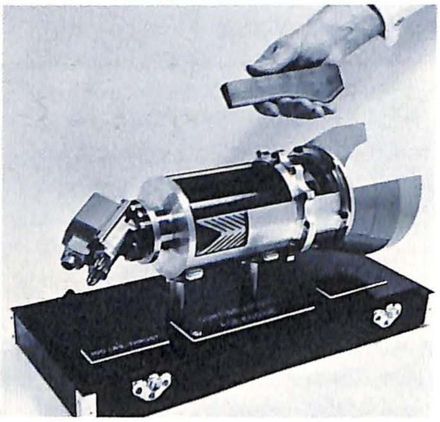
A prototype vibrator has produced 3,500 pounds of static force and 2,200 pounds intermittent force at 1,000 cycles a second.

The electric-field valving principle may eventually be applied in shock generators, sonic generators and high-performance hydraulic servo valves.

Pyrolitic Graphite Wedge Used in 100-Pound Thruster

A 100-pound thrust attitude control rocket engine which uses pyrolitic graphite is being built by Curtiss-Wright Corporation for the National Aeronautics and Space Administration's Manned Spacecraft Center at Houston, Tex. It is an axially-cooled engine which can accommodate the hotter, high energy propellants without weight or "lost fuel" penalties.

A wedge of pyrolitic graphite fits into the combustion chamber and nozzle. The high conductivity of the material combined with a spray-cooling technique, permits essentially unlimited continuous or pulsed operation without efficiency or weight penalties inherent in



present reaction control systems.

Studies of the concept, says Curtiss-Wright, based upon the present state-of-the-art, indicate the engine is scaleable up to 1,500 pounds of thrust.

With an eye toward controlling escalating spacecraft weights, a number of studies and development programs are being conducted to develop high-energy propellants which in turn will reduce the amount of on-board propellants required for total mission performance of future vehicles.

IBM Develops Computerized System for Air Controllers

To enable ground controllers to better manage air traffic, International Business Machines Corp. is developing for the Federal Aviation Agency a computerized system to record and process flight plan and position information for air traffic controllers. Objective is a nationwide automatic system to make air traffic control information available to controllers from takeoff to landing.

To test the new system, large-scale simulation of typical air traffic control problems will be conducted at FAA's Atlantic City, N.J., facility. Field implementation of the system will be tried out at Hilliard, Florida.

Principal equipment for receiving, processing and distributing data is located in the central complex being developed around the IBM 9020 data processor. Because of its modular design, the complex can be expanded as the need for more computing capacity and storage develops. If the module should fail, it is automatically disassociated from the operating system and replaced by a spare module while remaining units continue to function.

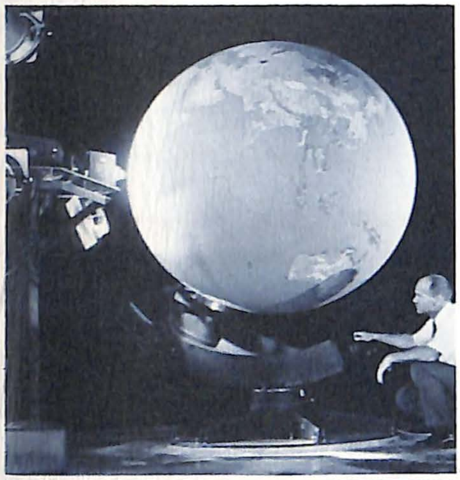
Bendix Makes Breakthrough With Deep Sea Transponder

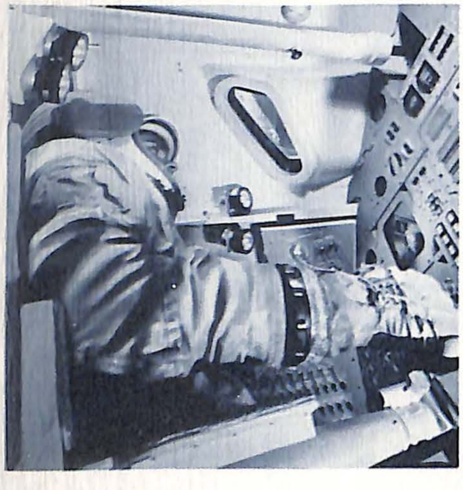
The Bendix Corporation has made what it considers to be a major breakthrough in underwater electronics by developing a deep ocean transponder which after three years of submersion at a depth of 6,000 feet is still returning signals.

Designed for a year's test off the California coast, the transponder has been interrogated at regular intervals since it was placed on the ocean floor some 29 miles off Point Hueneme April 6, 1963. In recent tests, the transponder was returning signals almost as strong as when it was first placed on the ocean floor.

Bendix attributes its long life to a lead acid battery, its power source, which maintains low temperatures, keeping internal self-discharge to a minimum. Undersea pressures hold gassing to low levels and produce intimate contact between electrolytes and the plates.

The transponder is triggered by a sound signal transmitted through the water from a surface ship or submarine and replies by answering the signal. The time interval between transmission and reception is measured and converted into distance, providing the ship with an accurate indication as to its position in relation to the transponder.





NAA Simulates Space Flight Motion for Apollo Tests

North American Aviation has developed the only existing facility that can simulate space flight motion with a man in an Apollo capsule who can operate a prototype stabilization and control system and a prototype guidance navigation system.

Developed originally as an engineering tool for the design of NASA's Apollo spacecraft command and service modules, it performs all essential functions of command service module systems for the earth orbital phase of the lunar mission. Apollo astronauts are scheduled to check out the facility by simulating a moon voyage.

The simulation complex includes an Apollo "space table," called a "dynamic motion simulator," which sways and pitches like a spacecraft in flight in response to commands of the Apollo test crew or the automatic control system. It rotates and inertial sensors detecting the motion relay signals to the flight crew instrument panel.

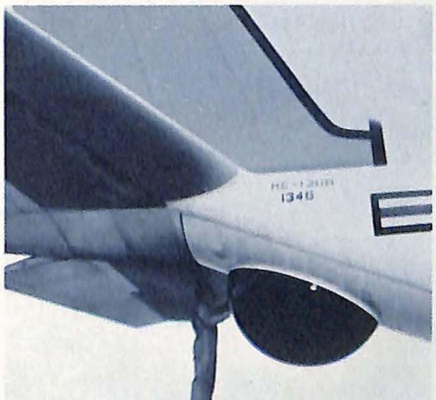
The command module wooden mockup has the equipment needed to provide the flight test crew members with a realistic environment. It is full scale, has three flight couches and a complete set of controls and displays, most of which are operational.

Iceberg Detection System Developed by Sperry Rand

Sperry Microwave Company Division of Sperry Rand has developed a radiometric iceberg detection system to be installed on aircraft which is currently being flown by the Coast Guard on ice patrol from Argentia, Newfoundland.

Revolving dish detectors, housed in a dome jutting from beneath the tail of the aircraft, scan the sea taking continuous readings of the microwave thermal energy. All objects emit this energy, the amount depending on their temperature and surface characteristics. An iceberg has a distinct "signature" which the operator can identify.

Scientists and engineers at Sperry are actively investigating its application in other areas, including geological surveying, ship and aircraft navigation, air pollution control, and all-season weather forecasting.



Douglas Uses Fizz Tablet In Fuel Tank Slosh Tests

While watching his young son's toy boat sail around the bathtub under the steam of an effervescent pill, a Douglas Aircraft Company laboratory technician came up with the idea of placing a common effervescent tablet into a propellant tank to determine the amount of sloshing occurring in space rockets.

Researchers have found that the fizz stream from the tablet provides a quick, accurate look at such behavior from the bottom to the top of a liquid column. They can tell from the fizz stream the degree and extent of fluid agitation from the bottom up giving a kind of X-ray picture of the action.

This information has helped them to install sensors and anti-sloshing devices, such as baffles, more scientifically inside the fuel tanks and on the rocket.

Douglas estimates that use of the tablet has saved approximately $2000 in engineering man hours and additional materials that would have been required for more complex testing.

Titanium Rivets Cut Weight In Lockheed C-5A Fanjet

Though heavier than aluminum size for size, the use of titanium rivets will cut more than 7,500 pounds from the C-5A fanjet that Lockheed-Georgia is building. The explanation is that the greater shear strength of titanium fasteners permits use of smaller sizes, aluminum alloy structures of lesser gauges to meet static and fatigue requirements and allows flanges with smaller widths.

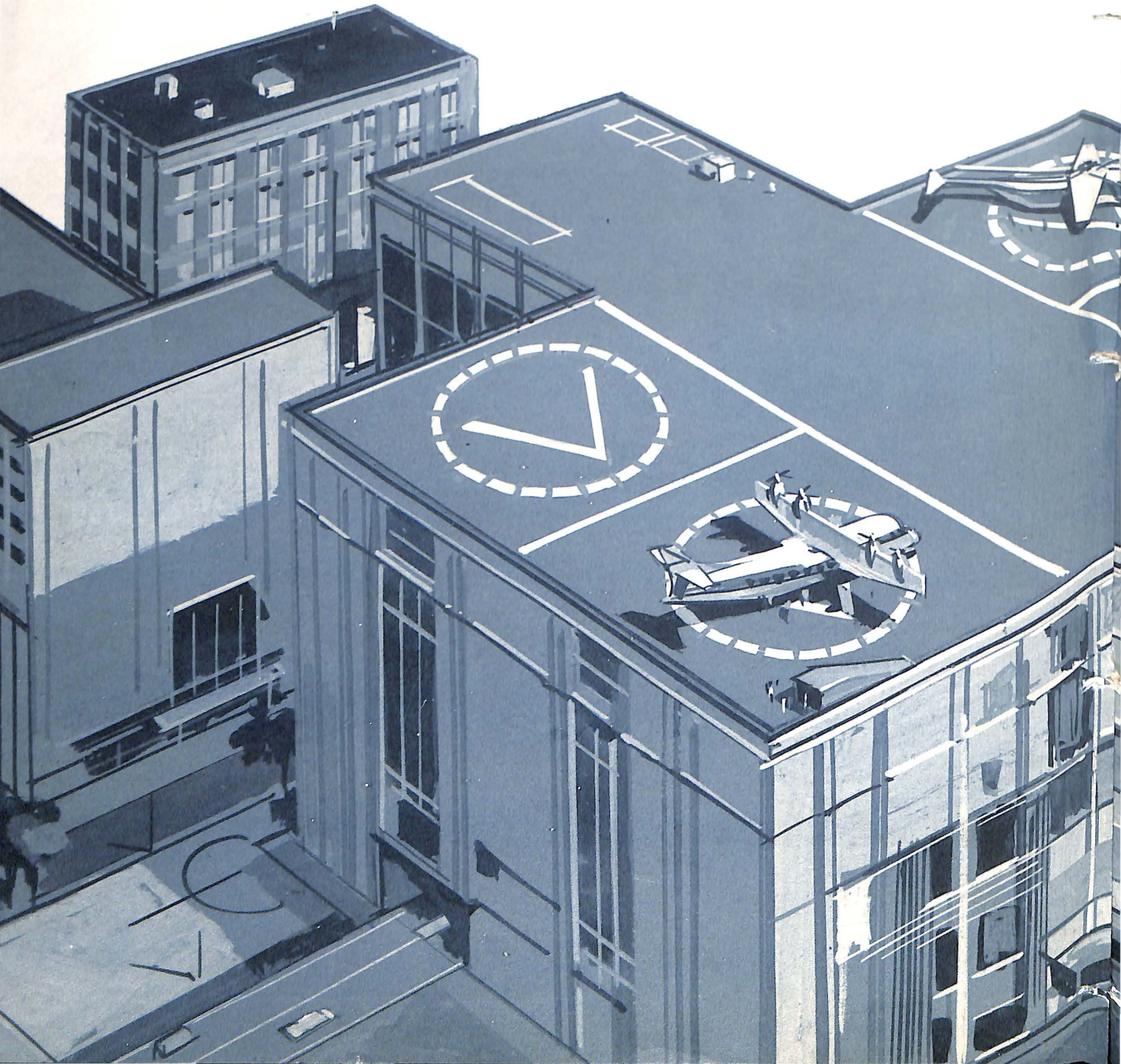
Titanium is also being used in engine bleed air and anti-icing ducts which will cut 200 pounds per airplane. Nylon screws in trim attachments will save 20 pounds, microminiaturized engine instrumentation, 32 pounds, and welded tubing joints, 200 pounds.

And in the C-5A's electrical system, where output is 50 percent greater than in the Lockheed C-141, its total weight will be 20 percent less.

At the start of the C-5A program, Lockheed-Georgia solicited pound-paring ideas from prospective subcontractors and suppliers resulting in 15 firms responding with 151 suggestions.

VTOL

A SOLUTION FOR URBAN TRANSPORT



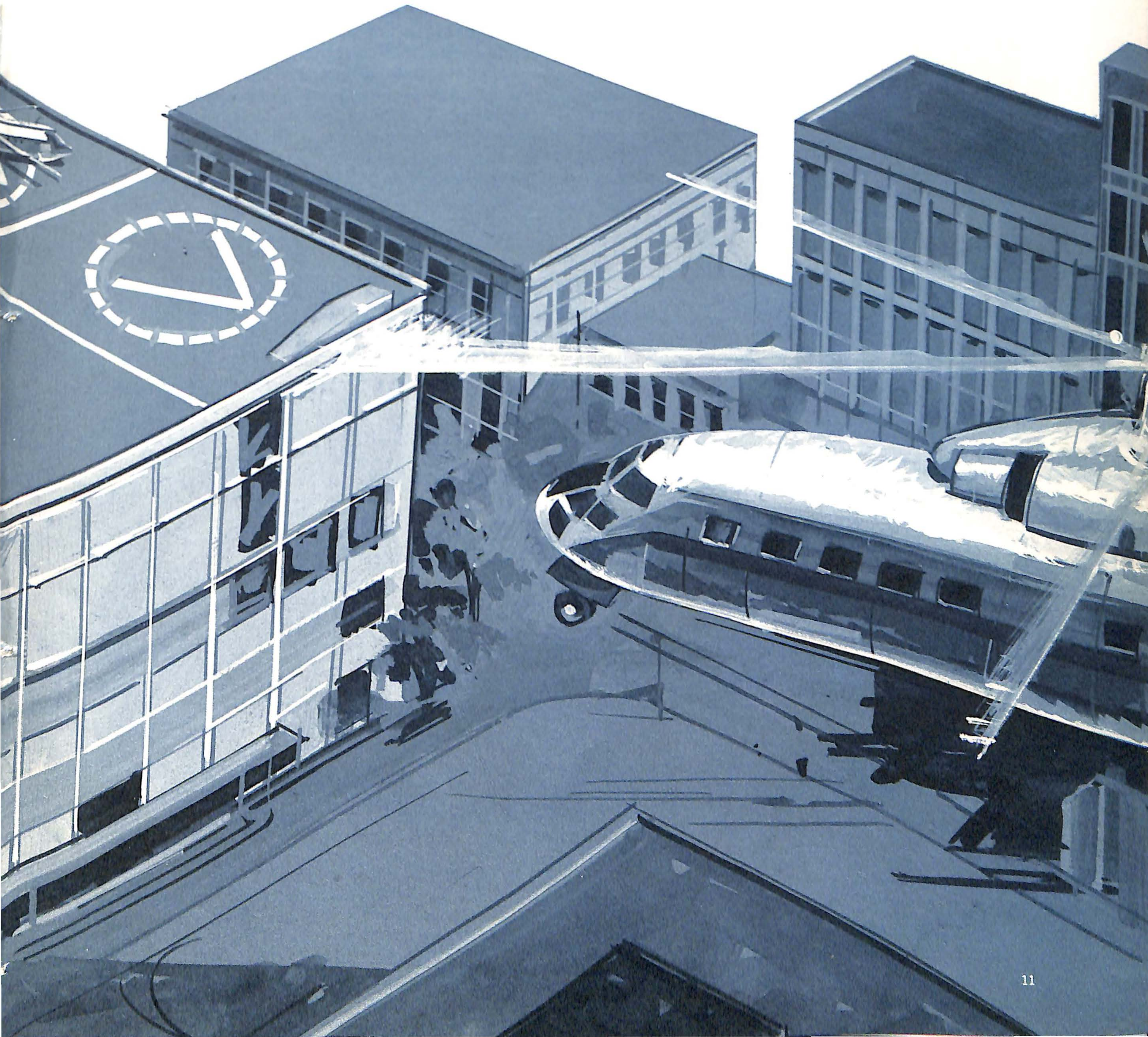
Public transportation capable of handling today's expanding and highly mobile population within and among large cities poses a major predicament for federal and urban officials.

Oceans and continents today can be spanned by aircraft in a matter of hours; it still takes the same time to reach a city only a few hundred miles distant because of ground traffic congestion. And the situation is destined to become much worse before any improvement is evidenced.

Long mindful of the problem, vertical lift aircraft manufacturers have been advancing the state-of-the-art of the VTOL (vertical takeoff and landing) aircraft to the stage where it will be feasible by the mid-1970s to provide a practical VTOL transportation system for the American commuter that will be economically competitive with conventional methods.

Aerospace Industries Association's Vertical Lift Aircraft Council recently released a report — The Economies of VTOL Systems — prepared for presentation to the Governmental Task Force on Interurban Air Transportation which provides an analysis of current and projected VTOL capabilities as applied to this short-haul market.

The Council points out that "the middle spectrum of transport airplanes is well developed and the supersonic transport program ultimately will complete the upper limits. VTOLs will complete the lower end of



VTOL

this spectrum and by doing so provide one of the most economical solutions to the short-haul problem."

Five years ago, advanced verticraft such as the tilt-wing, the fan-in-wing, the quad duct, the stopped rotor composite, the hot cycle compound and high-speed rotor wing were concepts. The promise was there but so were the technical problems.

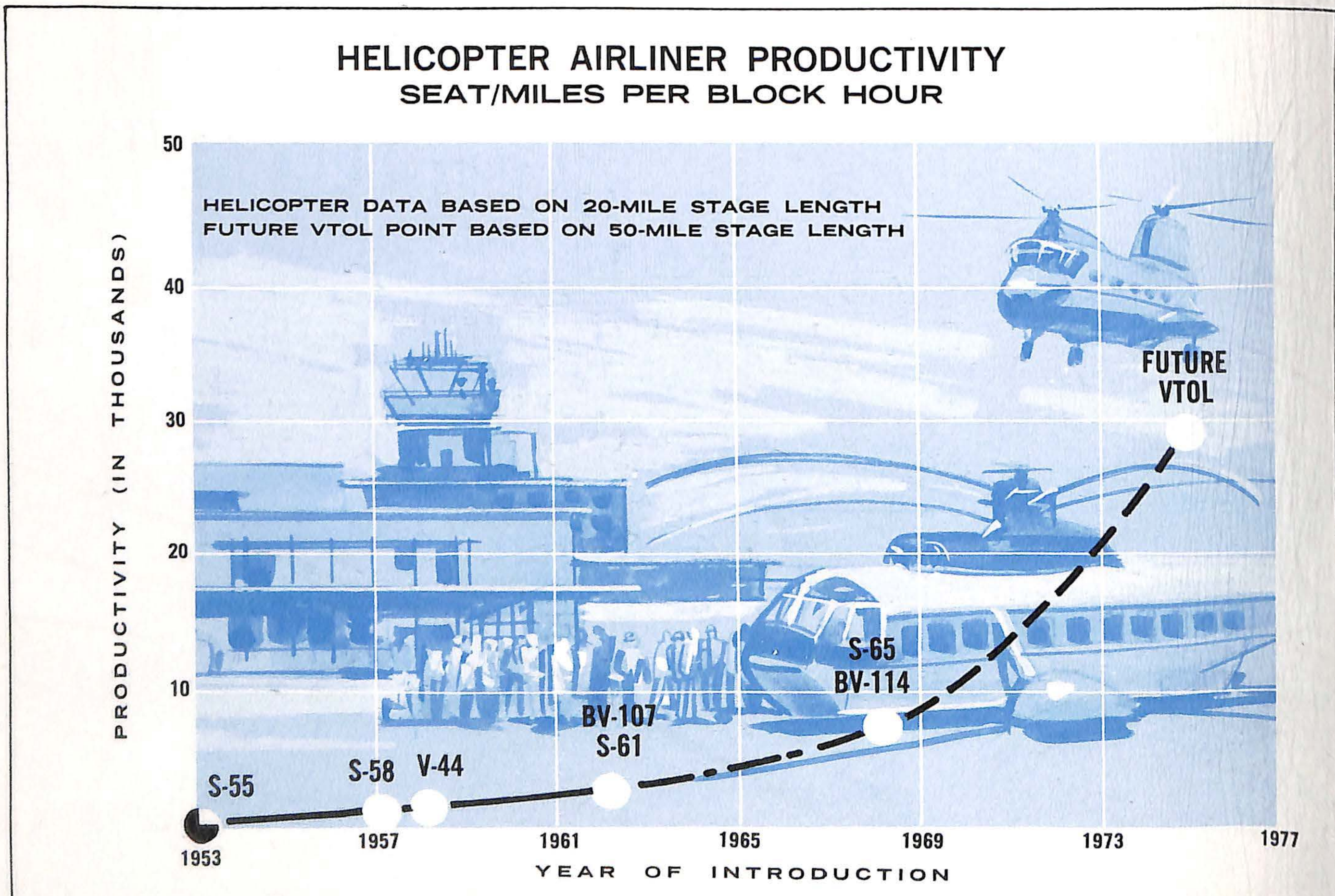
Today basic engineering problems have been solved. VTOL technology as it applies to the civil short-haul interurban commuter has reached a high point.

The VTOL system envisioned by the Council features fast verticraft quiet enough to be good neighbors when operating from close-in V-ports at city waterfronts or at city circumferential highways where it would connect with ground public transportation.

Ready acceptance by the public seems assured because VTOL service will greatly reduce the travel time on trips ranging up to 200 miles.

Economically, the Council sees many advantages both to the government and to the communities involved. V-ports would remove less property from the tax-rolls than large airports. Cost of a V-port would be less and bring business direct to the heart of the city, directly supporting urban renewal projects and the maintenance of downtown property values.

Highway and rail congestion would be reduced as would improvement costs on remote airport access highways. Unlike surface systems, the only road bed or right-of-way costs are in navigational aids. A better inter-city transportation system would increase the air transport industry's contribution to the Gross National Product.

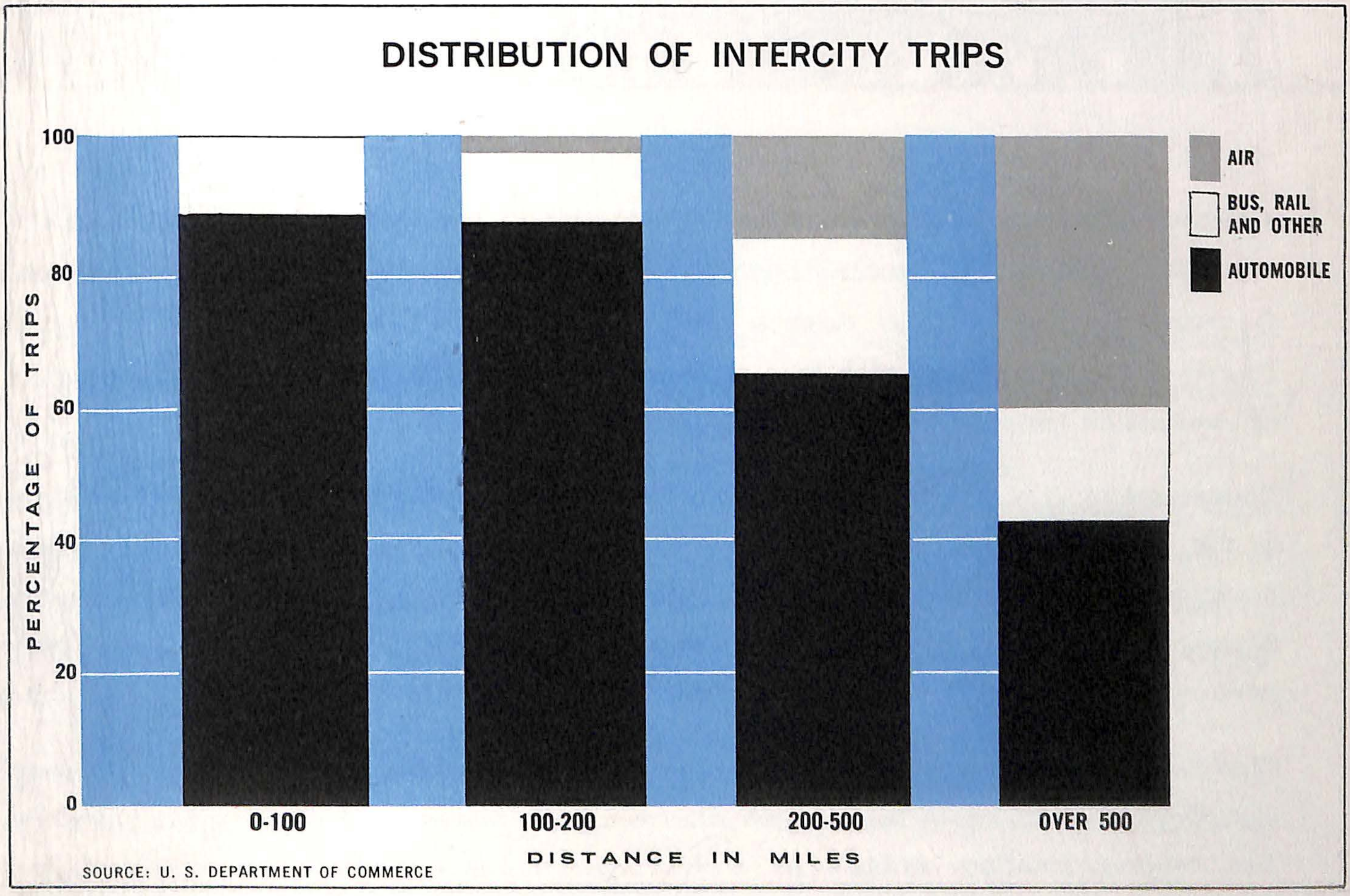


For the airlines, it is estimated that reduced ground delays and faster speeds of which the VTOL is capable, on short stage lengths, would provide direct operating costs competitive with conventional transportation. This would also result in increased utilization. On a 100-mile shuttle run, approximately New York to Philadelphia, nine round trips could be completed during a 10-hour day as opposed to six for an airplane. On a 200-mile run, such as New York to Washington, six round trips could be accomplished in place of four.

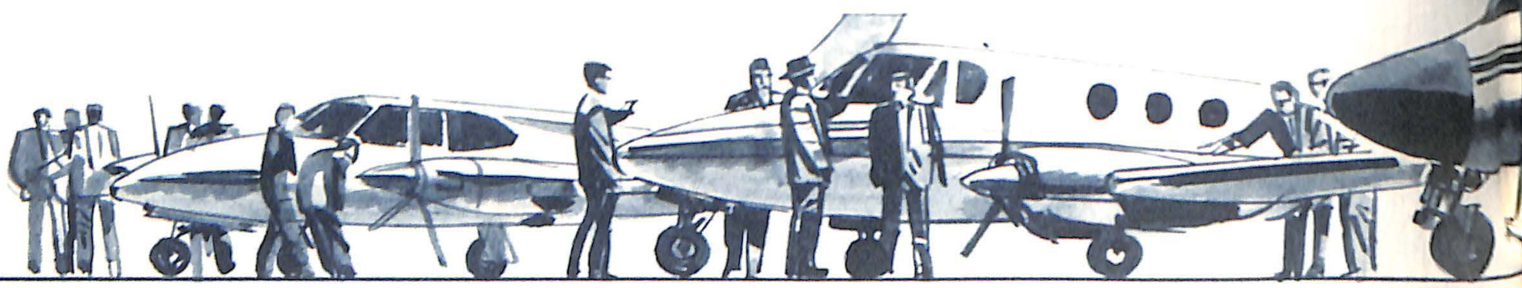
In the end, the passenger stands to save his time and his money in the more economical VTOL service.

Based upon its studies and those of other agencies with which it has cooperated, the Vertical Lift Aircraft Council recommends that a governmental agency be empowered to meet "immediately" with appropriate state and municipal authorities and with representatives of the air transport industry as well as manufacturers. Such a conference, says the Council, should seek a means of acquiring public acceptance of VTOL transportation systems, establishing safety regulations for V-port operations, and locating V-ports particularly in respect to noise problems along approach paths.

It calls for continued and increased programming of aeronautical research and development in this area, broad VTOL flight experience under operational instead of a test environment and recommends that the Federal Aviation Agency continue its coordination with the National Aeronautics and Space Administration and all VTOL projects to prepare in advance the airworthiness regulations and flight test procedures by which a vertiliner will be certified.



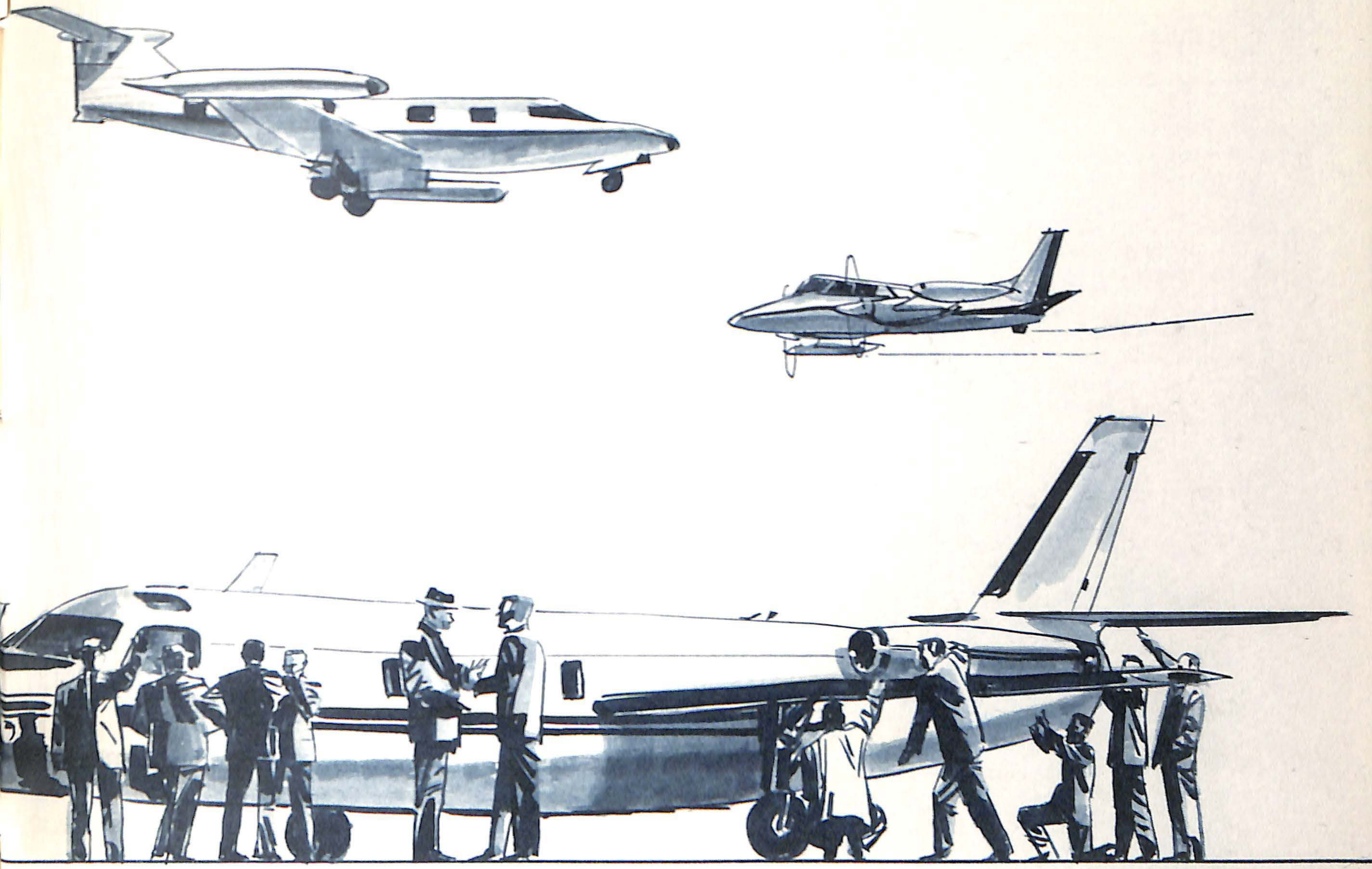
EUROPEANS VIEW GENERAL AVIATION -U. S. STYLE



To study the size, scope, operation and economic impact of general aviation in the United States, 23 high-ranking government and aviation leaders from West Germany, Switzerland and Austria recently completed a ten-day air tour of this country. The aircraft in which they traveled were provided by member companies of Aerospace Industries Association's Utility Airplane Council.

Sponsored by the Aircraft Owners & Pilots Association of Germany, an affiliate of the AOPA of the U. S., the 4,500-mile itinerary included visits to aircraft and equipment manufacturing plants in Pennsylvania, Florida, Oklahoma and Kansas. Stops were made at busy major airports as well as small airfields where only general aviation serves the air transportation needs of the area.

The Europeans, all of whom are concerned with transportation, economics and civil flight regulations in their home countries, discussed with community leaders and national aviation officials air traffic control, airport development, aviation



service facilities, air safety, the economic impact and other aspects of general aviation as parts of the nation's total air transportation system.

Throughout the tour they were enabled to see for themselves the ease of operations, the absence of red tape and excellent cooperation which exists between all types of air service in this country.

Robert V. Reynolds, Federal Aviation Agency Assistant Administrator for General Aviation Affairs, and Max Karant, vice president of AOPA, accompanied the tour. Among the foreign guests was Germany's Secretary of State for Aviation, Erwin Lauerbach, Dr. Heinz Knott, of the Ministry of Finance, and Prince Georg von Waldburg zu Zeil, president of the German Aero Club.

Result of the air tour was a better mutual understanding between people who, although they speak different tongues, talk the same language – development and progress through general aviation.

AEROSPACE COMMENTS

Congressman John W. Wydler
before the American Society of Tool and Manufacturing Engineers

"The systems management approach of the aerospace industry is well suited to the complexities of urban civilization. The State of California has begun several projects. Mayor Lindsay is investigating specific applications for New York City. Senator Nelson has begun hearings on the applications of aerospace techniques at the Federal level.

"This is why I see a productive and profitable future for your industry. It is recognized as a unique national asset, already proven magnificently successful in aeronautics, guided missiles and space technology; and ready to contribute to other national objectives of economic growth and environmental quality.

"The remaining problem is to avoid any loss in momentum for this industry — a peculiar amalgamation of scientists, engineers, and management which thrives on change, cannot stand still, and insists on progress. . . ."

Cyrus S. Vance, *Deputy Secretary of Defense before the Grain and Feed Dealers Association*

"In pursuing the first prong of our military strategy — the destruction of main force units — our commanders have available powerful and flexible resources.

"Our airborne mobility — we now have more than 1,600 helicopters in South Vietnam — more than are possessed by all other Free World armies combined — and our mounting fire power on land, sea, and in the air, give us effective tools with which to deal with the main force units. As a measure of firepower available, it may be noted that for the present month of March the projected air-delivered munitions alone in South Vietnam will be two and a half times the average monthly rate in the three years of the Korean War, and we are prepared to support even higher rates in the months ahead.

"Moreover, soon we will place in operation against military targets in South Vietnam modified B-52 bombers which can carry a conventional bombload 57% greater than those now in use. The modified B-52 s each will be able to deliver 60,000 pounds of bombs. These B-52 s are a concrete example of our determination to give our fighting men everything they need to do the job."

David D. Thomas, *Deputy Administrator, Federal Aviation Agency before the Helicopter Association of America*

"The absence of a downtown landing facility in the nation's capital illustrates the major difficulty that could impede the proper growth of the rotorcraft industry — the insufficiency of suitable and convenient landing areas. Here, I think, is a proper salesman's role for this industry — the educating of our communities and municipalities to the advantage of the rotorcraft. There will be no helicopters until our local officials are convinced that the helicopter is an advantage — not a nuisance. Perhaps the key here is the function of the chopper as an emergency vehicle. The helicopter is, in fact, the greatest emergency vehicle ever invented.

"This message should be brought home to our local municipalities and local public utilities. In my own home area of Washington, helicopters are saving lives and assisting in municipal operations. We, however, are fortunate in that that city has on its outskirts — Fort Belvoir — a base for an Army helicopter unit. Other cities are not as fortunate. How many lives could be saved if each community possessed its own chopper? How many drownings prevented? How many policemen suffer accidents chasing stolen cars? Could a chopper increase highway safety? Can it reduce crime? These are the things we must sell.

"The big need, it seems to me — more important perhaps than all the rest — is for imaginative selling — an imagination as creative as the vehicle itself. The helicopter is a marvelous vehicle. We must be prepared to use and reap the benefits of its marvelous ways. If we do this, there is no limit to your future."

Dr. Edward C. Welsh, *Executive Secretary National Aeronautics and Space Council before the Churchman's Club*

"The national space commitment is the largest concerted effort undertaken by any nation to advance the frontiers of human knowledge. Combining as it does industrial, academic, and governmental resources, it has given us an advanced technology second to none. . .

"In all, our space commitment is a multi-dimensioned national mission whose scientific, technological, economic, spiritual, and political connotations go to the very core of our national character. Its impact permeates all aspects of our society. Its energizing force is felt throughout our economy, our educational structure, and in our relations with other nations. It is a seedbed of invention, a spur to our productivity, a source of insurance for our national security, a stimulus to learning, and a worldwide ambassador for peace.

"Because of it, our chances of improving medical research and finding a cure for cancer or for heart disease are greater — not less. Because of it, our chances of improving our educational system and solving a vast range of social problems are greater — not less. The truth is that the issue is not space progress instead of progress in some other worthy field, because the space program contributes importantly to advances in practically all other lines of endeavor, and it stimulates the national economy at the same time. We are wealthier, not poorer, because of the space effort."

AIA MANUFACTURING MEMBERS

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Aerojet-General Corporation
Aeronca Manufacturing Corporation
Aeronutronic Division, Philco Corporation
Aluminum Company of America
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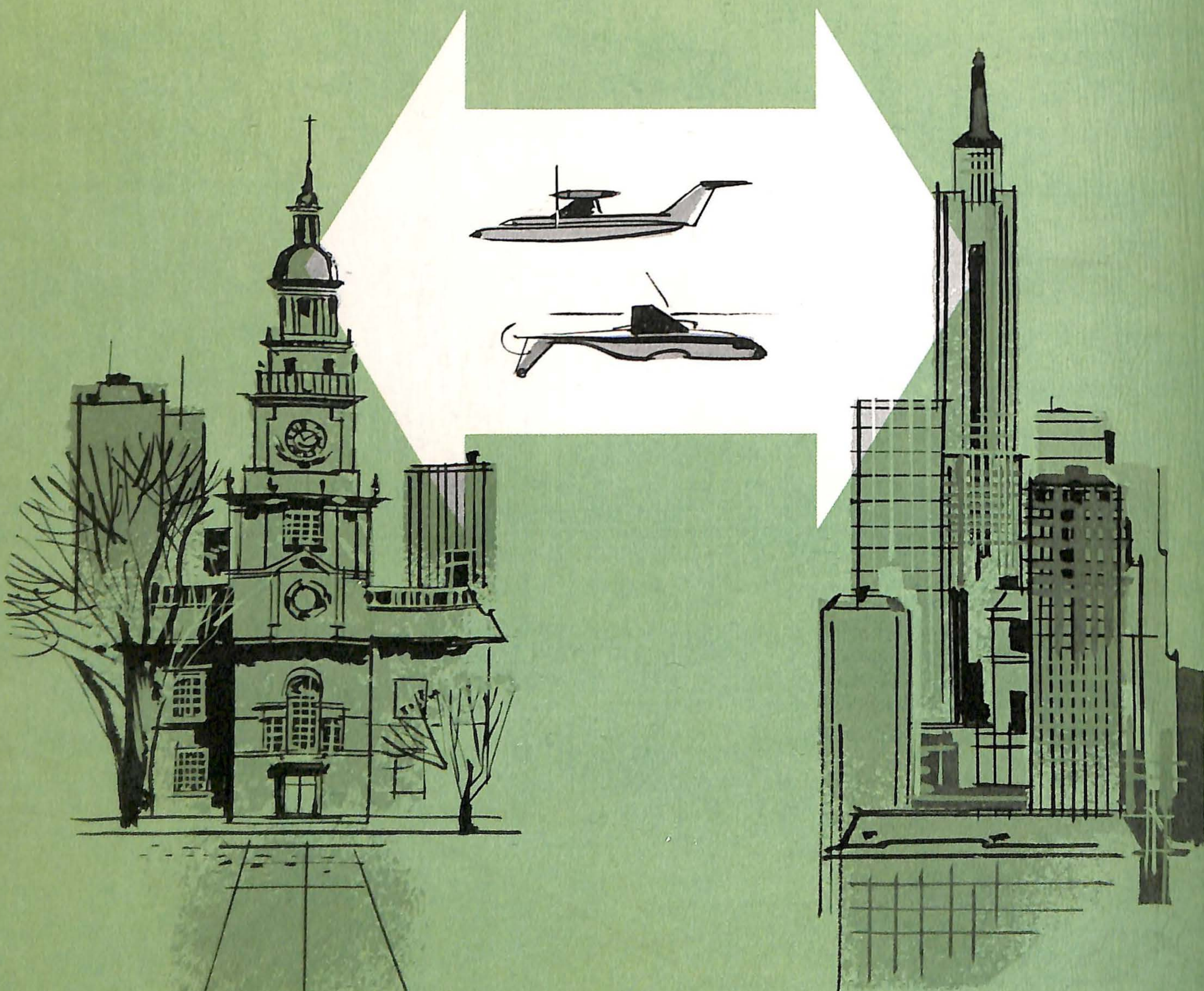
AEROSPACE INDUSTRIES ASSOCIATION
1725 De Sales St., N.W., Washington, D. C. 20036

The U. S. faces a problem in providing modern intra- and inter-urban transportation. (See *VTOL — A Solution For Urban Transport,* page 10).



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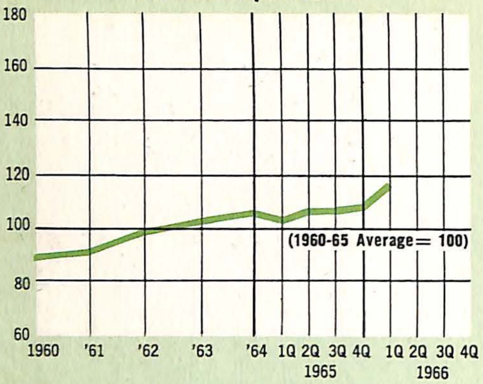
■ Next Up: APOLLO

■ Subcontracting: AEROSPACE BENCH STRENGTH

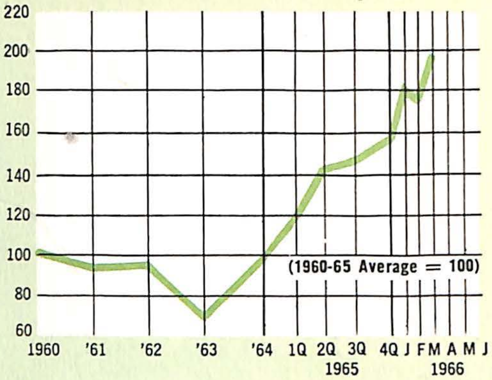
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

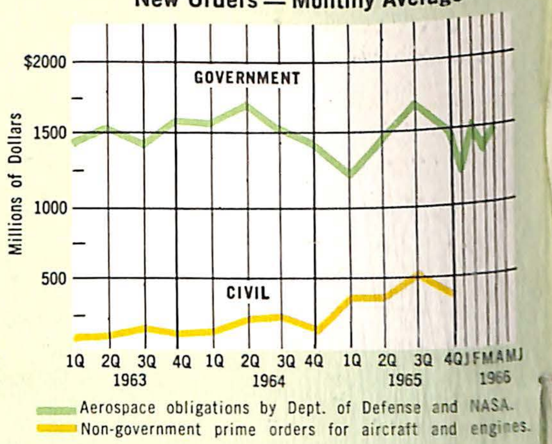


Value of Civil Aircraft Shipments



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 March 31	20.0	20.9	22.4 E
	Billion $	Quarterly	4.8	1966	5.0	5.3	5.6
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	April 1966	1,020	988	1,247
Aircraft	Million $	Monthly	601	April 1966	835	663	859
Missiles & Space	Million $	Monthly	550	April 1966	185	325	388
Aerospace expenditures: Total	Million $	Monthly	1,067	April 1966	923	1,190	1,016
Aircraft	Million $	Monthly	561	April 1966	461	729	628
Missiles & Space	Million $	Monthly	506	April 1966	462	461	388
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	April 1966	183	345	240
Expenditures	Million $	Monthly	180	April 1966	437	428	400
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	692	May 1966	948	1,385	1,485
Value	Million $	Monthly	15	May 1966	26	34	37
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	Quarter Ending	15.2	18.7	20.4
U.S. Government	Billion $	Quarterly	11.6	Dec. 31	11.7	12.7	13.7
Nongovernment	Billion $	Quarterly	3.7	1965	3.5	6.0	6.7
EXPORTS							
Total (Including military)	Million $	Monthly	110	April 1966	155	139	151
New Commercial Transports	Million $	Monthly	24	April 1966	41	55	50
New Utility Aircraft	Million $	Monthly	2	April 1966	5	9	9
PROFITS				Quarter Ending			
Aerospace — Based on Sales	Percent	Quarterly	2.3	March 31	2.7	3.5	3.1
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	1966	5.4	5.7	5.6
EMPLOYMENT: Total	Thousands	Monthly	1,132	April 1966	1,127	1,247 E	1,259 E
Aircraft	Thousands	Monthly	499	April 1966	446	524	530
Missiles & Space	Thousands	Monthly	496	April 1966	512	551	558
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	April 1966	3.13	3.34 E	3.34 E

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.
** Base for averages has been modified in this issue from 1960-64 to 1960-65

GENERAL AVIATION: RECORD GROWTH

Manufacturers of general aviation aircraft are today at their highest level of activity. In May 1966 eleven utility aircraft manufacturers reported to the Aerospace Industries Association more than $37 million in utility aircraft sales, an increase of 42 percent over the $26 million of these aircraft sold in May 1965. In the period January-May 1966 utility aircraft sales reported to AIA exceeded $172 million, 50 percent more than the $115 million for the same period in 1965. (These figures are not totally comparable due to a change in the number of manufacturers reporting to AIA from eight to eleven in 1966).

This increase in sales has been followed by substantial increases in employment. Employment in utility aircraft companies is expected to increase from 25,183 to 28,290, a 12 percent gain, between September 1965 and June 1966. Employment of scientists and engineers in these companies is expected to rise from 1,436 to 1,744, a 21 percent increase, in the same period.

The number of utility aircraft shipped also has been rising. In May 1966, 1,485 were delivered, 57 percent above the 948 in May of 1965. The number of utility aircraft shipped in May of 1966 was 115 percent above the annual average between 1960 and 1965 of 692.

This dramatic increase in utility aircraft activity is the result of increasing personal and corporate income, rising numbers of pilots, and increased emphasis on rapid point-to-point transportation. In 1966 the Federal Aviation Agency reported that the number of people flying in general aviation aircraft approximated those flying with the domestic scheduled airlines.

Use of utility aircraft has broadened. In 1964 over 52 percent of these aircraft were utilized for personal purposes, approximately 24 percent for business purposes, and the remainder for aerial applications, air taxi, instructional and other purposes. Business uses predominated in hours flown in 1964 with over 37 percent of the total.

Several current trends indicate that utility aircraft shipments and hours flown may grow even more rapidly than present government estimates now forecast.

In the first six months of 1966, shipments of smaller utility aircraft (four places and under) amounted to 2,600, more than the total number of these aircraft produced in the years 1954 to 1956. Purchasers of small aircraft have usually traded up to larger aircraft within a number of years. The increasing purchases of smaller aircraft now indicates that future sales for larger aircraft may grow more rapidly than in the past.

Marketing efforts by utility aircraft companies have been enhanced in recent years as the demand for these aircraft has grown, and these marketing efforts are a strong force for future sales.

Technical innovations, such as the introduction of turbine aircraft, are expected to increase demand from those requiring rapid transportation.

All of these factors point to an expanding market for utility aircraft through 1975.

AIA

aerospace

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CONTENTS

The purpose of AEROSPACE is to:

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

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

Foster understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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.

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Next Up:

APOLLO

Complex 39 of the John F. Kennedy Space Center, the half-billion dollar American moonport, is taking shape. Already completed is the world's largest structure, the Vertical Assembly Building, where technicians will put together the mammoth Saturn V launch vehicle and the Apollo spacecraft.

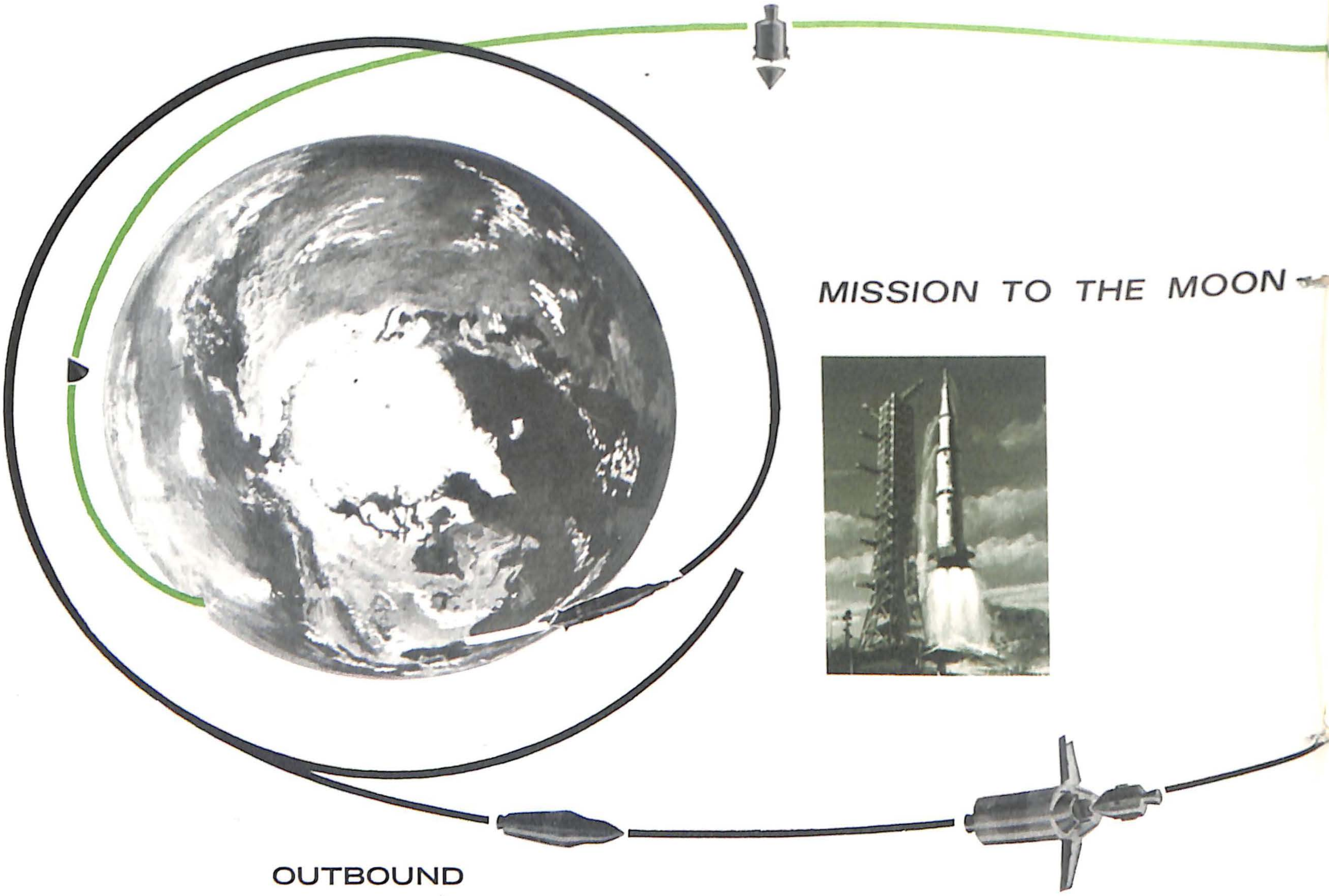
The adjacent Launch Control Center is also ready. On the "crawlerway" which extends from the assembly building to the two pads three and five miles distant, the 6,000,000-pound crawler/transporter and the 446-foot mobile launcher it carries are being tested at the unspacelike pace of a mile an hour. Thousands of yards of concrete roadway inter-connect the pads and the assembly, control and support buildings.

Many of the construction workers have already moved out. Some remain, putting the finishing touches to Pad B, certain utilities and ground support facilities. Within the next several months, they, too, will complete their jobs and move on, to be replaced by a steady influx of government and contractor personnel to flesh out the cadre already on site. Before another year passes, Complex 39 will be operational; before the decade ends, it will be the departure point for the most momentous mission in the history of exploration, the landing of men on the moon.

Among the 12,000 National Aeronautics and Space Administration people engaged in Project Apollo and the quarter of a million industrial workers who build the equipment and facilities, there is nothing but optimism that the "within the decade" deadline to which the late President Kennedy committed the nation in 1961 will be met. Much of the Apollo hardware has already been built and tested. It is tested first as an individual part, then as a unit formed by a number of parts, as a subsystem formed by a group of units and finally as an integral element of the complete spacecraft or launch vehicle. Literally hundreds of thousands of tests — sonic, X-ray, chemical, structural, static, dynamic, vibrational, functional and environmental tests — have been accomplished. For the most part the equipment has proved itself; where problems exist, there appear to be clear paths toward solution.

Now it is time for the larger step, in-flight "qualification," or demonstration of the reliability of each component in space. Between now and the first moon flight, NASA will conduct about a score of Apollo qualification and dress rehearsal flights, orbital and suborbital, manned and unmanned. For purposes of clarity, the flights can be grouped into six phases involving two types of launch vehicles and two different versions of the spacecraft.

First of the launch vehicles is Saturn IB, which NASA prefers to call the Uprated Saturn. This vehicle, capable of sending 40,000 pounds into earth orbit, is composed of two stages, the lower developing 1,600,000 pounds of thrust and the upper, called S-IVB, powered by a single liquid hydrogen engine producing 200,000 pounds thrust. Saturn V has three stages: a 7,500,000 pound thrust basic stage designated S-IC; the five-engine S-II intermediate stage of 1,000,000 pounds thrust; and the "topper," the S-IVB. Although no component of the Saturn/Apollo system can be termed more important than another, the S-IVB, common to both



MISSION TO THE MOON

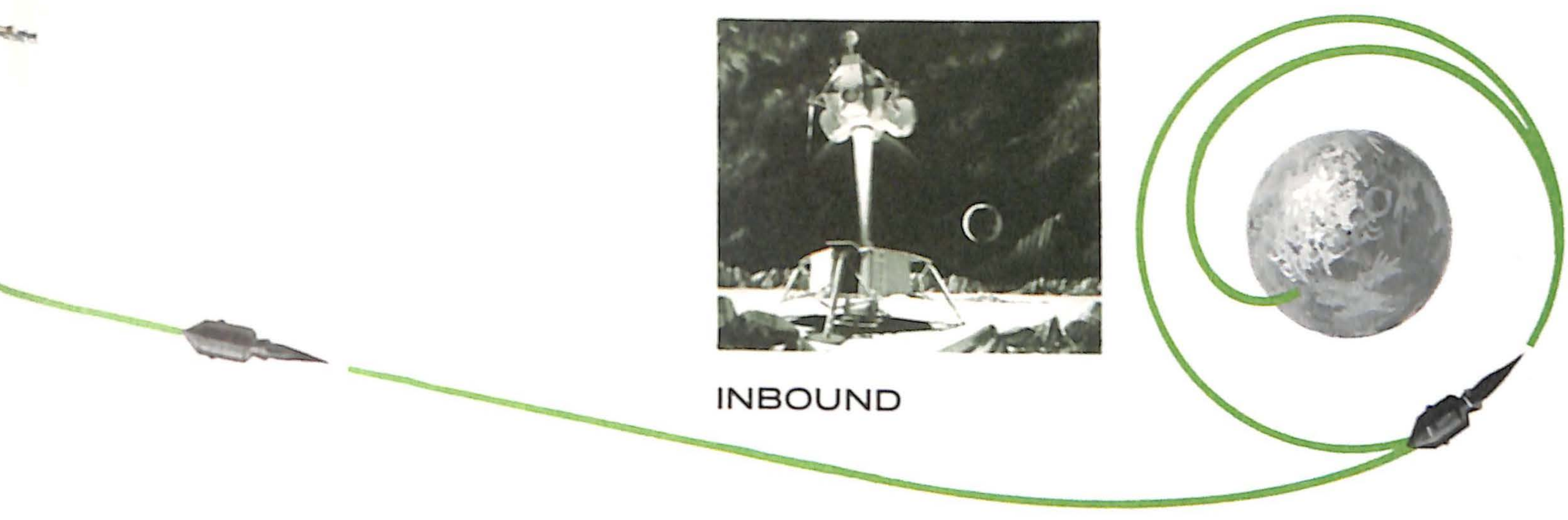
OUTBOUND

vehicles, has a particularly critical assignment in the moon launch. First, after the two lower stages have boosted the spacecraft to orbital altitude, S-IVB's power provides the required velocity for orbit. Then, unlike the earlier stages which drop back to earth, S-IVB stays with the spacecraft — "power down" — for a later assignment. After a period of check-out in orbit, its engine is re-started to supply the "kick" into lunar trajectory.

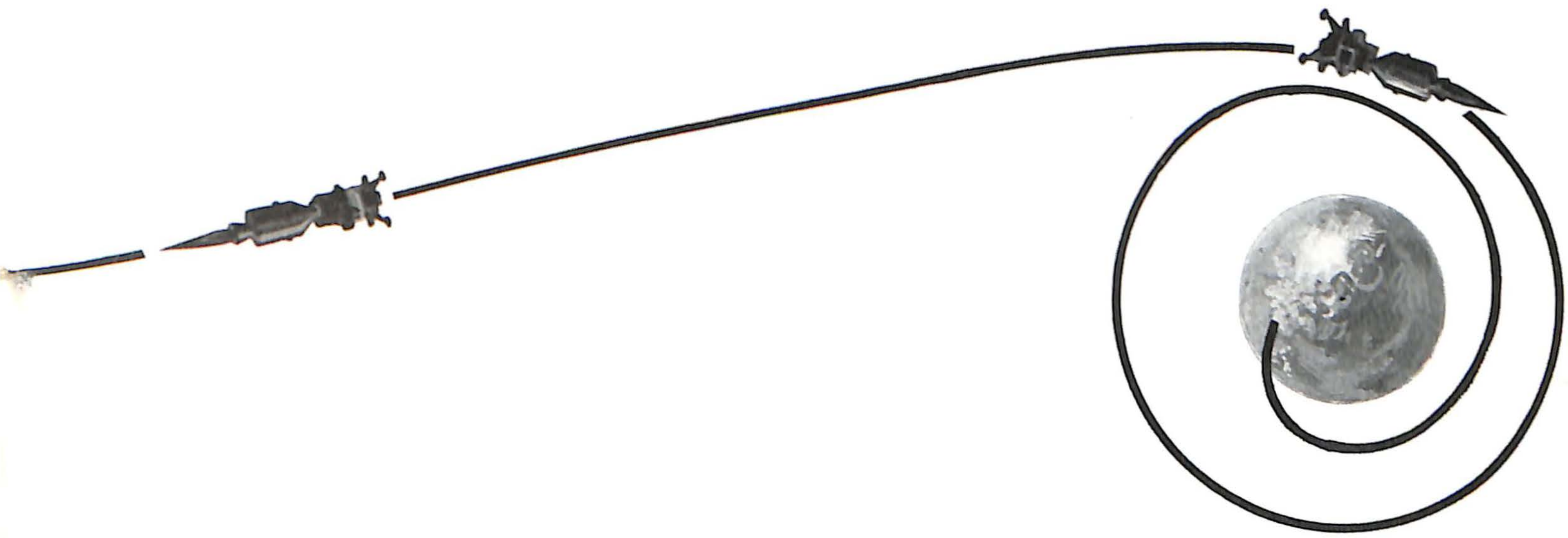
Phase 1 of the flight test program, consisting of three unmanned flights of the Uprated Saturn, is already underway. Its major objectives are complete check-out of all components of the launch vehicle and some elements of the Apollo spacecraft, with special emphasis on the spacecraft's heat shield and the behavior of the hydrogen fuel of the S-IVB in the space environment.

One might wonder why the heat shield requires special attention in view of the many successful re-entries accomplished by Mercury and Gemini spacecraft. The answer lies in the far greater re-entry velocity, hence greater friction heating, of an Apollo returning from a mission in which it has escaped earth's gravity. Re-entry velocity is about 36,000 feet per second, some 10,000 feet per second higher than a re-entry from earth orbit. It would have been possible to design a mooncraft which could be directed into earth orbit, then make a descent in the proven Mercury/Gemini manner. This would have required a powerful braking rocket to "subtract" the difference between lunar return velocity and earth orbital velocity, and such a rocket would have imposed a weight penalty of several hundred pounds. Since weight was a critical factor in Apollo design, NASA elected to develop a new shield capable of absorbing the greater heat of direct descent. This new and vital item of equipment, therefore, requires a series of qualification tests.

Phase 1 got underway on February 23 of this year with the first flight of the Uprated Saturn. Primary objectives, which were successfully met, included check-out of all components of the launch vehicle, its structural integrity, test of the subsystems of the unmanned Apollo spacecraft and the performance of the heat



Artist's conception depicts some of the major steps of NASA's projected manned lunar landing mission. The lower flight path shows the outbound trajectory: first, a period in earth orbit for systems check, then the kick into lunar trajectory, the turnaround maneuver, a midcourse correction (there will probably be three), the velocity subtraction which enables the Apollo spacecraft to go into lunar orbit, and the descent to the moon. The upper path illustrates the LEM ascent to a mating with the main spacecraft, the start of the homebound trajectory, midcourse correction, the separation of the service module and the earth re-entry.



shield. In a short suborbital flight, the spacecraft was driven back toward earth at a very steep angle and at a velocity of 28,000 feet per second. This provided the first of several checkpoints of the heat shield's performance "envelope."

The second flight will not carry a spacecraft. In addition to the general test of the launch vehicle, the main objective is checkout of the S-IVB stage in orbit. Little is known about the behavior of hydrogen fuel in space and NASA wants to insure the re-start capability.

The third flight, due in late summer, will be similar from the standpoint of objectives to the February mission, with this difference: The spacecraft will be boosted into a suborbital path that will take it through three-quarters of an orbit to a landing in the Pacific rather than the Atlantic. Apollo will re-enter in a shallow trajectory at 28,000 feet per second, absorbing greater heat in the long, flat trajectory. This is the second checkpoint of heat shield performance; the others, at 36,000 feet per second, will be obtained in later flights of the Saturn V booster.

If all three flights are successful, NASA will be ready to embark on Phase 2, the first manned Apollo flights, probably in the latter part of this year. The Uprated Saturn will be the booster for this series, since Saturn V will not yet be man-qualified. The Lunar Excursion Module of the spacecraft will not figure in this phase except for an unmanned checkout flight; ordered into development about a year later than the rest of the Apollo hardware, it will be a year behind in the manned flight test schedule.

The spacecraft will consist of the Command and Service Modules, known collectively as CSM.

Phase 2 flights will involve a type of spacecraft termed Block I, identical in all respects to the later Block II except that it has no provisions for docking with the LEM (the lunar landing mission demands two CSM/LEM dockings, one on the outbound flight, the other when the LEM returns from the lunar surface). On these Phase 2 flights the objectives will be complete test of the myriad Apollo systems with the exception of the docking apparatus, and "man/system interface," or astronaut familiarization with the equipment.

Phase 3, to start sometime in 1967, will be devoted to Uprated Saturn launches of the entire three-module spacecraft. Actually, the spacecraft fueled for a lunar mission weighs 90,000 pounds, a payload well beyond the weight-lifting capability of the Uprated Saturn, so the various modules will carry only partial fuel loads, enough to meet test objectives. The objectives are the same as Phase 2 with a couple of added starters: familiarization with the LEM and the "turnaround maneuver."

The turnaround maneuver is a part of the lunar mission dictated by safety provisions. As the Apollo spacecraft sits on its booster prior to launch, its various components are arranged in this order: topmost, the launch escape tower; next in descending order, the Command Module, the Service Module and the LEM. In case of an emergency at low altitude, this arrangement permits the escape system to propel the command module containing the astronauts to an altitude from which they can safely descend by parachute.

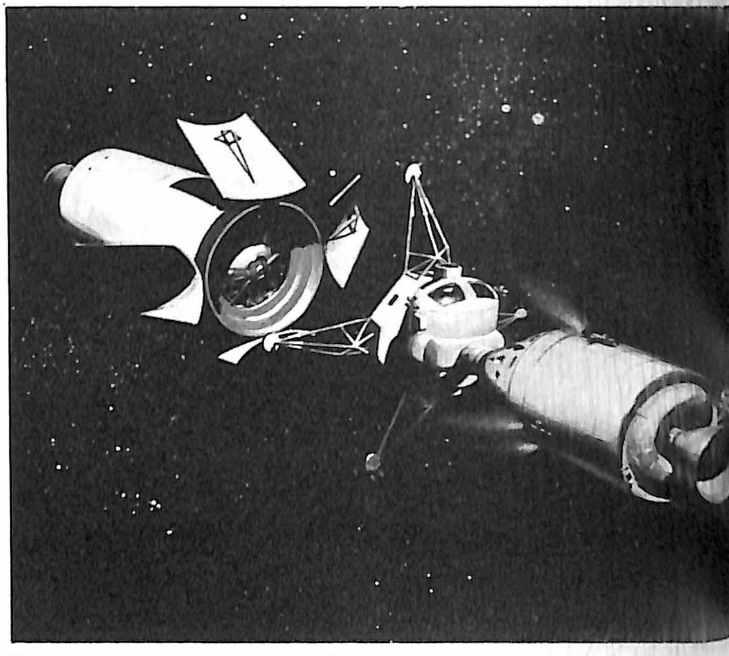
However, this line-up of the modules makes it impossible for the astronauts to transfer from the Command Module to the LEM, so the order must be rearranged in space. The re-arrangement takes place shortly after injection into lunar orbit. It is accomplished by separating the moon-bound payload into two "temporary spacecraft," one composed of the Command and Service Modules, the other of the LEM and the still-attached S-IVB stage. As the two halves coast close together in space, the commanding astronaut fires short bursts of rocket power from the Service Module thrusters, turning the CSM around so that it is nose to nose with the LEM. After he jockeys the CSM to a mating, the merged hatches of the Command Module and the LEM form a connecting tunnel. The S-IVB, its job completed, separates to drift in solar orbit. This turnaround maneuver, the Apollo version of rendezvous and docking, will be practiced several times during Phase 3.

In Phases 2 and 3 there will be considerable extravehicular activity, or space walking. Astronauts will emerge from their spacecraft garbed in the advanced Apollo spacesuit and equipped with a new life support/propulsion backpack system called the Extravehicular Mobility Unit. The EMU is capable of supporting life in space independent of the spacecraft's environmental control system for periods up to four hours.

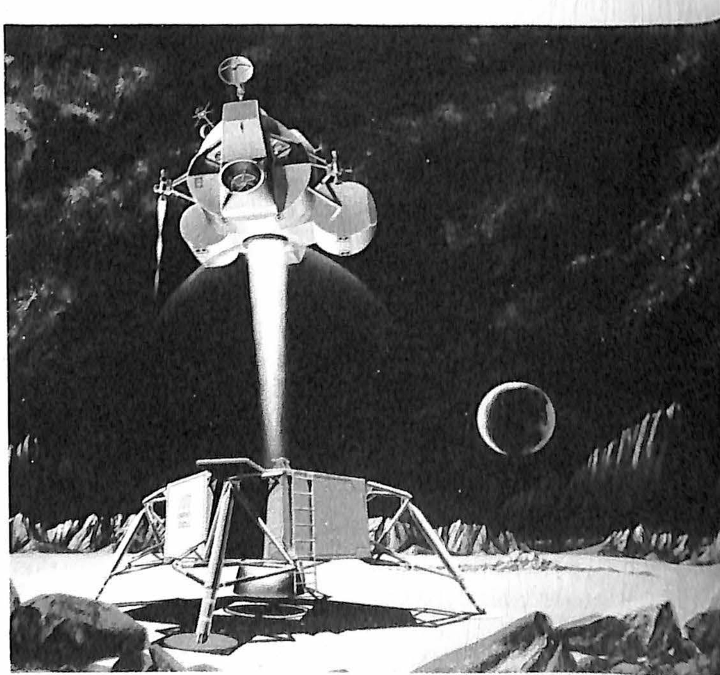
Duration of these Uprated Saturn manned flights — and of the later Saturn V missions — is "open-ended," meaning that it can be anything up to the 14-day limit of the spacecraft's life support equipment. A nominal lunar mission would require seven days — 72 hours up, the same for return and as much as 24 hours on the lunar surface. It is likely that the average earth-orbital mission will be longer, probably about 10 days, because of the multiplicity of systems to check out and the variety of experiments to be performed.

As to how many missions there will be in the Uprated Saturn portion of the project, Apollo program director Maj. Gen. Samuel C. Phillips, USAF, says simply, "Whatever it takes, as many as we need to

Toward earth orbit.



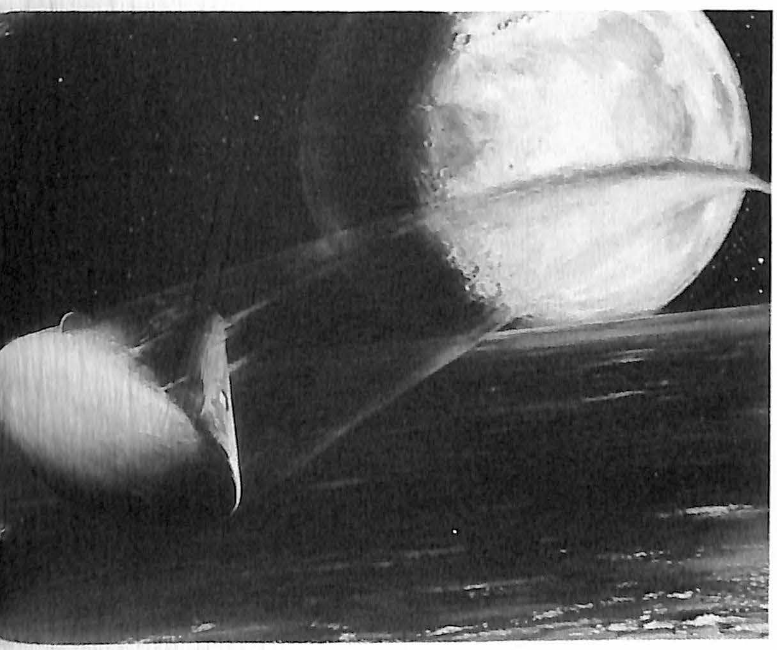
Turnaround completed.



Lunar ascent.

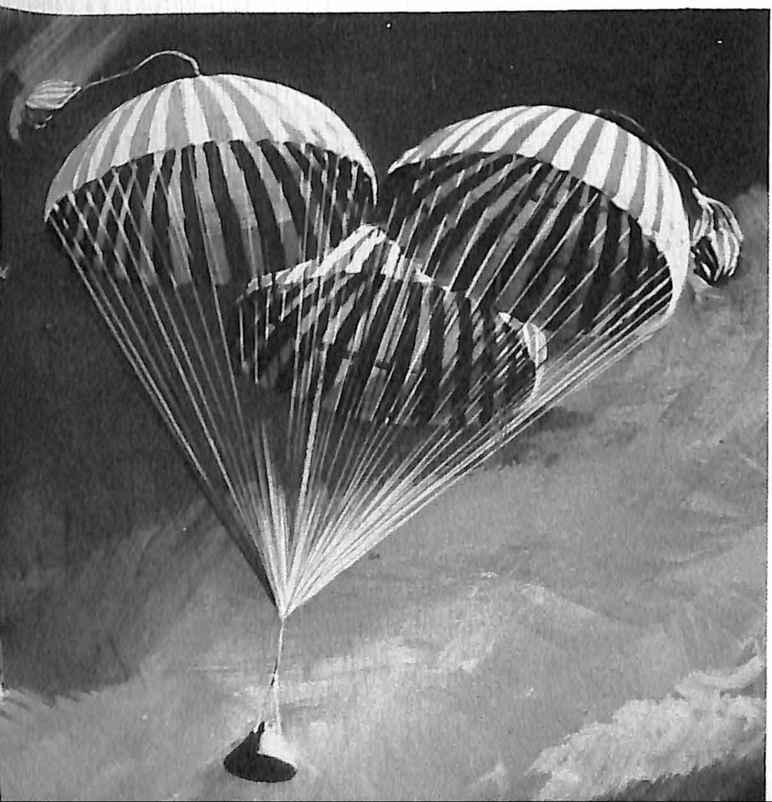
verify all systems." There are 12 vehicles available and Gen. Phillips feels "we might use eight to 10 of them." Phase 3 should be completed by early 1968, perhaps in 1967.

Phase 4 will run concurrently with the manned Uprated Saturn flights and should be completed earlier. This phase consists of two unmanned tests of the huge Saturn V moonbooster. Again the objectives include an all-systems check of both launch vehicle and spacecraft. The spacecraft will be "flown" by an electronic crew, a programmer which will put the Apollo through its paces in the same manner as would a human crew.



Earth re-entry.

Earth landing.



The finale of each of these flights will be another heat shield test, rounding out the performance envelope.

Early in 1968, NASA will move into Phase 5, a series of flights employing the complete lunar mission "stack," the three-stage Saturn V booster and the three-module spacecraft at its fully-fueled weight. Although mission details are still being refined, indications are that these flights will be conducted at relatively high altitudes, up to 5,000-6,000 miles. Missions will include "more of the same," repetitions of the various maneuvers and experiments conducted in earlier phases. There will also be two very important maneuvers which cannot be conducted with the smaller Uprated Saturn. One of them involves "deboosting," or changing from a given orbital altitude to a lower one; this simulates the transfer necessary on a lunar mission from the enroute trajectory to lunar orbit. The other is the high-velocity, 36,000 feet-per-second re-entry into earth's atmosphere.

Phase 5 is also on a whatever-it-takes basis. When it is completed, NASA will have a complete "lunar capable system," one which has fully demonstrated its capability to send man to the moon and bring him back safely.

One final phase remains before the actual moon flight — Phase 6, the dress rehearsal. Every item of equipment has been verified, the astronauts and the various ground-based teams have gained the experience they need for the gigantic task to come. Now NASA will fly a complete lunar mission with the spacecraft remaining at all times under the influence of earth's gravity — the launch, earth-orbital check-out, the insertion into lunar trajectory, the mid-course corrections, the injection into lunar orbit, the descent to the moon, the LEM's return to the waiting CSM, the homebound trajectory, the re-entry and the parachute landing in the ocean. It is possible to make a realistic simulation of all of these steps on an earth-orbital flight, with one exception: the actual touchdown on the lunar surface. For this portion of the dress rehearsal, NASA will make a semi-simulation; the LEM will detach from the CSM, descend under its own power to a lower orbit, then return to a mating after a make-believe period of lunar exploration.

If everything goes perfectly, there may be only one dress rehearsal; there might be two, three, four or five. When NASA's top management is convinced that "all systems are go," it will schedule the *Big One*, the lunar landing, the culmination of nine years of prodigious effort, the goal of 3,000 hours of manned flight experience, the end toward which the nation will have expended billions of dollars.

From the Vertical Assembly Building at Complex 39, the crawler/transporter will trundle its 11,500,000-pound cargo of mobile launcher and space vehicle on a three-hour journey to the launch pad. After the customary count-down, the five mighty engines of Saturn V's lower stage will roar into action, starting three intrepid explorers on man's greatest adventure.

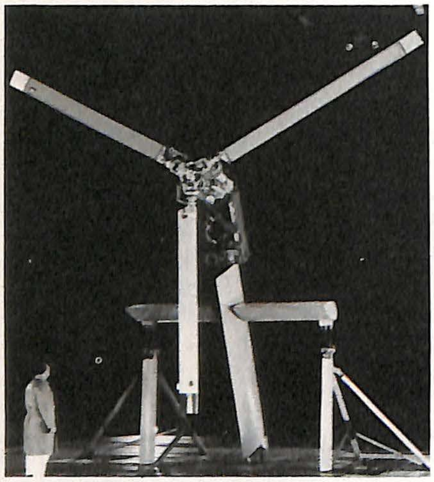
— *James J. Haggerty*

AEROSPACE NOTES

Bell Builds Rotor System For Space Capsule Landings

Textron's Bell Helicopter Company has designed a three-bladed rotor system that could lead to astronauts safely landing space capsules at low speeds like a helicopter.

The rotor, developed under a National Aeronautics and Space Administration contract, is 25 feet in diameter, and would trail behind the capsule in a folded position parallel to the rotor mast. Upon reentering the earth's atmosphere, the pilot would unfold the rotors and begin turning them without power from the vehicle to maneuver



the capsule to earth for a low-speed landing.

The rotor system offers a pilot the capability of flight-path control from hypersonic flight to touch-down at near zero vertical and forward speeds.

Other advantages, Bell engineers say, include selection of a landing in unprepared areas by the spacecraft pilot. Astronauts now depend on parachutes, using the ocean to cushion landings.

Aerojet-General Designing Water Purification Plant

Aerojet-General Corp. is designing a water purification plant employing a reverse osmosis cleansing process to produce 50,000 gallons of pure water per day under a development contract awarded by the Department of Interior's Office of Saline Water. When built, it will be the largest water purification plant utilizing the reverse osmosis process.

This process or technique makes use of a cellulose acetate membrane much like the cellophane on a pack of cigarettes to filter out pollution, bacteria, viruses, chemicals, radioactivity, hardness, alkalinity, detergents and scale. The membrane is particularly effective on brackish water found in some contaminated rivers, streams and wells. Study is continuing in use of reverse osmosis to remove salt from sea water.

Contamination can be removed at room temperature eliminating the need for large amounts of costly energy to generate heat for the plants. Aerojet officials at the company's Von Karman Center at Azusa, Calif., believe reverse osmosis may eventually be able to produce water for 30 to 60 cents per thousand gallons compared to one dollar per thousand gallons for equipment now in use.

The new 50,000-gallon per day pilot plant will be mounted in a 35-foot-long trailer operated by remote control from the Von Karman Center 50 miles distant.

RCA Develops Two-Pound Radar Set for Battlefield

A two-pound battlefield radar has been developed by Radio Corporation of America to make possible "blind" firing of such weapons as grenade launchers, machine guns and bazookas.

Only slightly larger than a pie box, the device is so light that it can easily be mounted on the barrel of a man-held firearm. Developed by RCA's Missile and Surface Radar Division, Moorestown, N. J., the radar unit is dependent upon the sounds generated within the earphones which the user wears.

Type and location of target is discriminated by means of the "doppler effect"—the shortening of sound or radio waves when an object is moving toward the listener or receiver and the lengthening of these waves when it is moving away. A man can be trained to determine exactly not only where his target is but what it is as well.

Since the doppler return on moving targets is precise, and the radar is extremely light, the device lends itself to such applications as an accurate ground speed indicator for light planes. The ranging feature could also give accurate readings of true altitude above terrain, and with modification it could make the unit useful as a terrain avoidance advice.

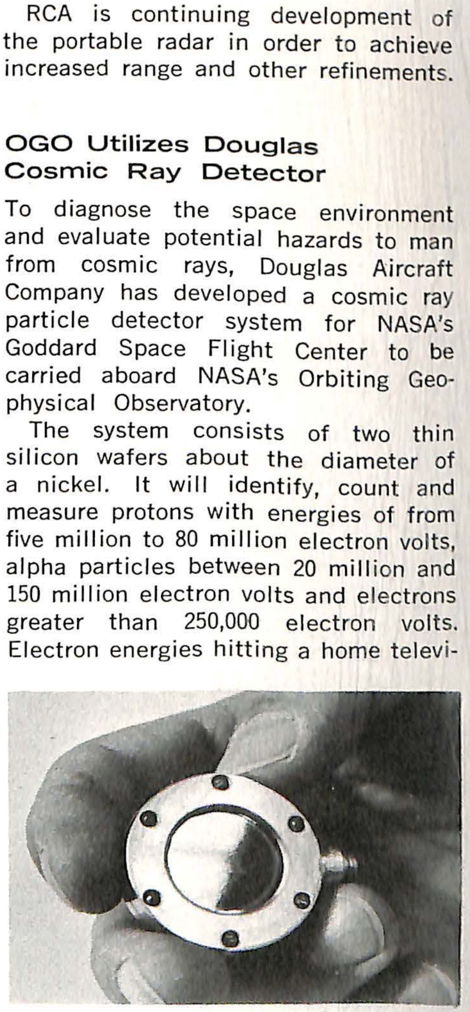
Only auxiliary equipment required for operation of the radar unit is a small, man-pack battery also weighing two pounds, and headset. Total power consumption of the device is three watts, and battery packs are available to give up to 10 hours of operation. Solid-state circuitry is used throughout the unit including the transmitter power amplifier.

RCA is continuing development of the portable radar in order to achieve increased range and other refinements.

OGO Utilizes Douglas Cosmic Ray Detector

To diagnose the space environment and evaluate potential hazards to man from cosmic rays, Douglas Aircraft Company has developed a cosmic ray particle detector system for NASA's Goddard Space Flight Center to be carried aboard NASA's Orbiting Geophysical Observatory.

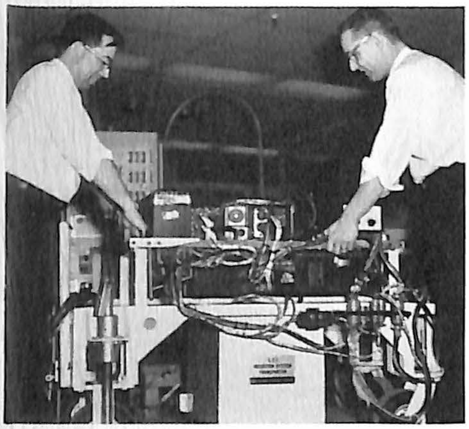
The system consists of two thin silicon wafers about the diameter of a nickel. It will identify, count and measure protons with energies of from five million to 80 million electron volts, alpha particles between 20 million and 150 million electron volts and electrons greater than 250,000 electron volts. Electron energies hitting a home televi-



sion screen are about 20,000 electron volts.

Information from the detectors will be stored on tape and telemetered to NASA's ground receiving stations from the satellite. Particle detectors will be calibrated during the flight electronically and by an alpha particle source.

The rectangular-shaped OGO will carry the 4.2-pound Douglas experiment along with 24 others, when it is launched into an elliptical polar orbit in 1968 from the Western Test Range. At that time the sun will be approaching a period of maximum activity.



Kearfott Produces Precise Inertial Navigator for USAF

Kearfott Systems Division of General Precision's Aerospace Group has delivered the first of a new generation of low cost inertial navigation systems slated to be flight tested in the Lockheed C-130 and Convair F-106 aircraft.

Result of a seven-year development program, the inertial navigator is designed to better the one nautical mile per hour error required by the Air Force and is expected to cost less than $25,000 in production. During branch tests in the company's Wayne, N. J., plant, this system performed with accuracy ranging between one and two nautical miles per hour.

The system consists of two major elements, a lightweight, two-gyro platform and a panel mounted computer which incorporates the controls and displays. Microcircuitry is used extensively in the computer and for the platform electronics. Many of the circuits are mounted within the platform proper.

Ultra-sonic Traffic Detector To Help Solve City Congestion

Ultra-sonic traffic detectors developed by Sperry Rand Corp. have been delivered for New York City's automated traffic control center under a $5.4 million contract.

The radar-like devices use subaudible sound waves to detect the presence or motion of any type vehicle. Mounted above or to the side of a thoroughfare, they can cover one, two or three traffic lanes.

The above-ground location makes installation and maintenance less costly than devices located in the street. Solid-state circuitry used in each compact unit achieves high reliability, the company reports.

New York City has 1,100 of the detectors on order. Similar devices have also been ordered by Pittsburgh, Houston, Atlanta, Ft. Lauderdale and Baltimore.

Grumman Simplifies Document Storage, Retrieval for LEM

Storage and retrieval of the large quantities of documentation involved in the Lunar Excursion Module project has been simplified by Grumman Aircraft Engineering Company with the use of microfilm and a novel retrieval system by which any document can be retrieved in 10 seconds or less and be printed into a hard copy by the same machine in another 14 seconds.

Every piece of written information received in Grumman's LEM Data Operations Services is first coded according to a special digitized system, then microfilmed. Negative of the microfilm is processed and placed on a cartridge which holds from 300 to 2,000 documents depending upon the number of pages, amount of coding and type of coding in each document.

To dig out any document so processed, the searcher places the cartridge in the retrieval station search equipment and inserts the proper code into the retrieval keyboard. Any document can be found in this way within 10 seconds or less and be printed into hard copy by the same machine in another 14 seconds.

If an engineer needs a 20-page document, he can not only view it page by page on the display screen but can have a copy of it for permanent use in less than five minutes.

North American Contains Gigacycles in Special Lab

Engineers of North American Aviation's Missile Guidance and Control Electronics Laboratory at Columbus, Ohio, have designed a special test room to contain gigacycles (one billion cycles generated per second). Otherwise these electronic "varmints" might escape to the outside world threatening television reception and airport tower transmissions.

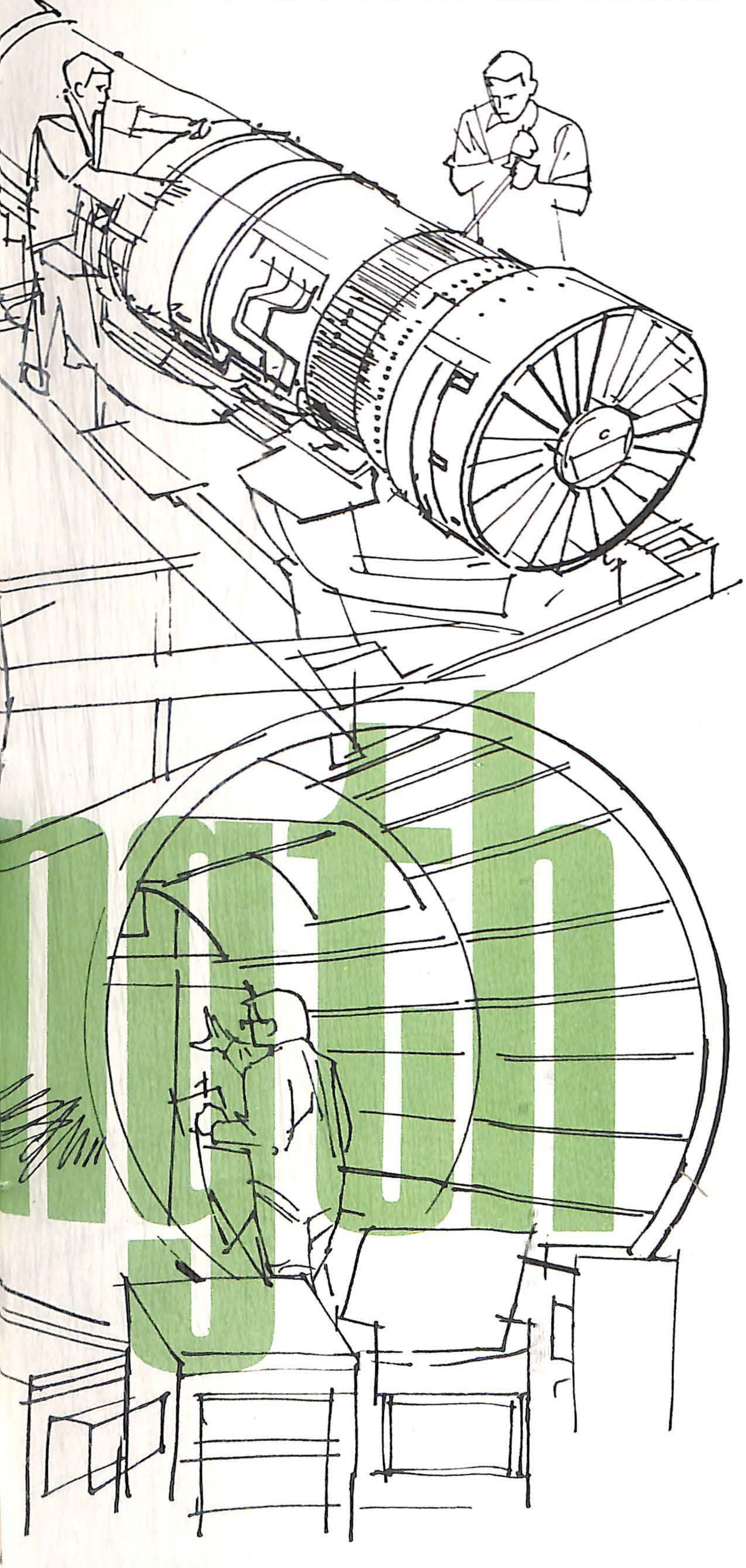
Working as they must with extremely high ranges such as 10 gigacycles, a means had to be found to protect the gigacycle from outside sources such as electric lines, radio stations, and electronic tests from other areas of the plant.

Walls and ceiling of the test room are shielded with metal. Light cords are encased in metal. The metal-encased doorway is four inches thick. Metal inter-locking fingers around the door are fitted to assure absolute tightness.

By shielding the room completely, the ultra sensitive equipment will not register errors.


aerospace
bench

SUBCONTRACTING:



In recent years, a new dimension has been added to the aerospace industry manufacturing structure — the first tier subcontractor, a firm that has a specialized capability to accomplish major portions of a program at competitive prices for a prime manufacturer.

Today first tier subcontracting in the aerospace industry is big business. This is particularly true in the aircraft field, where the recent development of a new family of huge commercial and military transports demands subcontract assistance far beyond the requirements of the industry a decade ago. Further, under an increasingly widespread policy of "share-the-risk" on commercial programs, major subcontractors must have strong financial support for development, tooling, and preliminary production on the projects for which they are responsible.

Currently, a handful of prime contractors are developing and manufacturing all of the major transports being produced in the United States. They also have numerous other major programs in the broad field of aerospace. At the same time, there are still other prime contractors whose major programs have phased out or have been greatly curtailed, leaving them with surplus design, engineering and production facilities. To utilize these capabilities they have become major subcontractors.

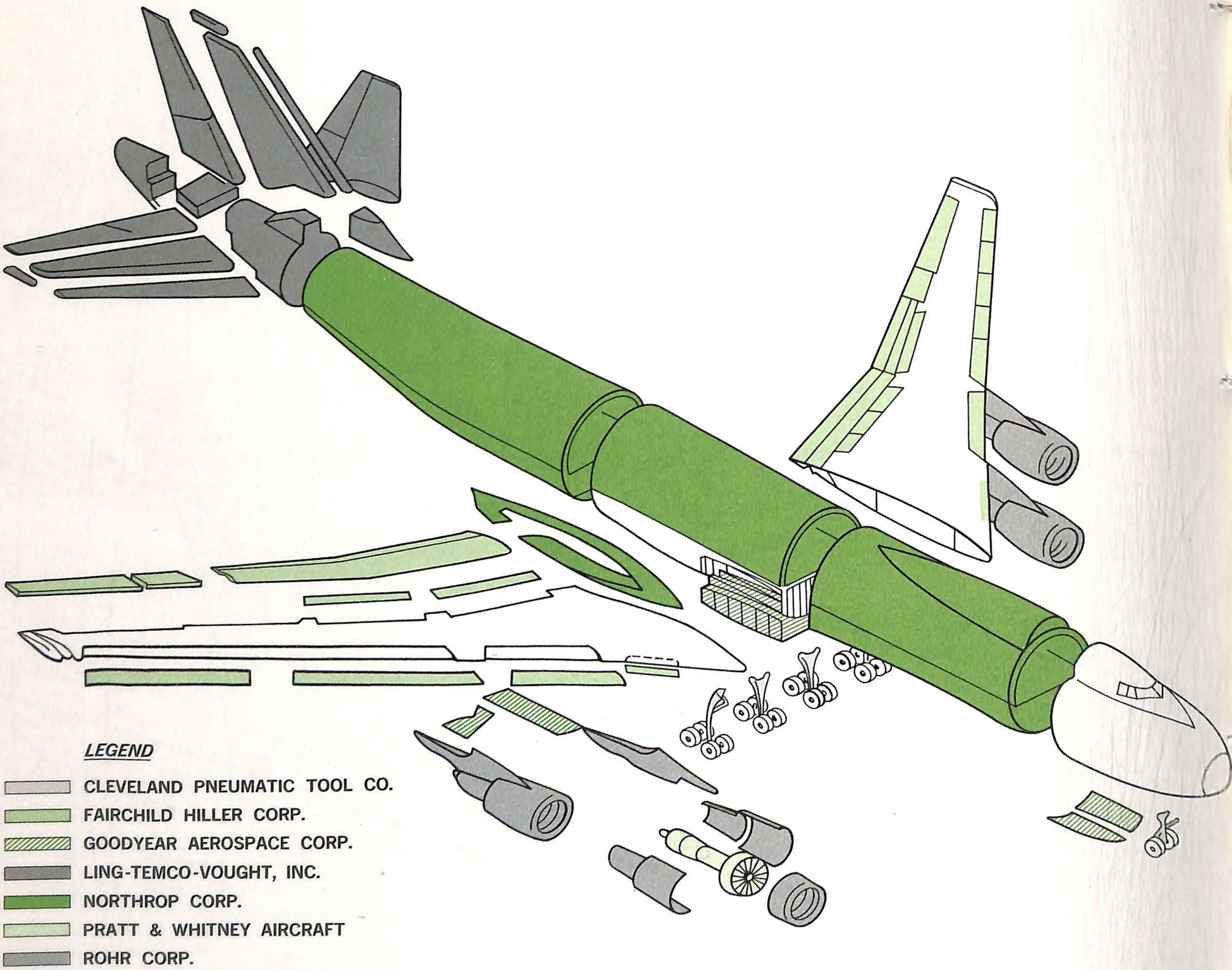
This development has had the effect of keeping intact the enormous capability of the industry, so that in event of a national emergency production could be quickly increased to meet requirements without waiting for a long period of recruitment and plant rehabilitation. With major subcontracts spread over a broader area of the industry, the larger subcontractors have created a greatly expanded roster of second tier subcontractors. This has a healthy effect on the economy of many small businesses and the communities in which they operate. These second tier subcontractors have no share-the-risk responsibility; they are paid when they deliver their products to the first tier.

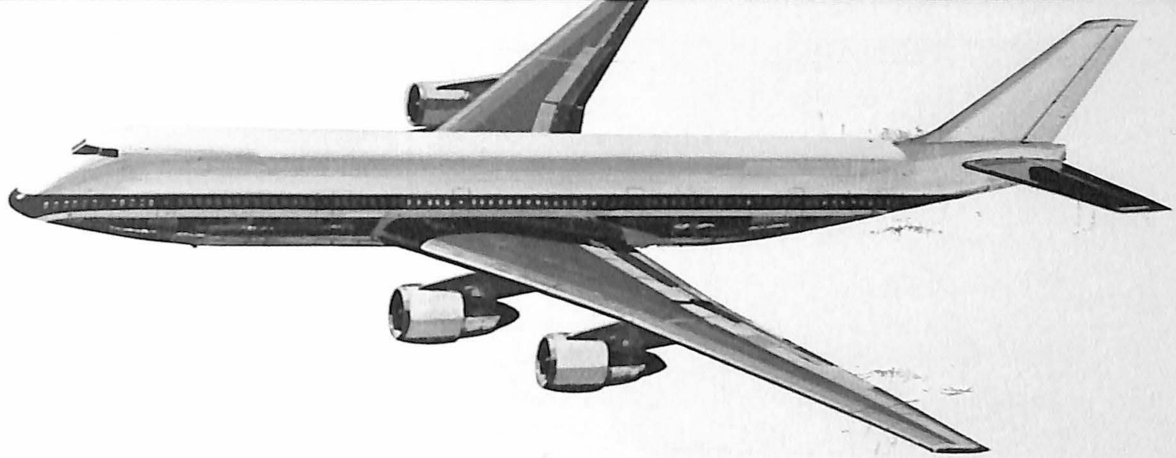
Demands by the transport contractors for a broader variety of assistance brought other firms, largely prime contractors themselves, into subcontracting. They were able to meet profitably the competition of those companies that were exclusively subcontractors. These companies are aware that their customer is their chief potential competitor because of the capability of the customer to produce most of the assemblies needed to complete a program. Consequently, for years firms specializing in subcontracting kept their engineering and administrative staffs to a minimum, thus holding down their overhead.

This situation has changed. Firms that are exclusively subcontractors have expanded their engineering and technical forces, and the primes entering the field find a ready demand for their entire organizations.

One example of an exclusive subcontractor who has kept pace with the demands of the industry is Rohr Corporation. There are other examples, of course, but Rohr several years ago began a consistent program of expanding and upgrading its engineering and technical organization. Today, it compares favorably with similar organizations of some of the primes.

Approximately 65 percent of the airframe weight of The Boeing Company's 490-passenger 747 commercial jet transport will be subcontracted. The subcontracted units are built to Boeing's engineering and quality standards and shipped to Boeing for installation, final assembly and flight test. Major subcontractors for the 747 are identified in legend. Pratt & Whitney Aircraft Division of United Aircraft Corp. is building the jet engines.





Rohr early specialized in the design and manufacture of "power packages," which later were called jet pods, for multi-engine aircraft, and currently is producing these units, along with numerous other assemblies, for all the large transports. This experience, and the diversification that accompanied the upbuilding of its engineering and technical facilities, has made Rohr perhaps the largest exclusive aerospace subcontractor in the industry.

Although the product mix of most major, first tier subcontractors is varied, there appears to be a tendency to specialize. In the recent award of subcontracts by Boeing on its 747, 490-passenger commercial transport, the six major subcontractors were companies that have become widely known for the products represented by the contracts they received. Rohr, for example, won the jet engine pod and pylon subcontract; Cleveland Pneumatic Tool Company, the 16-wheel landing gear; Fairchild Hiller Corporation, the ailerons, spoilers, wing trailing edge and leading edge flaps; Goodyear Aerospace, center wing section, and main and nose landing gear doors; Northrop Corporation, sections of the main passenger fuselage; and Ling-Temco-Vought, the tail surface and rear body section. These subcontracts, over the first eight or 10 years of production, are expected to amount to from $150 million to $250 million for each of the six companies.

Similar patterns of subcontracting are used by Douglas Aircraft Co. and Lockheed Aircraft Corp. for their transport programs. Lockheed is subcontracting 60 percent (by airframe weight) of the huge C-5A cargo aircraft it is building for the Air Force. Douglas subcontracts a substantial part of its DC-9 work.

Although most of the companies engaged in large subcontracting work have the capability to produce virtually any component for a major aircraft, each has established a special reputation in a particular area of manufacture, and the major primes more and more look to them as specialists.

Selection of major subcontractors is by no means a casual procedure by the primes. Until detailed plant and capability surveys convince the prime that the company in question can meet all specifications and production schedules, and maintain top quality, the latter is not invited or, in most cases, permitted to submit a bid or proposal. Also, on commercial programs, due to the share-the-risk provision, the subcontractor's financial responsibility must be established.

The preparation of bids and proposals by hopeful subcontractors has in itself become an expensive procedure. One subcontractor recently said that the cost of submitting a proposal has increased by at least 20 times, as compared to the cost of a proposal 10 years ago. This, alone, has eliminated many companies because after spending hundreds of thousands of dollars preparing a proposal, there is no assurance of winning the subcontract. Price is an all important consideration and, all things being fairly equal, it is the low price that wins. Cost-plus-fixed-fee contracts, except in a very few developmental programs, are a thing of the past. Rohr, for example, says that 98 percent of its contracts in its $335 million backlog are fixed price, won in competitive bidding.

Aircraft programs that 10 or 15 years ago totaled millions of dollars, today are figured in billions, and the biggest program of them all — the supersonic transport — is yet to come.

The efforts of companies, both prime and subcontractors, now producing today's airplanes and developing those of tomorrow, are by no means limited to aircraft. Missiles for the military and vehicles for space exploration are being developed with great rapidity, and the major aircraft builders are heavily involved.

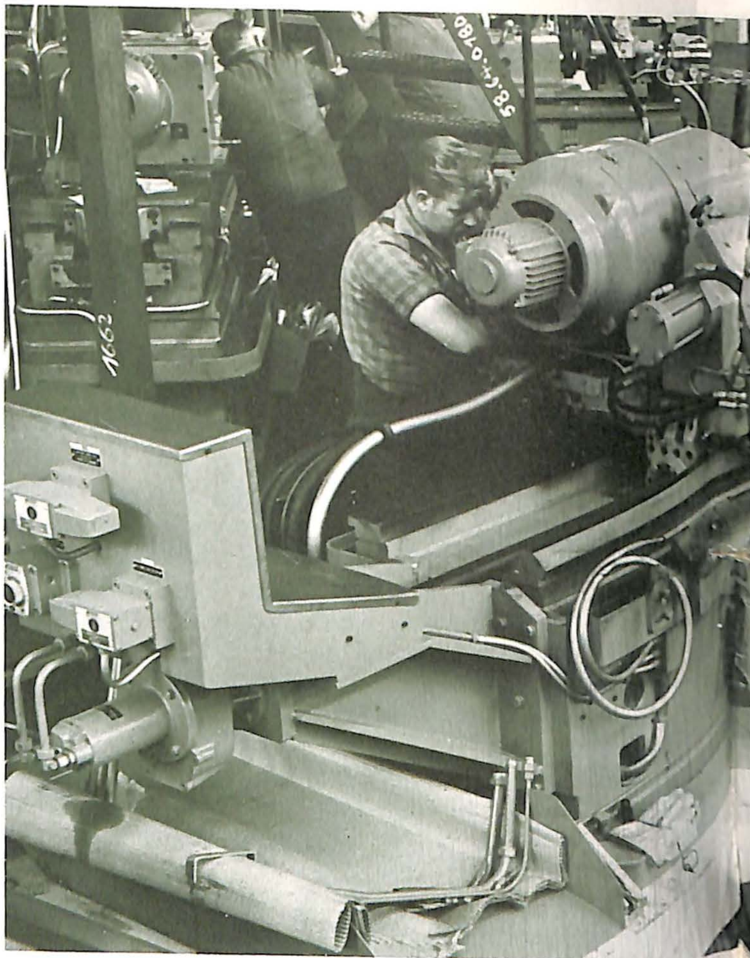
With perhaps a few exceptions, though, space product development has not been as attractive financially to many subcontractors as has the new revival in aircraft. One reason may be that comparatively few aircraft facilities are suitable for sophisticated space vehicle production, and heavy investments are required to provide the equipment necessary to participate to any appreciable degree in the subcontract programs. The leading primes and some of the major subcontractors who have the financial resources to do so have invested heavily in facilities.

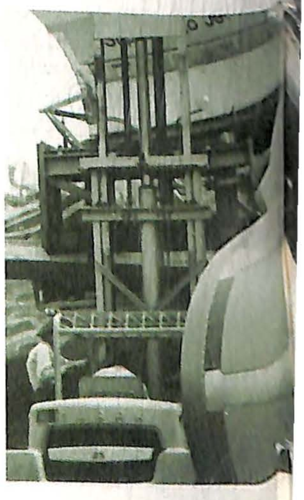
First tier subcontracting developments in aerospace have resulted in a stronger, more stabilized industry. A few years ago capacity greatly exceeded foreseeable production demands. It appeared then that some major companies, with fine production records, might be compelled to go out of business.

But this has not happened. By joining forces on some of the larger contracts, and spreading the required work over larger areas, the industry is utilizing the skills and facilities of most of the major firms within it. The requirements of today are so much greater than they appeared to be a few years ago that prospects for the next decade are bright.

BIG LIFT FOR BORERS

When United Aircraft's Pratt & Whitney Aircraft Division needed two profile boring machines ordered from a West German tool manufacturer to meet jet engine production commitments recently, the company had them shipped by air. The profile borers, each of which weighs 13 tons, are used to machine the interiors of eight-foot-long turbine shafts, a procedure requiring less than half the time and a fraction of the cost of the same job by conventional boring methods. ■ Lufthansa, the West German airline, loaded the 26 tons of sophisticated machinery aboard a Boeing 707-320C air freighter at Stuttgart, lashing each unit to the floor. When loaded, the shipment filled the entire 100-foot length of the cargo hold. It was the heaviest single shipment ever handled by Lufthansa. ■ Less than eight hours after takeoff from Stuttgart, the profile borers were landed at New York's John F. Kennedy International Airport. From Kennedy the machinery was trucked north to P&WA's North Haven, Conn., plant. By that time it had been in transit from the German manufacturer 4,000 miles away less than 48 hours. ■ Foundations were already in place at North Haven so the machines could be quickly installed and started into production. The company figures that what it saved in one day's production with the new profile borers more than offset the costs of air-freighting it from Germany. ■ Two additional profile borers ordered from the same manufacturer were shipped a few days later by surface transportation from Hamburg. Delivery of that shipment took three weeks. By the time they arrived at North Haven, the first two air-lifted borers were already in production. ■ But there were other savings besides the important one of time. The cost of more than a ton in packaging was saved by Pratt & Whitney on each machine. Shipping by air required only a minimum of plastic wrapping. The machines had been mounted by the manufacturer on skids for easy handling. Costs for handling were consequently less. On arrival there was not so much as a tear in the plastic cover protecting the precision machinery. ■ Insurance rates were lower too since the shipment was under maximum security at all time.





German machinists prepare big profile borer for air shipment.

Under plastic wraps, profile borer unit mounted on skid is carefully hoisted through front cargo door of Lufthansa jet freighter during night loading at Stuttgart.

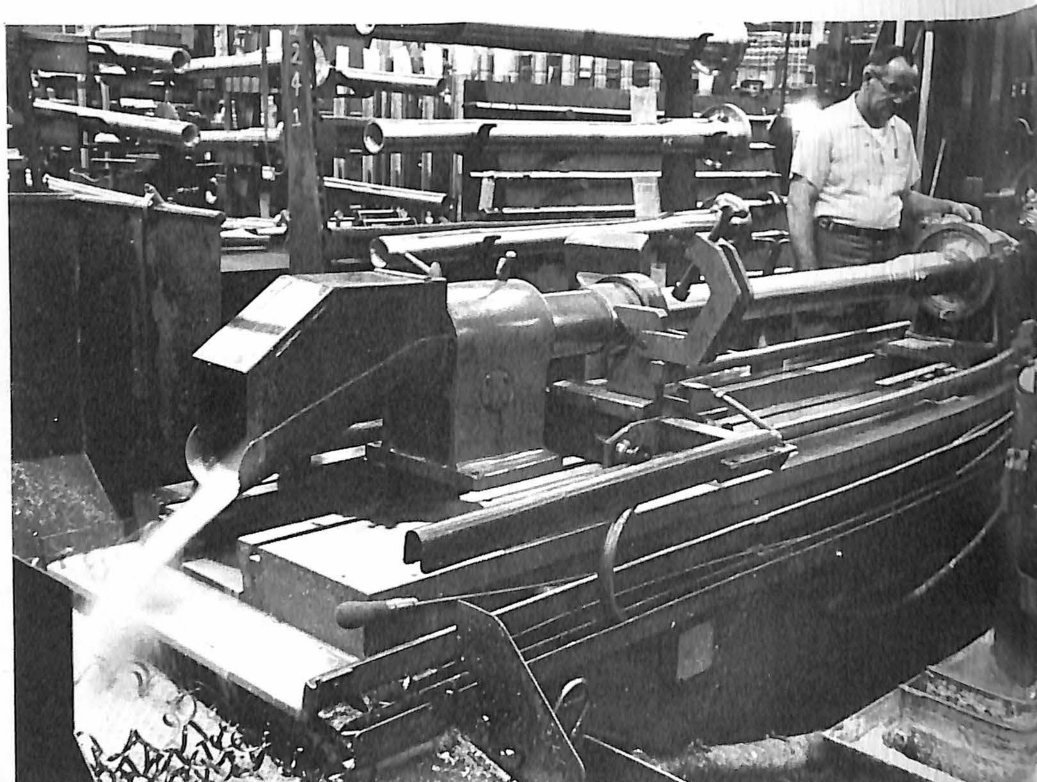
Trucked from factory, machinery arrives at Stuttgart's airport.

Inside hold, first unit of 26-ton load is rolled into position.

Eight hours later unloading begins at Kennedy International.

Each skid-load must be carefully eased out of the 100-foot long cargo hold at end of overseas flight.

Four units of boring machinery sit on Kennedy apron with accessory equipment upon completion of unloading, waiting for truck to carry it remaining distance to P&WA plant.



Since foundations were already in place at North Haven plant, profile borers could be quickly installed and placed in production. First turbine shaft is bored on new machine.

Harr Outlines Air Cargo Benefits

Commenting on the outlook for the growing air cargo business, Karl G. Harr, Jr., president of the Aerospace Industries Association, said recently in a speech in Atlanta, Georgia:

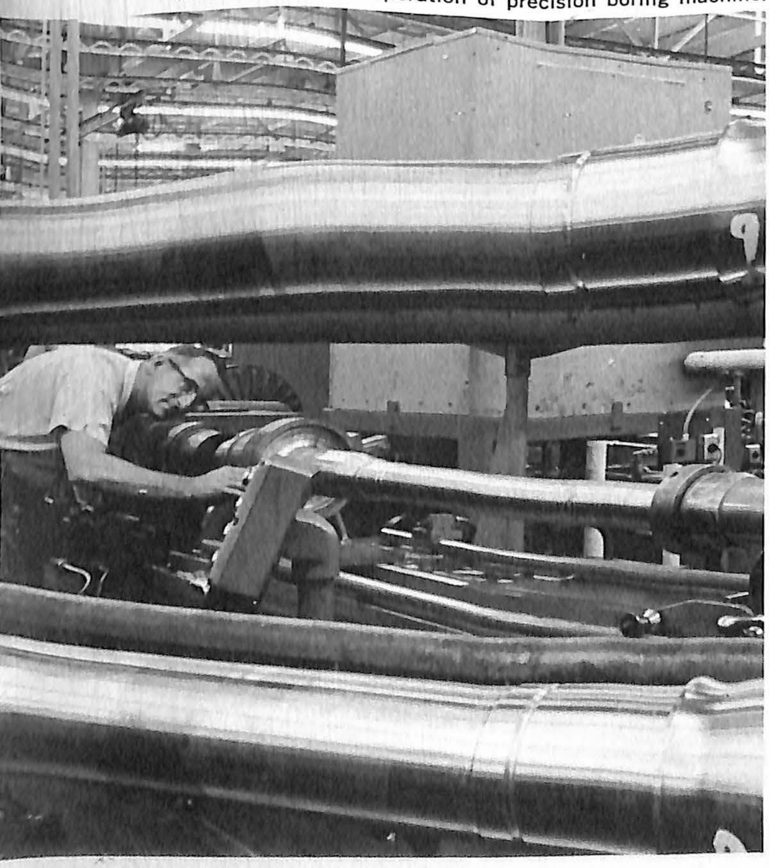
"The use of a jet cargo aircraft is providing the user with a unique opportunity to reappraise the entire costs and benefits derived from his current distribution practices. Not only is air cargo becoming competitive on a direct rate basis but it is enabling the manufacturer to reduce inventory costs, to reduce packaging costs, to reduce warehousing costs and to compress radically the length of time commodities are tied up and consequently non-productive in the distribution system.

"Management is being given a new opportunity to reduce costs by considering total distribution costs rather than transportation costs exclusively.

"At the present time shipments by air represent less than one percent of the nation's commercial domestic freight shipments. Even though this share is doubled, tripled or quadrupled in the next several years it will not satisfy the growing demands for transportation nor will it result in an absolute reduction in the dollar volume of other transportation modes.

"But the potential contribution of air cargo can be exploited for the benefit of the economy only to the degree to which it becomes part of an integrated system. It matters little how fast a point to point shipment may be made if all time saved in the air is lost on the ground by inaccurate tie-ins to the overall system."

Sighting along eight-foot long jet turbine shaft, P&WA machinist checks operation of precision boring machine.



AIA MANUFACTURING MEMBERS

Abex Corporation
Aerodex, Inc.
Aerojet-General Corporation
Aeronca Manufacturing Corporation
Aeronutronic Division, Philco 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
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 Corporation
Lear Siegler, Inc.
Ling-Temco-Vought, Inc.
Lockheed Aircraft Corporation
The Marquardt Corporation
Martin Company
McDonnell Aircraft Corporation
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
The Ryan Aeronautical Company
Solar, Division of International Harvester Co.
Sperry Rand Corporation
  Sperry Gyroscope Company Division
  Sperry Phoenix Company Division
  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

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

Huge profile boring machines were shipped by air cargo from Germany to U. S. (See *Big Lift for Borers,* page 14).

aerospace

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION • AUGUST 1966

■ **AIR FREIGHT— High and Climbing**

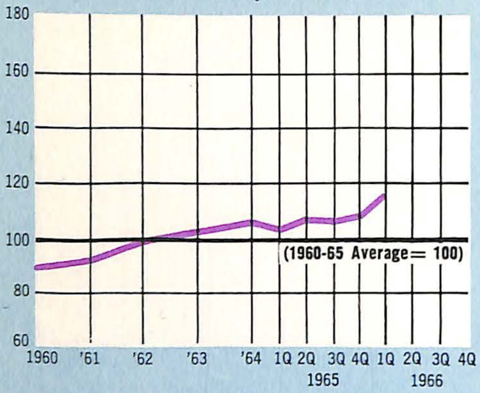
By Charles S. Murphy
Chairman, Civil Aeronautics Board

■ **EYES ON THE WEATHER**

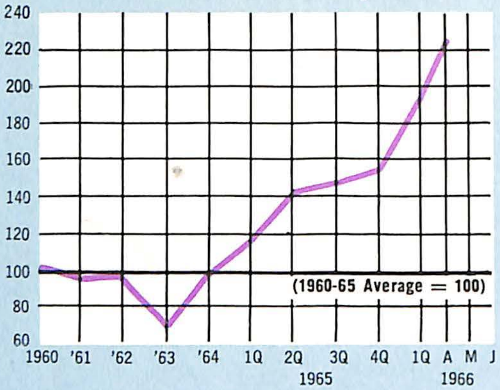
AEROSPACE ECONOMIC INDICATORS

CURRENT

Total Aerospace Sales

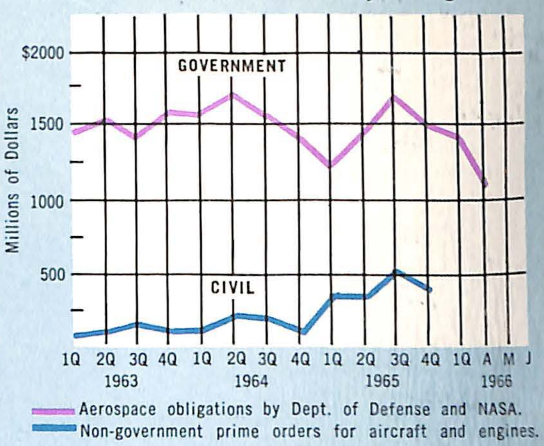


Value of Civil Aircraft Shipments



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 March 31	20.0	20.9	22.4 E
	Billion $	Quarterly	4.8	1966	5.0	5.3	5.6
DEPARTMENT OF DEFENSE							
Aerospace obligations: Total	Million $	Monthly	1,151	May 1966	914	1,247	785
Aircraft	Million $	Monthly	601	May 1966	588	859	584
Missiles & Space	Million $	Monthly	550	May 1966	326	388	201
Aerospace expenditures: Total	Million $	Monthly	1,067	May 1966	938	1,016	759
Aircraft	Million $	Monthly	561	May 1966	527	628	528
Missiles & Space	Million $	Monthly	506	May 1966	411	388	231
NASA RESEARCH AND DEVELOPMENT							
Obligations	Million $	Monthly	215	May 1966	337	240	296
Expenditures	Million $	Monthly	180	May 1966	334	400	485
UTILITY AIRCRAFT SALES							
Units	Number	Monthly	692	June 1966	978	1,485	1,396
Value	Million $	Monthly	15	June 1966	27	37	38
BACKLOG (60 Aerospace Mfrs.): Total	Billion $	Quarterly	15.3 #	Quarter Ending	15.2	18.7	20.4
U.S. Government	Billion $	Quarterly	11.6	Dec. 31	11.7	12.7	13.7
Nongovernment	Billion $	Quarterly	3.7	1965	3.5	6.0	6.7
EXPORTS							
Total (Including military)	Million $	Monthly	110	May 1966	113	151	118
New Commercial Transports	Million $	Monthly	24	May 1966	18	50	28
New Utility Aircraft	Million $	Monthly	2	May 1966	7	9	9
PROFITS				Quarter Ending			
Aerospace — Based on Sales	Percent	Quarterly	2.3	March 31	2.7	3.5	3.1
All Manufacturing — Based on Sales	Percent	Quarterly	4.8	1966	5.4	5.7	5.6
EMPLOYMENT: Total	Thousands	Monthly	1,132	May 1966	1,130	1,261	1,273 E
Aircraft	Thousands	Monthly	499	May 1966	488	532	537
Missiles & Space	Thousands	Monthly	496	May 1966	515	558	564
AVERAGE HOURLY EARNINGS, PRODUCTION WORKERS	Dollars	Monthly	2.92	May 1966	3.15	3.34	3.36 E

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.

COMMERCIAL TRANSPORT BACKLOG—A RECORD HIGH

The backlog for commercial turbine-powered transports increased more than $1 billion in the six months from Dec. 31, 1965 to June 30, 1966, and was at a record high of $4.7 billion at mid-point of this year.

In this same period, the number of turbine transports on order rose from 809 to 941, an increase of 16 percent, according to reports to the Aerospace Industries Association from The Boeing Company, Douglas Aircraft Company and Fairchild Hiller Corporation.

Commercial transport backlog for export rose from $986 million in the six-month period to more than $1.3 billion, and the number of aircraft ordered by foreign customers increased from 212 to 268, a 26 percent gain.

The rising level of orders has resulted in a demand for more commercial transport aircraft employees. A recent survey of aerospace employment by AIA showed that transport employment was expected to rise nearly 36 percent from 66,919 to 90,800 between September 1965 and June 1966. Employment of scientists and engineers in transport assignments was predicted to increase from 7,157 to 9,368, a gain of about 31 percent.

The recruiting and training of new production workers is one of the most knotty problems facing the transport manufacturers. As an example, a manufacturer of commercial transport engines has established a goal of hiring 1,500 workers a month for the next year. In most cases the skill level of most of the new workers must be sharply raised in order to meet demanding quality requirements.

The present high level of orders for transport aircraft is the result of several developments in both the airline and aerospace industries:

These include:

- The current expansion and modernization of the airline fleet largely resulting from the growing demand for airline travel.
- The development of subsonic aircraft even more efficient than those now in operation, with resultant declining operating costs.
- The rapid expansion of air freight in both domestic and foreign markets.

The primary impetus for the increase in orders for transport aircraft has been the rapid traffic growth in past years and predictions for a faster growth rate in the future. The Federal Aviation Agency has forecast a long-run normal growth between 1965 and 1971 of a minimum of nine percent per year for the domestic market. The international traffic of the U. S. carriers, according to FAA, is also expected to increase steadily.

AIA

aerospace

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The purpose of AEROSPACE is to:

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

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

Foster understanding of commercial and general aviation as prime factors in domestic and international travel and trade;

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

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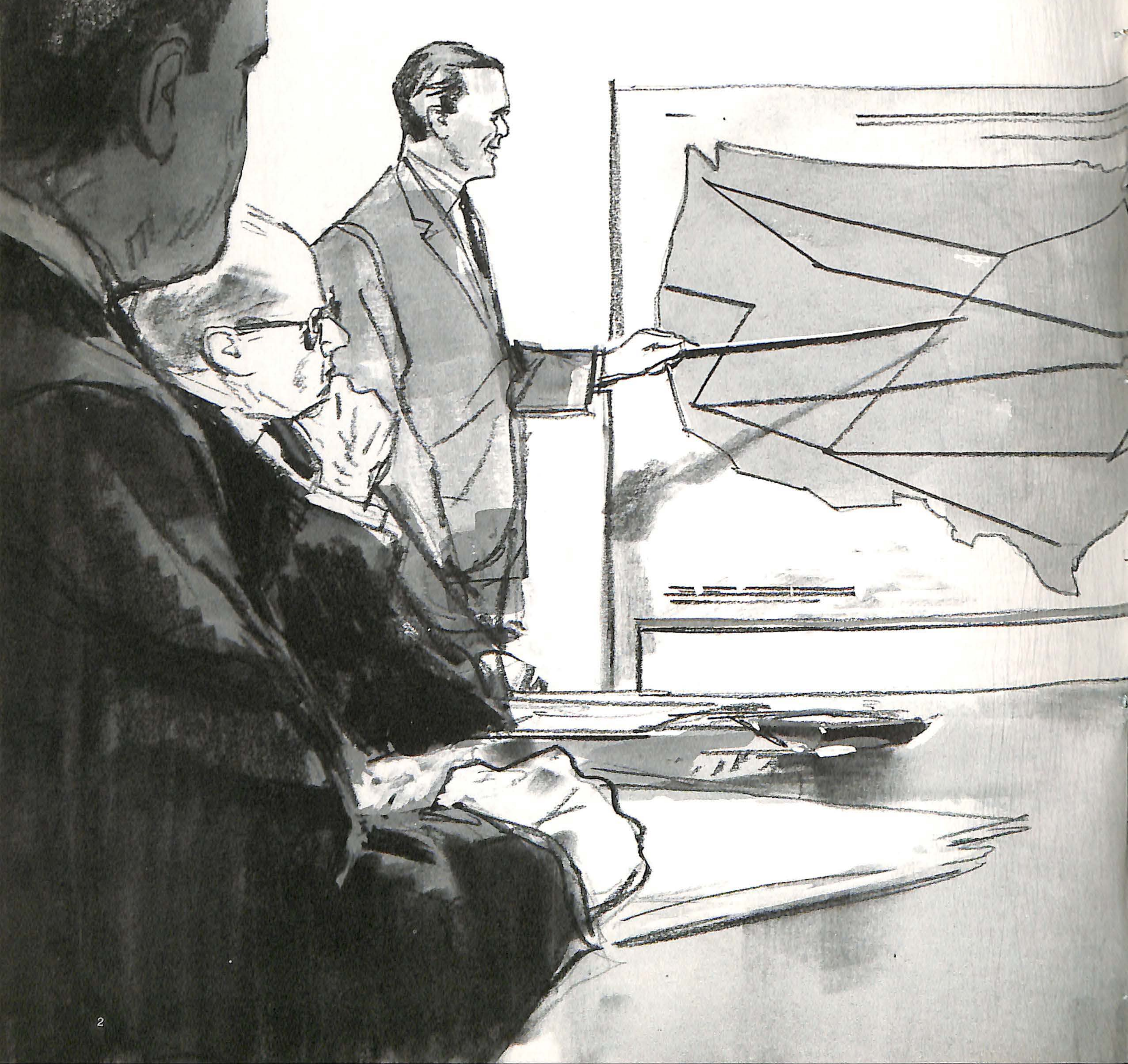
AIR FREIGHT—High and Climbing

By **CHARLES S. MURPHY**, *Chairman*
Civil Aeronautics Board



Once considered an incidental stepchild of the airline industry, the air freight business has exploded into a major enterprise with prospects of expanding even more rapidly in the immediate future. Today's air freight boom is beyond the expectations of the clearest-eyed optimist even a decade ago.

Growth of this important segment of the airline industry had been gradual up until the advent of jet freighters. In 1960, cargo ton-miles amounted to 18.1 percent of the total revenue ton-miles. In 1965, it amounted to 25.8. Despite increasing passenger traffic and decreasing cargo rates during this same period, freight revenue moved from 10.1 percent of total airline revenues to 11.4 percent. Over the past 10 years, cargo traffic has multiplied four times in volume.

In terms of ton-miles, there seems little doubt that the volume of air freight business will become larger than the air passenger business in our generation. It could be that technological developments to come will lead to even far greater growth than now foreseen.

Air freight's growth has been directly related to the nation's economic upswing and the capacity of the air carriers to provide sufficient space for freight. In 1950, the best freight aircraft then available, the Douglas DC-6A, could produce 46,000 ton-miles of air freight service per day. Today's DC-8F jet freighter can pro-

Surge of air freight business underscores the need for improved communications between air carriers and shippers. Representatives from both groups will meet this fall in a series of air cargo workshops in five cities to discuss problems and prospects.

duce 240,000 ton-miles of service per day, a five-fold improvement. Tomorrow's air cargo giants, the Lockheed C-5A and Boeing 747 air freighters, will double the ton-miles of service produced per day by a DC-8F.

In the past five years, air freight traffic has more than doubled. Airlines expected a 16 percent increase in the domestic freight field in 1965. They achieved a 25 percent increase. Internationally, the airlines planned for a 25 percent increase and achieved a 46 percent increase. Some airline economists are even predicting that their goals set for 1970 will be achieved in 1966.

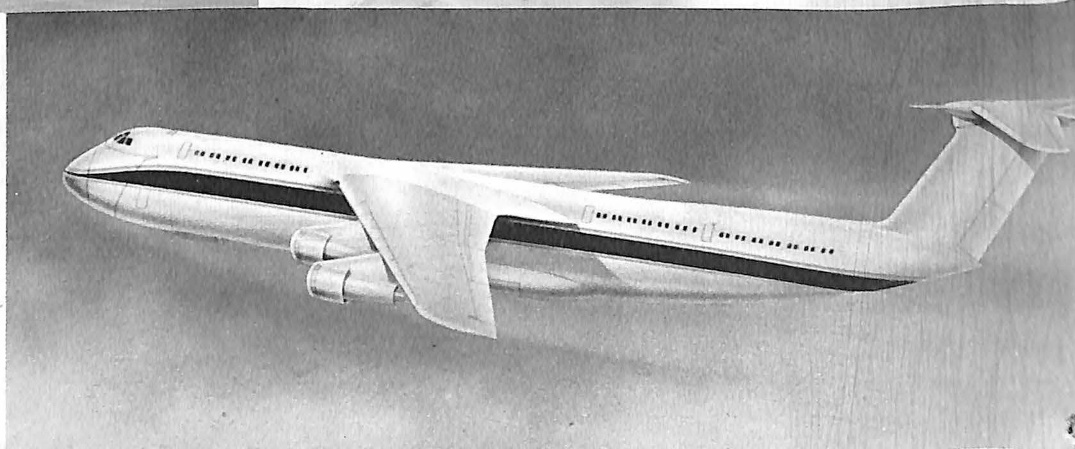
The scheduled airlines have a combined fleet of all-cargo freighters numbering 55 jets in addition to 23 turboprops and 85 piston-powered aircraft. If this fleet is utilized with maximum loads in average service, it can develop 19 million ton-miles of cargo service daily.

On order are more than 100 jet freighters capable of producing an additional 25 million ton-miles of service a day.

It should be noted that air freight is beginning to pay its own way. The operation of scheduled all-cargo service by the certificated industry is now in the profit column. The all-cargo plane operations of certificated carriers for the year ending December 31, 1965, resulted in an operating profit after taxes of $6.3 million. The international/territorial operations provided $11.7 million of this profit while the domestic operations resulted in a loss of $5.4 million. However both carrier groups continue to show improvement in earnings and the profit trend for all-cargo aircraft is continuing in 1966.

The all-cargo freighters are only a part of the story. Most air freight is flown in the cargo compartments of

Air freighters of the future such as the Lockheed 500 (right) and the Boeing 747 (top right) are expected to double the ton-miles of service produced per day by today's Boeing 707-320C (top left) or Douglas DC-8F (bottom).



passenger airliners. On the propeller-driven airliners in 1958, only 3,000 to 5,000 pounds of cargo capacity was available on a typical transcontinental non-stop passenger flight. Today's jet airliner handles up to 20,000 pounds of cargo in addition to passenger baggage. In other words, today's passenger jet's cargo hold accommodates as much freight as the entire cabin space in the old DC-4.

Air freight volume last year alone totalled 1.7 billion ton-miles, an increase of 32.9 percent for the year.

One of the reasons for the recent upsurge in air freight has been the decision by more and more manufacturers to distribute their products by air. Everything from heavy machine tools to fragile cut flowers, fruits and vegetables is being carried by air. Deliveries formerly requiring days now require hours. This speed and convenience provides the advantage of lower warehousing costs, less inventory tied up in transit, less product obsolescence, lower insurance costs, lower packaging costs and a shorter reorder-delivery cycle for industry.

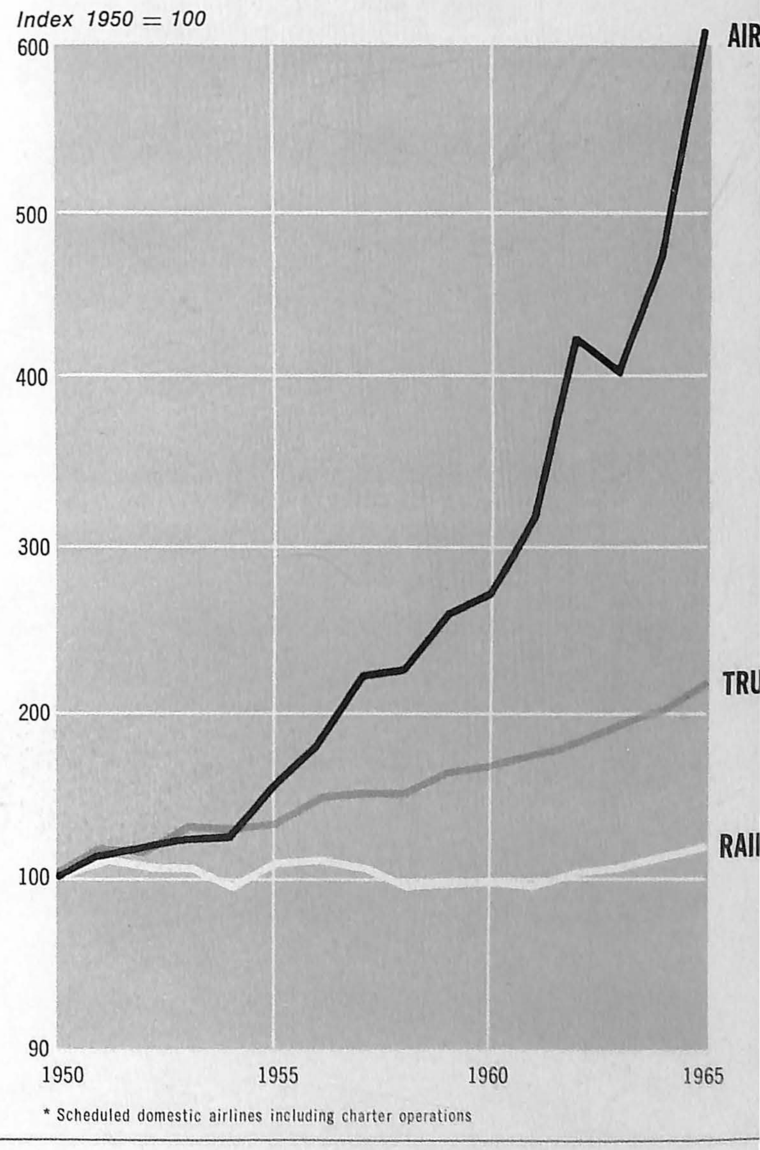
A greeting card company, for example, saved an estimated $90,000 a year by closing a warehouse and making direct air freight shipments from its home plant. Sears, Roebuck now supplies its Honolulu stores by air freight from Los Angeles. A maker of baby shoes, who previously distributed part of his output through warehouses, cut two days in total distribution time by making shipments by air and closing down warehouse facilities. Pratt & Whitney Aircraft Division of United Aircraft Corporation recently received heavy, sophisticated machine tools by air from a German firm. The company figures it saved more than the cost of the air freight in the first day's production with the new machinery. Honeywell Inc. began using air freight in January for all of its exports of computers and other electronic products and expects to realize annual savings in excess of $240,000.

To an increasing degree, air-shipped products are no longer being limited to perishables of high value. The deciding factor in choosing a particular mode of transport has now become the overall margin of profit to be realized rather than the lowest priced service.

The greater use of computers in compiling data on all aspects of total distribution costs as well as in mon-

Twenty-ton drill rig is loaded aboard a Lockheed L382 Hercules commercial transport at Fairbanks, Alaska, for a flight across the Brooks Mountain range.

GROWTH OF DOMESTIC CARGO TRAFFIC
Intercity Cargo Ton-Miles



* Scheduled domestic airlines including charter operations

itoring inventory levels is a major factor behind today's phenomenal growth in air freight. In addition, more efficient aircraft resulting in lower freight rates as well as the aggressive marketing campaign of the airlines have contributed significantly to this growth.

The advantages of using air freight can be very great to a shipper of products involving tens of thousands of spare parts or large varieties of sizes and colors or to a shipper that needs only to maintain a single national warehouse with a short reorder cycle.

Because of the spurt of growth in air cargo, the airlines have also found means of improving loading and unloading operations on the ground to the point where a jet freighter can today be loaded or unloaded in less than half an hour. Handling and packaging costs have been lowered by means of the adoption of standardized containers which can be loaded in the shipper's own plant for direct delivery to planeside.

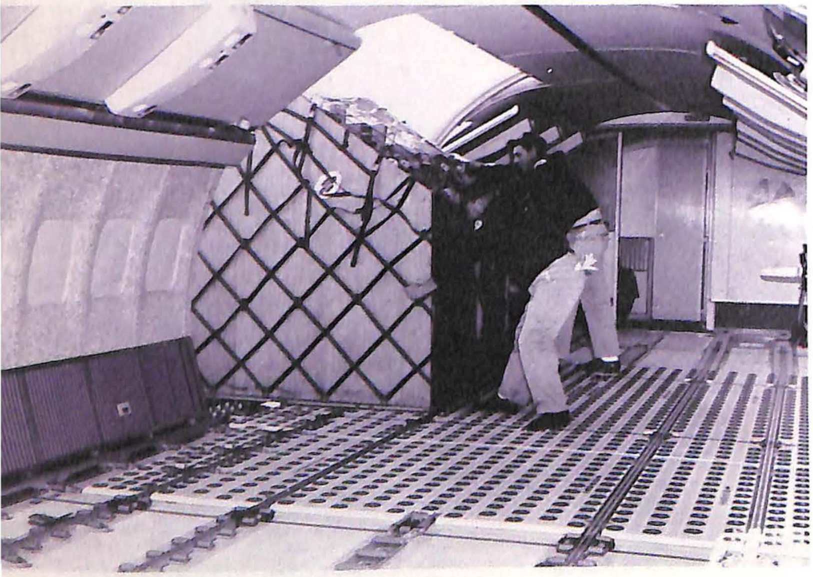
New mobile lifts, pallet transporters and planeside loaders have been developed to speed the transfer of goods. Eventually we expect to have air freight terminals in which one man operating a console of push button controls sorts freight by destination and flight and positions it for pallet build-up. Documentation of each shipment can be done electronically to cut down further on time.

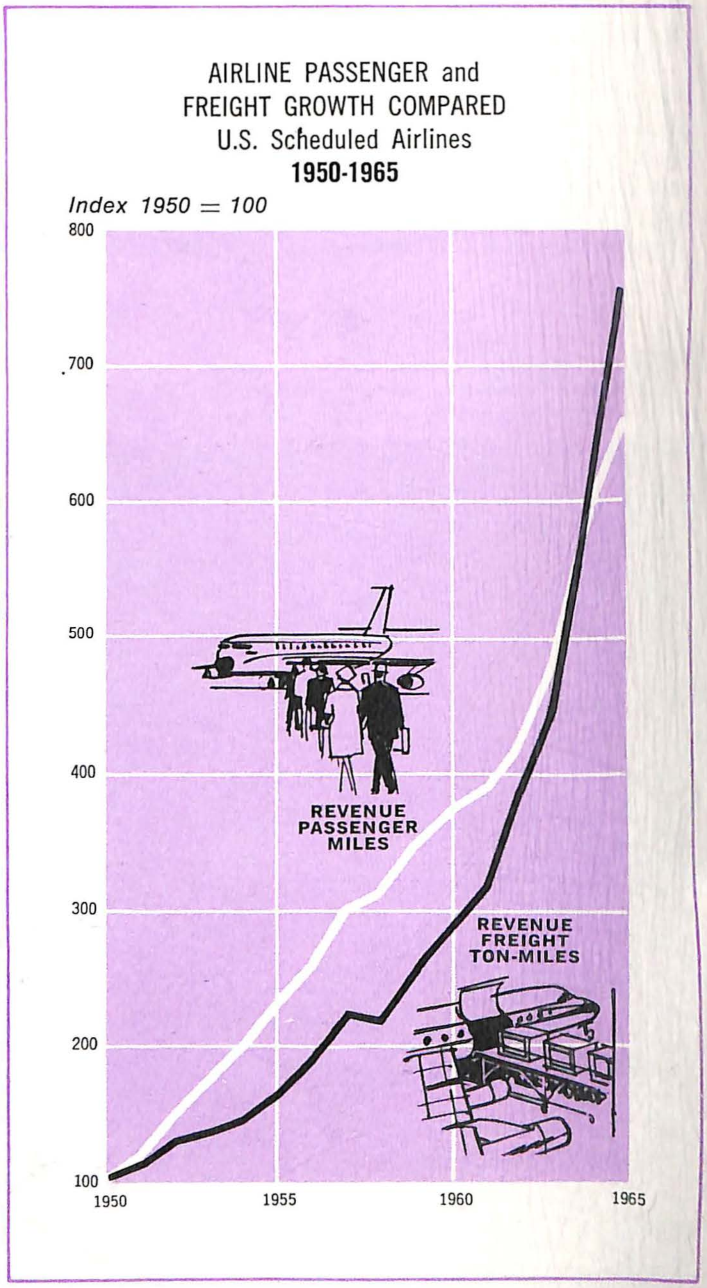
The jet age has not only doubled the speed of airlifting freight but has also cut in half the time required for handling cargo on the ground.

But even more must be done to improve ground handling if the full potential of increased air lift capacity and its speed is to be fully realized.

Although statisticians are fond of citing that 99 percent of the nation's freight now moves by surface

Boeing 727QC (quick change) crew members move seat and galley pallets to cargo door (above). Cleared of seat and galley pallets, cargo pallets are loaded (below). Change to cargo configuration has been made in eight minutes, increases utilization and earning power of the aircraft.





carriers, such a mathematical exercise ignores the fact that air and surface transportation are not and never will be 100 percent directly competitive. But the time is near when air transportation will dip into those commodity areas which are directly competitive with motor and rail carriers on a ton-mile cost basis.

As the gigantic air freighters of the future are placed in service, flying greater capacity loads at lower ton-mile cost, more and more shippers can be expected to change their distribution patterns from surface to air.

The recent surge of air cargo has pointed up the need for improved communications between air carriers and shippers. The momentum of the development of air transportation has been so swift that it has outpaced communications between carriers and their customers. The future expansion of air freight cannot rely entirely on single carrier contact and communication with individual shippers.

Recognizing the need for a broad interface between the carrier industry and the nation's shippers, the Board has worked out arrangements with the National Industrial Traffic League to conduct jointly a series of five regional air cargo workshops throughout the United States this fall. NITL sponsorship of these workshops should prove to be very effective, representing as it does some 1,600 industrial and manufacturing concerns, traffic and trade associations and chambers of commerce.

For many years, surface carriers and their customers have, by means of statutorily-approved rate bureaus and various types of shipper-carrier advisory boards, joined in discussions with respect to mutual problems and joint programs. Up to the present time, there has been no requirement for a similar air freight-oriented dialogue. But all this is changing and the CAB-NITL program has been designed to establish a direct channel of communication between shippers and carriers.

The workshop programs will be held in five major cities: Seattle, Miami, New York, Chicago and Los Angeles. Invitations to attend have been extended to industrial traffic managers and air carriers, both domestic and international. Members of the CAB will attend and assist in the discussions. It is hoped that from these joint discussions will evolve a valuable contribution upon which future air cargo business will rely heavily.

Roundtable discussions will center around the service requirements of shippers and the capabilities of air carriers to meet them, an analysis of carrier rate publication procedures, the role of the CAB, and shipper participation and contribution to the rate-making process.

Our transportation needs in the days, weeks and months ahead will be so vast that we will need to make the most effective use of every mode of transportation available to us. Air freight transportation, like all transportation, will play a major role in the overall solution. The CAB has an obligation to promote the kind of air transportation system that will serve the public interest best. That means we should seek the most efficient use of the resources devoted to air transportation and seek to obtain the best possible service at the lowest reasonable costs.

10 TOP COMMODITIES MOVING IN DOMESTIC AIR FREIGHT

(Based on Revenue Ton-Miles)

1965	1955
1. Machinery parts and equipment	1. Machinery parts and equipment
2. Auto parts and accessories	2. Cut flowers
3. Wearing apparel	3. Electrical products
4. Printed matter	4. Wearing apparel
5. Electrical products	5. Printed matter
6. Fresh fruits, vegetables and berries	6. Auto parts and accessories
7. Cut flowers	7. Aircraft parts
8. Magazines and books	8. General hardware
9. General hardware	9. Advertising display matter
10. Metal products	10. Photographic film

Joseph T. Geuting, Jr., vice president and a director of NAEC, and manager of AIA's Utility Airplane Council, presents the Brewer Trophy to Mrs. Marshall.

Mrs. Marshall Is Awarded Brewer Education Trophy

Mrs. Jane N. Marshall of Washington, D. C., is the winner of the 1965 Frank G. Brewer Trophy, awarded annually for outstanding contributions to aerospace education of the nation's youth.

The citation for Mrs. Marshall stated: "For her contributions to enlarged aerospace horizons for those who teach our nation's youth. Through her creative writing in educator-oriented aerospace publications, her development of timely bibliographies and teaching aids, and her leadership in the organization and administration of aerospace education workshops for teachers, she has contributed significantly to fuller understanding of the impact of flight upon all Americans."

As editor for the National Aerospace Education Council, Mrs. Marshall has compiled three aviation education bibliographies and several editions of an aerospace education sourcebook. Under an NAEC contract with the National Aeronautics and Space Administration, she has compiled three editions of an extensive aerospace bibliography.

She is the writer and editor of **SKYLIGHTS**, a monthly publication of NAEC, and author of **Aerospace Highlights, Helicopters at Work,** and **Project Apollo—Manned Flight to the Moon.**

Aeronautical Propulsion Hall Opened at Smithsonian

The Smithsonian Institution has opened the Hall of Aeronautical Propulsion which traces aviation's historic advances from the supercharger to the turbojet.

A product of the vast collections of the National Air Museum, the exhibition features eight piston engines with various cylinder configurations, from a pre-World War I rotary, through World Wars I and II "V" and inline engines, to a post-World War II radial and a horizontally opposed engine. Four turbojets, a World War II engine with an operating cutaway — illustrating the centrifugal air compressor — and a modern unit with an "operating" cutaway showing the axial flow air compressor are also on display.

Between the piston and the turbojet engines is a turbosupercharger (in effect, a jet engine minus a fuel-burning system) that links the two types of engines.

In addition, seven propellers are exhibited — three of which are grouped as an educational display to link the principal categories.

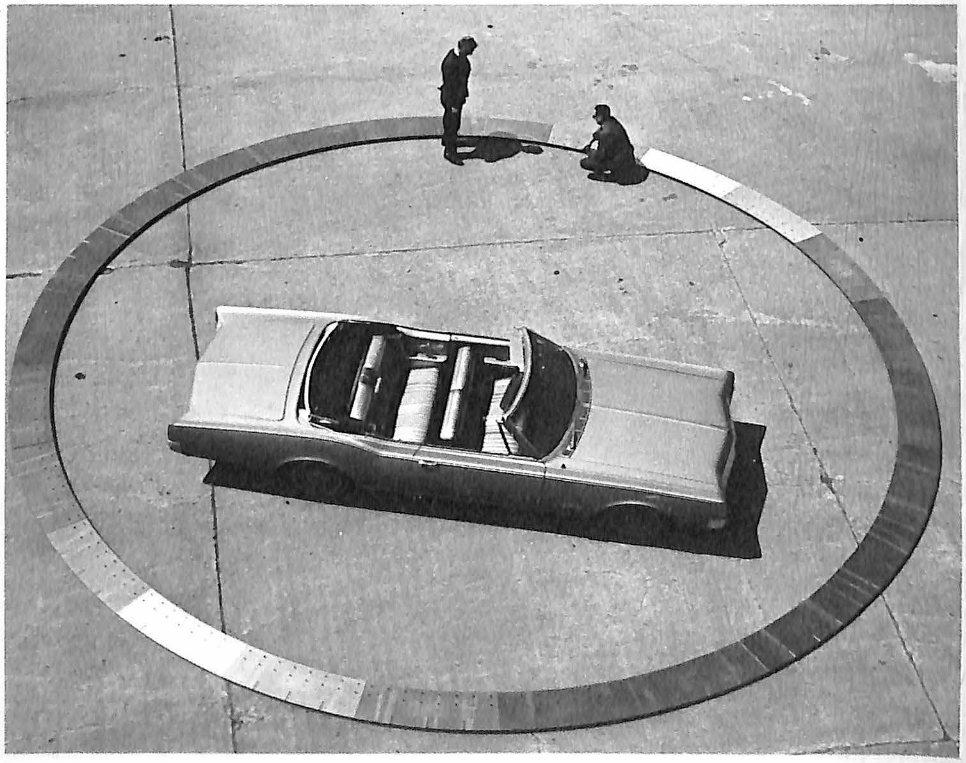
Goodyear Brake Performs Apollo Deceleration Tests

Something new in brakes has been developed by Goodyear Tire & Rubber Company at Akron, Ohio, for post-Apollo space flight research at the Ames Research Center of the National Aeronautics and Space Administration. The high torque capacity hydraulic brake will be used in NASA's man-carrying motion generator in which Apollo astronauts will simulate soft landings on the moon.

The Goodyear brake will provide deceleration from approximately 60 feet per second or 41 miles an hour, to zero in two-tenths of a second. The $6.5 million simulator will be the heart of Ames Research Center's new $10 million Space Flight Guidance Facility near Mountain View, Calif.

The motion generator is a highly complex centrifuge with a 50-foot boom having an acceleration capability of up to 50 Gs. Either a one-man or three-man capsule can be affixed to the end of the boom suspended in a gimbal fixture so that motions can be made about three flight axes. It will be able to represent realistically a complete space mission from launch through mid-course flight to reentry and landing under both normal and abort conditions.

Goodyear's custom-designed brake system consists of a disc that is 32 feet four inches in diameter and six brake assemblies spaced around the disc. It is fabricated in 24 segments and machined to a thickness of five-eighths of an inch. The six brake assemblies will be mounted on the centrifuge room foundation. At each maximum brake application, friction pads will squeeze against a steel disc with about 3.8 million pounds of pressure achieving a stop force of nearly eight Gs.



Bell Air Cushion Vehicle Used in Vietnam Operations

Patrols along the Mekong Delta region of South Vietnam are using three armed air cushioned vehicles developed by Textron's Bell Aerosystems Company from a British design.

This seven-ton vehicle, designated the PACV for Patrol Air Cushion Vehicle by the Navy, has no difficulty coursing across shallow water, sand bars and even rice paddies peculiar to that area. The craft can travel at speeds exceeding 65 miles per hour on a four-foot thick cushion of air forced downward beneath the craft by a horizontally-mounted fan.

Both the cushion fan which supports the craft and the aft-mounted propeller which gives it forward speed are driven by a 1,000 shaft horsepower General Electric marine gas turbine engine.

Bell supplied the Navy with three of these new craft and trained the crews to operate them along the Niagara River near the firm's Buffalo, N.Y., plant.

Martin To Convert F-106Bs To Advanced Pilot Trainers

Two F-106B jet fighters will be converted into this nation's most advanced pilot trainers by the Martin Company for the Air Force.

The two-seat jets will be able to simulate accurately the landing maneuvers of lifting body spacecraft and the flight characteristics of a wide variety of high performance aircraft including the F-111, F-104, F-4 and the rocket-powered X-15 research plane.

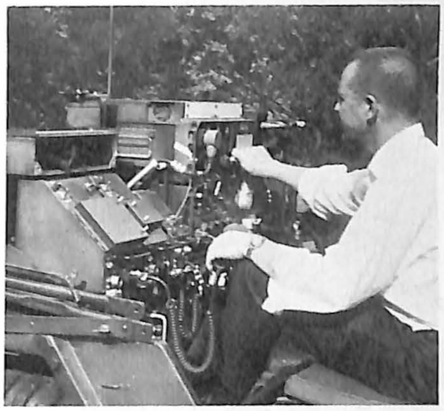
Called Variable Stability Trainers (VST) in their modified forms, the aircraft will be assigned to the Aerospace Research Pilots' School at Edwards Air Force Base, Calif., after conversion and flight testing by Martin's Baltimore Division.

The VST's most important mission at Edwards will be as trainers for pilots picked to fly maneuverable lifting bodies — wingless aerospace vehicles which derive lift from their shape alone.

Martin is currently building two such lifting bodies for the Air Force, an unmanned vehicle called PRIME and a manned vehicle called SV-5P under the PILOT program.

Mobile Communication Units Serve Forward Air Controllers

First mobile, jeep-mounted communication centers specifically designed and built to military specifications for forward air control parties are rolling off



production lines of General Dynamics Electronics Division at Rochester, N.Y.

Units consist of four radios and associated antennas mounted on a base that can be moved from their normal jeep-mount to an armored personnel carrier or light truck if the need arises.

Produced under an Air Force $10 million contract, units are designed to meet the needs both of a direct air support party and of tactical air control parties. They provide immediate communication with both air and ground forces whether vehicle in which they're mounted is moving or stopped.

Operating over high, very high and ultra high frequencies, they can transmit and receive with sets in aircraft, ground stations or manpack units. They can be powered from the jeep's own power system or from a trailer-mounted portable generator system.

The units will be operated by Tactical Air Command, the Pacific and European Air Forces, and supporting elements of the Air Force Communications Service.

AEROSPACE POWER Tells Aviation, Space Achievements

AEROSPACE POWER, A Pictorial Guide, by Charles Coombs, deals with America's achievements in and the aerospace industry's contribution to aviation and space flight. Mr. Coombs says that gathering material and writing a book on a subject such as aerospace where things change and move so fast — "yesterday's satellite is today's museum piece" — is akin to chasing a phantom. These difficulties notwithstanding, Mr. Coombs has produced a volume that is an invaluable reference book and makes absorbing reading for both the student as well as the aerospace sophisticate.

By the chronological assemblage of a collection of photographs and illustrations covering major phases of the industry, all linked together with narrative and full captions, Mr. Coombs has created an illuminating story of this country's aviation and space program.

In the book's Foreword, Karl G. Harr, Jr., president of the Aerospace Industries Association, commends the author for having "written skillfully about a most exciting industry with a pictorial panorama that is as up to date as tomorrow's countdown." Mr. Harr states the book should go far in penetrating the information barrier that frequently arises between the public and the industry because of those associated with the industry who "slip too easily into professional jargon and parochial assumptions."

Readers of this historical review of U.S. achievements in private, commercial and military aviation and in space cannot help but arrive at the same conclusion as that of Mr. Coombs: "It is man's nature to reach for the stars, and his reach is getting longer each day." (AEROSPACE POWER, A Pictorial Guide, Charles Coombs, William Morrow and Co., N.Y. 1966, $4.95)

EYES ON THE WEATHER

"Seldom, if ever, has a complex technological effort in its early stages returned such valuable dividends."

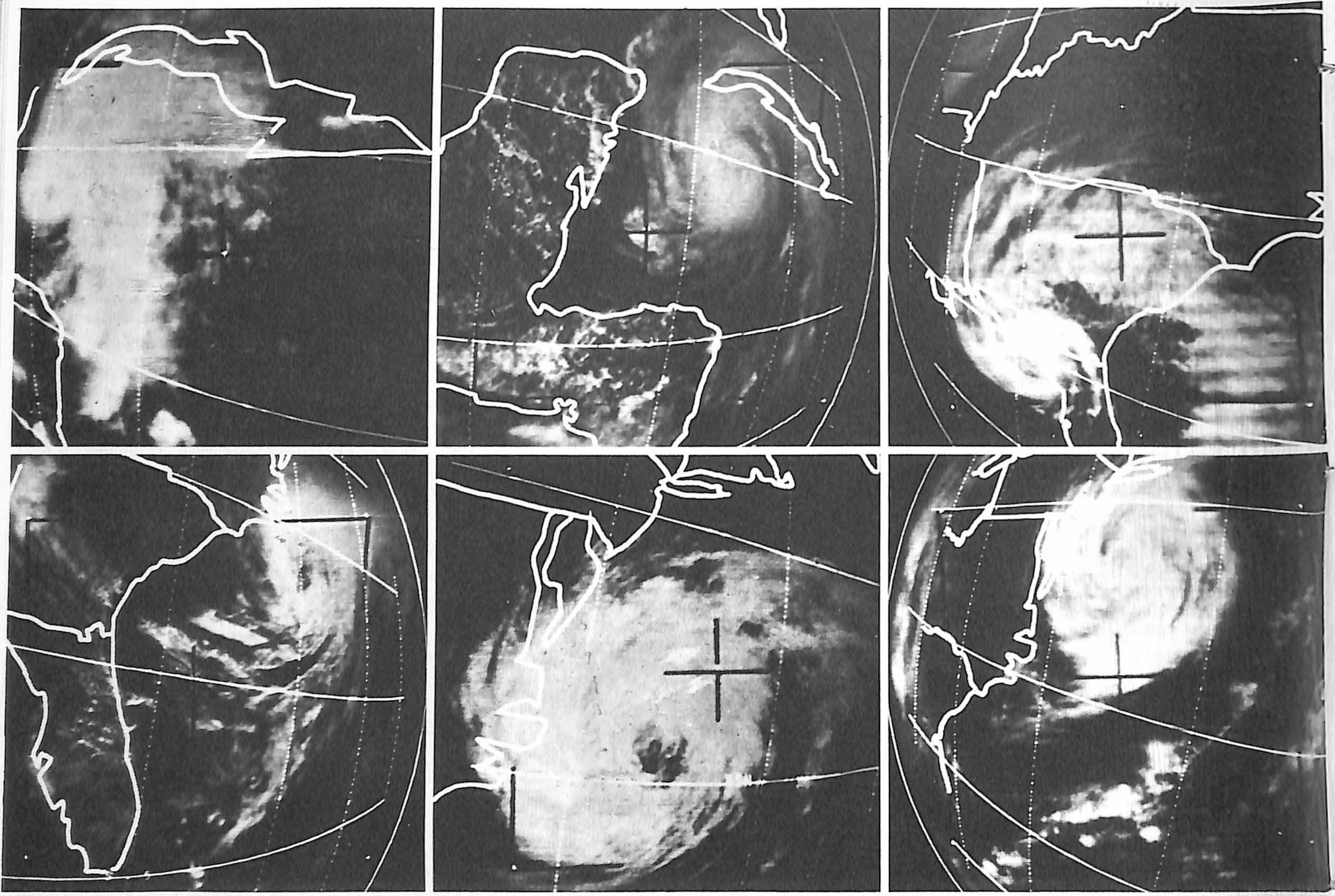
The Tiros series of experimental weather satellites was thus characterized by the late Dr. Hugh L. Dryden, then Deputy Administrator of the National Aeronautics and Space Administration. The characterization applies equally to the Essa series and to Nimbus advanced meteorological satellites.

Often called "Hurricane Hunters" or "Weather Eyes," meteorological satellites were originally an Army research and development project which was transferred to NASA in 1958 when the space agency came into being.

Purpose of the project was to demonstrate that satellites equipped with television cameras — and some with infrared ray sensors — could photograph the earth's cloud patterns from orbits several hundred miles in space. The pictures would then be transmitted to ground stations, theoretically with enough clarity to aid meteorologists in predicting weather trends.

On April 1, 1960, the space agency launched the first weather satellite into an orbit crisscrossing the earth's tropical and temperate zones every day. Within hours, NASA ground stations were receiving surprisingly good photos of cloud masses. Keyed to the land and sea areas over which the clouds moved, the pictures were fed into the U. S. Weather Bureau's analysis system. They were integrated with information gathered

Infrared pictures taken by a Nimbus weather satellite, shown in an artist's conception, reveal cloud heights and surface temperatures. Heat emitted is measured by infrared, and the satellite can determine cloud heights with an accuracy of 1,000 feet and surface temperatures within 2 degrees Fahrenheit.



Essa 1 weather satellite photographed the life cycle of Hurricane Alma as it was born in the western Carribean south of Cuba (top left); grew into a tropical storm near the Yucatan Channel and matured into a full fledged hurricane as it neared Cuba (top middle); swept into the Florida panhandle with winds up to 100 mph (top right); lost energy and again became only a tropical storm as it passed over the southeastern U. S. into the Atlantic (bottom left); turned north and moved up the Atlantic coastline (bottom middle); finally turned northeast and died out after brushing the Atlantic seaboard (bottom right).

by balloons, rockets, aircraft, and other established means for sampling weather make-up and trends. Especially useful were photos from vast oceanic regions where tropical storms may breed and build up for days before they are detected by ships or aircraft. Thus, the first Tiros proved beyond doubt that weather satellites could improve forecasts for air and sea traffic scheduling — civil and military — and greatly aid in general-purpose weather predictions.

That has been the story of weather satellites ever since.

To date, Tiros, Nimbus, and Essa satellites have transmitted to ground stations some 600,000 excellent cloud-formation pictures, pinpointing and tracking practically every major storm since Tiros I orbited. The photos have been used to construct over 20,000 cloud maps for daily weather reports and predictions. Satellite information has enabled the U. S. Weather Bureau to issue more than 2,500 special storm bulletins.

As a spectacular example, in September 1961, Tiros III located Hurricane Carla brewing in the Caribbean, traced the storm as it veered into the Gulf of Mexico, then signaled that the hurricane would strike the coastal lowlands of East Texas and Louisiana. This afforded ample time to evacuate some 500,000 people before the storm struck the area.

Winds as high as 135 miles per hour swept storm tides inland. Carla raged far into Texas, then swerved into Oklahoma and northward. Flanked by tornadoes, the hurricane was accompanied by torrential rains and flash floods.

Tiros III closely tracked and reported on the storm until it blew out over the Great Lakes. The Army Corps of Engineers estimated property damage at nearly the half-billion dollar mark. But thanks to timely mass evacuation, the death toll from Carla was held to 46.

Another great hurricane that devastated the Texas-Louisiana coastal area in September 1900 killed 6,000 persons. The U. S. Weather Bureau gives Tiros III much of the credit for the speed with which early warnings of Carla could be broadcast.

By mid-May 1966, 14 American weather satellites had been orbited. Each was a technological step forward in equipment or operations.

The first two Essa satellites went into service on February 3 and 28, 1966. Like the 10 Tiros satellites that preceded them, each Essa is about the size and shape of a bass drum and is studded with silicon solar cells which convert sunlight to electricity for operating the onboard photographic and transmitting equipment. Both Essa I and II, launched from Cape Kennedy, Florida, roll like cartwheels in trans-polar orbits that circle the earth every 100 minutes at altitudes of about 500 miles to nearly 900 miles.

Essa I stores its cloud photographs on tape, then plays them back on command from ground stations at Fairbanks, Alaska, and Wallops Station, Virginia. Essa II features the Automatic Picture Transmission system (APT) which, as the satellite passes above, enables meteorologists anywhere on the globe to receive local cloud pictures with relatively simple and inexpensive equipment. So far, 150 APT ground units are operating in this country and abroad.

The Essa system is entirely funded and operated by the Environmental Science Service Administration (of which the U. S. Weather Bureau is part) of the Department of Commerce. As with the Tiros series, Essa satellites are constructed by Radio Corporation of America, as prime contractor, under the direction of NASA's Goddard Space Flight Center as agent for the Environmental Science Service Administration. Similarly, NASA was reimbursed for launching the Essa satellites which were boosted into orbit by Delta rockets, built by Douglas Aircraft Company.

Even more advanced weather satellites are in the offing. NASA is studying a larger, more versatile Tiros-Essa. Meanwhile, the space agency has made substantial progress with Project Nimbus.

Nimbus differs radically in design from the Tiros-Essa series. It is approximately three times heavier, weighing as it does more than 900 pounds. Nimbus resembles a buoy from opposite sides of which are expanded wings, or "paddles," plated with solar cells to furnish power in space.

The first Nimbus, fired in August 1964, survived a faulty launching and worked for 26 days before its control system broke down. Even so, this advanced NASA experimental satellite transmitted 27,000 cloud pictures that were highly useful to the Weather Bureau.

Nimbus II was launched May 14, 1966, from the Western Test Range, Lompoc, California, into a polar orbit. Six days later NASA officials announced that its performance was exceeding all expectations. It was transmitting to NASA ground stations extremely high-quality pictures from a battery of television cameras. In addition, infrared photo-sensing devices were providing thousands of nighttime cloud images almost as clear as pictures taken in full sunlight. Nimbus II was providing this information from earth's dark side via the Automatic Picture Transmission system.

NASA's prime contractors for Nimbus satellites are RCA and General Electric. Nimbus I and II were lofted into orbit by Thor-Agena rockets for which Douglas and Lockheed Aircraft Corp. were prime contractors.

In the brief space of six years, U. S. weather satellites have proved that, as they evolve, mankind will benefit enormously. For example, the National Academy of Sciences has estimated conservatively that weather satellites will save $2.5 billion a year for American farmers, fuel producers, public utilities, builders, and water managers within the very near future. This amounts to approximately half the present annual cost of the national program for the peaceful use of space.

American weather satellites comprise an outstanding example of bringing the technological potential of the United States into being and putting it to work not only for our own well-being but for that of other nations.

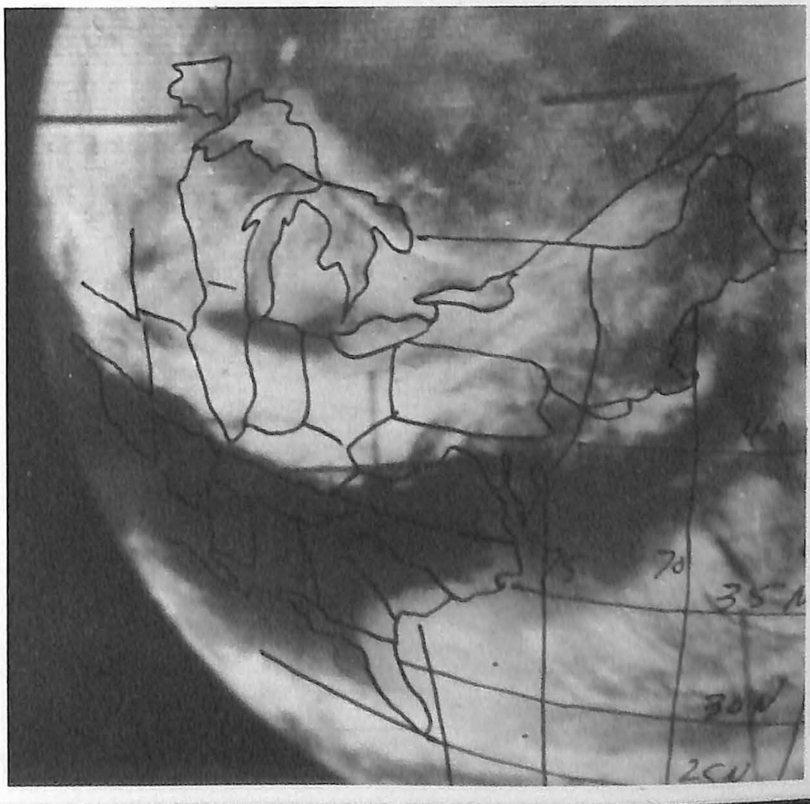
NASA and Weather Bureau satellites have discovered and tracked meteorological disturbances and made it possible to report them promptly around the world to the great advantage of fisheries on both sides of the Atlantic and Pacific.

Information from U. S. weather satellites has several times alerted the people of North Africa and Arabia to the approach of great sandstorms. Similarly, weather satellites have charted the onset of monsoon rains upon which depend the crops of Southeastern Asia. In both Southern and Northern Hemispheres, weather satellite reports on sea ice and ice conditions in waterways such as the St. Lawrence and the Great Lakes are saving hundreds of thousands of dollars annually by reducing the need to send out observation planes and ice breakers.

At present, 24- to 36-hour weather forecasts that will stand up reasonably well are received thankfully the world over. Authorities on meteorology and on the potentials of weather satellites have recently been saying that we are on the brink of a major breakthrough in forecasting. NASA's chief of space sciences and applications, Dr. Homer Newell, earlier this year gave this opinion to a subcommittee of the House Space Committee:

"Science believes that, with the aid of high speed computers, and these global satellite observations, it will be possible to extend forecast capability to as much as two weeks in advance."

Tiros IX weather satellite took this picture of a storm over the northern part of the U. S. Map overlay was drawn by a computer from telemetry signals received from the spacecraft.



Police officers in Lakewood, Calif., are never more than 150 seconds away from the scene of any crime through utilization of a day-night helicopter patrol that supplements conventional police cars. Lakewood, which has been policed by deputies of the Sheriff of Los Angeles County on a contractual basis for the past 12 years, is the first community in California — and in the U. S. — to have round-the-clock helicopter police patrol. ■ This 12-month experiment in advanced police technology — Project Sky Knight — is a joint project of Lakewood and Sheriff Peter Pitchess, with financial aid from the President's Office of Law Enforcement Assistance. Hughes Tool Company is providing, at cost, three of its Model 300, two-seat helicopters for the program. The helicopters are fitted with radio, camera, lighting and other police gear. ■ Sheriff Pitchess' Department, which polices the more than 4,000 square mile area of Los Angeles County, has been flying 'copters for patrol, search, surveillance and rescue missions for more than a decade. However, this is the first time that helicopter patrol has been employed to help police a single community day and night. ■ "The helicopter will never be more than two and a half minutes away from any part of the city and we believe they will prove to be invaluable deterrents to criminal activity," said Chief Hugh McDonald, head of the Sheriff's Technical Services Division. ■ Lakewood Mayor William Burns reported that businessmen and home owners have been encouraged to install flashing lights on rooftops that can be activated by a simple switch. The 'copter pilots and observers can see the lights day or night and can coordinate pursuit and capture of any criminal suspects. ■ "We believe it will be virtually impossible for a suspect to escape from the scene of any crime," the Mayor said. "The helicopters can trail a suspect, hover above him and direct ground patrols or — if necessary — actually participate in the apprehension of a suspect." ■ Courtney Evans, director of the Office of Law Enforcement Assistance in Washington, D. C., said law officers around the world will be paying close attention to Project Sky Knight. "We believe this is one of the most progressive law enforcement projects ever undertaken. It is perhaps the most dramatic support a patrolman has ever received since 1929 when radio-equipped patrol cars were introduced," he said.

'COPTER CRIME CONTROL

Patrol car officers compare notes with officer in a helicopter in a demonstrati of newest law enforcement techniq

Sheriff Peter Pitchess of Los Angeles County flies as an observer on one of the day-night helicopter patrols.

Helicopter pilots team with deputies of the conventional automobile patrol in checking map of Lakewood, Calif.

Officer aims a high intensity light which at night will light an area about as big as a football field.


HUGHES
N9456F
SHERIFF

AEROSPACE COMMENTS

General J. P. McConnell
Chief of Staff, United States Air Force
before the Commissioning Exercises
University of Arkansas

"We are a nation with extensive military commitments around the globe. It is obvious that if we are to honor these commitments, we must be able to deploy large military forces rapidly to overseas areas and supply them for extended periods of time. Since 1961, we have more than doubled our airlift capacity with the introduction of the C-135, the C-130E, and the C-141 into the Military Airlift Command.

"One of the most significant developments in Vietnam has been the sharply increased dependence of the military on in-country airlift. Original estimates were that surface transportation could handle approximately 65 percent of our in-country deliveries. We soon discovered these estimates to be way off the mark. At present more than three-fourths of the task of in-country delivery is done by airlift.

"Apart from their primary importance in meeting our military requirements, the air facilities that are being developed in Vietnam and throughout Southeast Asia will undoubtedly prove in later years to be of tremendous importance to the economic development of that area. In the long run, airlift coupled with U.S. civic action programs in both South Vietnam and Thailand may be our most significant contribution to a lasting peace in Southeast Asia."

Congressman Clement J. Zablocki
before the 81st Anniversary of Flag Day
at Stony Ridge School House, Fredonia, Wis.

". . . I believe that the United States can no more turn its back on space than could Christopher Columbus and those who followed choose to ignore America once it was discovered.

"This does not mean that we must undertake every conceivable project in space, or that we must attempt to accomplish everything at once.

"It means, rather, that outer space is the 'new world,' the 'new Frontier' for our Nation. We must continue on with the tasks we have begun.

"To do less is to relinquish our place as the leading nation on earth.

"Our nation once before failed to marshal all necessary resources in an exploration project. I am referring to the exploration of Antarctica.

"Admiral Byrd and the others who accompanied him accomplished their missions with only meager resources. Interest in the "White Continent" was low among our government officials.

"As a result, other nations'— including the Soviet Union — have done far more complete explorations, have accomplished far more in the search for minerals and oil than the United States.

"This should be a lesson to us. When we fail to make our best effort, other nations will seize the lead.

"If the United States is second in space, the ramifications could have far-reaching, historic effects."

H. M. Horner, *Chairman*
United Aircraft Corporation
before the National Association of Manufacturers
Symposium on Industrial Science and Technology

"In my own company (United Aircraft Corporation), back in 1959 we started an advanced concept engine development with company funds. This wasn't just a paper design. Operational hardware was involved. This development was later picked up by the Navy for the Missileer project which was subsequently cancelled. However, the engine concept was then chosen in a somewhat modified form for the F-111 and the A-7A, two of our more advanced and important weapons systems today.

"In the late 1940s, scientists at our Research Laboratories, using company funds, were engrossed in studying hydrogen as a possible propellant. Hydrogen was mighty powerful stuff, tricky and untamed. Hadn't it brought the Hindenburg to a fiery end? Yet, knowledge extracted from that basic research some two decades ago laid the base for subsequent work that has given us a practical hydrogen-fueled rocket engine today. That rocket engine, the RL10, has never failed in flight, a really remarkable record for such a radically advanced power concept.

"Those scientists who began studying hydrogen combustion two decades ago were thinking of a new fuel for a man-carrying airplane within the earth's atmosphere, and I doubt that any one of them thought their work would lead to the powerplant that would some day send a space vehicle to the moon. But the RL10 did just that. It propelled the Centaur space vehicle in a flight that soft-landed the Surveyor instrument package on the lunar surface to pave the way for our Apollo astronauts.

"I cite these examples to emphasize the important contributions that can be made by industry and to express the opinion that such contributions should be encouraged and not suppressed.

"I am of the opinion that the government-industry relationship in R&D projects should be more of a partnership as opposed to a master-slave concept. I believe that to accomplish this objective, industry must have more independence in its R&D endeavors.

"To do this, I feel sure that more company-controlled R&D funds are essential.

"To make possible these additional company-controlled funds, the government must assume a broad-gauge approach to cost disallowances and profitability in all contracts with industry.

"I remain convinced that by using this approach we can do a better job in R&D in the remaining years of the 20th century, do it faster and do it at less overall cost."

Stuart G. Tipton, *President*
Air Transport Association
before the International Aviation Club

". . . some of the experts who try to predict airline growth have recently been wrong by a factor of 2 and this year are wrong by a factor of 3. For example, in 1964, many observers agreed that an annual rate of increase in passenger miles of seven percent could be expected for U. S. domestic airlines. The increase this year so far is over 24 percent compared to the traffic in the first half of last year. This expansion in turn is built on increases of 15 and 18 percent in the two previous years. The predictions of only two years ago are thus being proved wrong by more than a factor of 3. Fortunately for the public, airline managements have geared up for a far more optimistic expansion of capacity than many experts thought would be required.

"A major factor in this extraordinary upsurge in domestic traffic is the freedom from capacity restrictions on domestic routes. Capacity provided and improvement in quality of the service reflect the business judgments of vigorous competitors on the market opportunities available. Given large additions to capacity, airlines mount massive efforts to sell additional seats. The ready availability of capacity results in a convenient service. Thus plenty of capacity is in itself a creative force resulting in faster traffic growth, better service to the public and higher profits. A restrictive attitude toward capacity is the most effective means of depressing both growth and profits.

"In practice, restriction of capacity in such a dynamic industry leads not only to underestimating the public's readiness to use air service but also holds up the level of fares unnecessarily. It is interesting to contrast the level of fares charged on domestic U. S. airlines, where there are no capacity restrictions, with intra-European fares. Many of the European markets are shared according to pre-arranged capacity agreements. For typical 200 and 300 mile stage-lengths, for example, U. S. domestic jet coach fares are 40 percent lower than intra-European; for a typical 700 mile stage-length, the U. S. fare is 33 percent lower; for a 900 mile stage-length, it is 34 percent lower.

"We are so accustomed to large figures on airline growth that we do not see them in any perspective. The basic trend since 1950 is a dramatic one. Revenues rose from $1.5 billion in 1950 to $9.3 billion in 1965."

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- Aerodex, Inc.
- Aerojet-General Corporation
- Aeronca Manufacturing Corporation
- Aeronutronic Division, Philco Corporation
- Aluminum Company of America
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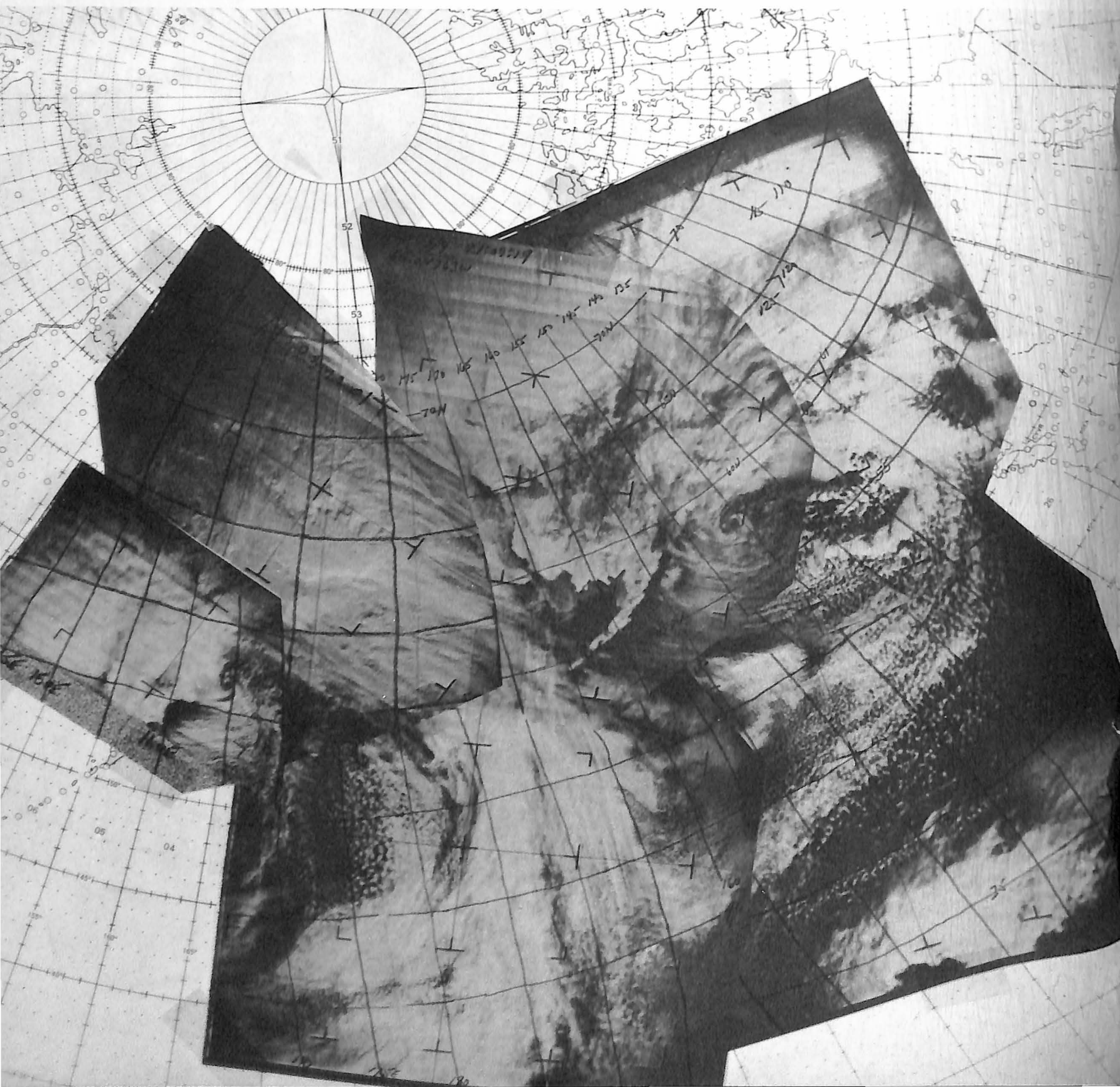
Essa II automatic picture transmission (APT) produced photos of western Canada, the Bering Sea, Gulf of Alaska and extreme eastern Siberia. (See *Eyes on the Weather,* page 10).



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